INVITATION FOR BID

Construction

B23-103CA

Date issued: August 16, 2023

FAIRFAX FULL SPECTRUM DETENTION AND WATER QUALITY POND

THE CITY OF COLORADO SPRINGS

CDOT Project No: STM M240-170
CDOT Project Code: 22178

The City of Colorado Springs hereby solicits Fixed Unit Price (FUP) Bids, as detailed in this Invitation For Bids (IFB), for the construction of a Full Spectrum Pond, Fairfax Tributary Basin at Powers & Research.

This IFB is posted to Rocky Mountain E-Purchasing BidNet Direct and the City of Colorado Springs' Procurement Services Website. It is available for all vendors free of charge, following free registration, at the Rocky Mountain E-Purchasing BidNet Direct website.

SUBMITTALS FOR THIS PROJECT WILL ONLY BE ACCEPTED ON THE ROCKY MOUNTAIN E-PURCHASING BIDNET DIRECT PLATFORM.

Please login to the following website to register (Free Registration) to submit a bid for this project. All required documents will be uploaded to the website.

https://www.bidnetdirect.com/

BIDNET Support

800-835-4603

Estimated Project Magnitude: $1,500,000 - $2,000,000

SECTION I – BID INFORMATION

1.0 BID INFORMATION

Section I provides general information to potential Bidders, such as bid submission instructions and other similar administrative elements. This Invitation for Bid (IFB) is available on BidNet (www.bidnetdirect.com). All addenda or amendments shall be issued through BidNet and may not be available through any other source.

1.1 SPECIAL TERMS

Please note the following definitions of terms as used herein:

The term "City" means the City of Colorado Springs.

The term "Contractor" or "Consultant" means the Bidder whose offer is accepted and is awarded the contract to provide the products or services specified in the IFB.

The term "Offer" or "Bid" means a bid submitted in response to this IFB.

The term "Offeror" or "Bidder" means the person, firm, or corporation that submits a formal bid or offer and that may or may not be successful in being awarded the contract.

The term "Project" refers to Fairfax Full Spectrum Detention and Water Quality Pond Project.

The term "Invitation for Bid" or "IFB" means this solicitation of formal, competitive, sealed bids from prospective bidders in which the intent is to award a contract to the resultant lowest responsible and responsive bidder.

1.2 BID ISSUE DATE

Invitation for Bid (IFB) Number B23-103CA is being issued and posted on www.bidnetdirect.com on August 16, 2023.

1.3 SUBMISSION OF BIDS

A. Bids are to be submitted electronically on BidNet Direct (www.bidnetdirect.com). Please review the submission requirements **well in advance** of submission date and time, and allow for ample time to upload each required document. It is recommended that Offerors begin the submission process at least one (1) day in advance of the proposal deadline.

   Offerors are solely responsible to ensure all required bid documents are uploaded and submitted correctly, and that a **confirmation number** is obtained upon successful submission. Customer support for BidNet Direct may be reached at (800) 835-4603.

B. Bids shall be received on or before: 10:00PM September 7, 2023. A public opening will be held via Microsoft Teams at that time. Web access and dial in information is below:

Microsoft Teams meeting

Join on your computer, mobile app or room device

Click here to join the meeting
Meeting ID: 287 432 368 903
Passcode: iGRgvw
Download Teams | Join on the web
Or call in (audio only)
+1 720-617-3426,,993962527# United States, Denver
Phone Conference ID: 993 962 527#
Find a local number | Reset PIN

C. Bid bond is required if total bid exceeds $50,000.00. (Also see 1.22)

D. The cost of Bid preparation is not a reimbursable cost. Bid preparation shall be at the Bidder's sole expense and is the Bidder's total and sole responsibility.

E. CDOT forms and submittals shall be submitted as follows:

1. All Bidders must submit the following forms. If these forms are not submitted, the bid will be considered non-responsive and shall be rejected.

    a. CDOT Form 606 – Anti-Collusion Affidavit
    b. CDOT Form 1413 – Bidders List
    c. CDOT Form 1414 – Anticipated DBE Participation Plan

2. The apparent low bidder must submit the following forms by 4:00PM the 5th business day after the bid opening.

    a. CDOT Form 605 - Contractors Performance Capability Statement
    b. CDOT Form 621 – Assignment of Antitrust Claims
    c. CDOT Form 1415 – Commitment Confirmation
    d. CDOT Form 1416 – Good Faith Effort Report

3. The following forms must be submitted after the award of the Contract.

    a. CDOT Form 1417 – DBE Participation Plan
    b. CDOT Form 1418 – Monthly Payment Summary
    c. CDOT Form 1419 – DBE Participation Report
    d. CDOT Form 1420 – DBE Participation Plan Modification Request

1.4 PRE-BID CONFERENCE

A pre-bid meeting will be held via Microsoft Teams at 1:30PM on August 22, 2023. This meeting is highly encouraged but not mandatory. Please use the link below to attend the meeting:

Microsoft Teams meeting

Join on your computer, mobile app or room device
Click here to join the meeting
Meeting ID: 258 768 553 21
Passcode: z8tRHd

Download Teams | Join on the web
Or call in (audio only)
+1 720-617-3426,,131738375# United States, Denver
Phone Conference ID: 131 738 375#
Find a local number | Reset PIN

1.5 LATE BIDS/LATE MODIFICATIONS OF BIDS

Bids, withdrawals or modifications of Bids received after the time set for opening, as designated in 1.3 above, are considered "late bids", and will not be accepted by the City, except as provided for in the City of Colorado Springs Procurement Rules and Regulations and approved by the Procurement Services Manager. Bidders are solely responsible for insuring their bids arrive on time and to the place specified in this Invitation for Bid.

1.6 MISTAKES IN BIDS - CONFIRMATION OF BID

If it appears from a review of a Bid that a mistake has been made, the Bidder may be requested to confirm its Bid in writing. Situations in which the confirmation may be requested include obvious, apparent errors on the face of a Bid or a Bid unreasonably lower than the other Bids submitted. All mistakes in Bids will be handled in accordance with the City of Colorado Springs Procurement Rules and Regulations**.**

1.7 PROCUREMENT RULES AND REGULATIONS

All formal IFBs advertised by the City of Colorado Springs are solicited in accordance with the City's Procurement Rules and Regulations. The City's Procurement Rules and Regulations can be reviewed and/or downloaded from the City's Procurement Services Division website at www.coloradosprings.gov. Any discrepancies or conflicting statements, decisions regarding bidding irregularities, or clarifications regarding clauses or specifications will be rectified utilizing the City's Procurement Rules and Regulations, when applicable. It is the Bidder's responsibility to advise the Contracts Specialist listed in this IFB of any perceived discrepancies, conflicting statements, or problems with clauses or specifications prior to the Bid opening date and time.

1.8 MINOR INFORMALITIES/IRREGULARITIES IN BIDS

A. A minor informality or irregularity is one that is merely a matter of form and not of substance. It also pertains to some immaterial defect in a Bid or variation of a Bid from the exact requirements of the invitation that can be corrected or waived without being prejudicial to other Bidders. The defect or variation is considered immaterial when the effect on price, quantity, quality, or delivery is negligible when contrasted with the total cost or scope of the goods and/or services being acquired.

B. If the City Procurement Services Division determines that a Bid submitted contains a minor informality or irregularity, then the Procurement Services Manager shall either give the Bidder an opportunity to cure any deficiency resulting from the minor informality or irregularity or waive the deficiency, whichever is to the advantage of the City. In no event will the Bidder be allowed to change the Bid amount. Examples of minor informalities or irregularities include but are not limited to the following:

    1. Bidder fails to sign the Bid, but only if the unsigned Bid is accompanied by other material

evidence, which indicates the Bidder's intention to be bound by the unsigned Bid (such as Bid security, or signed cover letter which references the Bid Number and amount of Bid).

2. Bidder fails to acknowledge an Amendment, although this may be considered a minor informality only if the Amendment, which was not acknowledged, involves only a matter of form or has either no effect or merely a negligible effect on price, quantity, quality, or delivery of the item or services bid upon.

1.9 REJECTION OF BIDS

The Procurement Services Manager has the authority to reject any Bid based on, but not limited to, the following:

A. Any Bid that fails to conform to the essential requirements of the Invitation for Bids shall be rejected.

B. Any Bid that does not conform to the applicable specifications shall be rejected unless the IFB authorizes the submission of alternate bids and the items or services offered as alternates meet the requirements specified in the IFB.

C. A Bid that fails to conform to the specified delivery schedule.

D. A Bid shall be rejected when the Bidder imposes conditions that would modify requirements of the IFB or limit the Bidder's liability to the City, since to allow the Bidder to impose such conditions would be prejudicial to other Bidders.

   For example, Bids shall be rejected in which the Bidder:

   1. Protects against future changes in conditions, such as increased costs, if total possible costs to the City cannot be determined. This includes failure to completely fill out required bid schedule.
   2. Fails to state a price and indicates that price shall be "price in effect at time delivery".
   3. States a price but qualifies it as being subject to "price in effect at time of delivery".
   4. Takes exceptions to the IFB terms and conditions.
   5. Inserts the Bidder's terms and conditions.
   6. Limits the rights of the City under any Contract/Invitation for Bid clause.

E. Any Bid in which the price is considered to be unreasonable or is over budget.

F. Any Bid if the prices are determined to be unbalanced.

G. Bids received from any person or contractor that is suspended, debarred, proposed for debarment, or under investigation for fraud, including failure to pay federal, state, local or city taxes.

H. When a bid guarantee is required and the bidder fails to furnish the guarantee in accordance with the requirements of the IFB.

I. Low Bids received from bidders who are determined to be non-responsible in accordance with the City's Procurement Rules and Regulations.

J. Any Bid that was prepared and submitted by a vendor who has been determined by the Procurement Services Manager to have an unfair advantage over other Bidders. Examples of an unfair advantage include, but are not limited to, the following:

1. A previous or prior employee who in the last six (6) months was directly involved in the design or specification preparation of the competed procurement.
2. A vendor who was directly involved in design or specification preparation of the competed project either for pay or voluntarily.

1.10 ESTIMATED QUANTITIES

If the Bid Form (Schedule A) herein contains estimated quantities, this provision is applicable. The quantities listed for each of the items in the Bid Form are only estimated quantities. Contractors are required to bid a firm unit price for each item specified. The actual quantities ordered may fluctuate up or down. The unit prices proposed by each Bidder will remain firm and will not be re-negotiated if the estimated quantities are not met or are exceeded. This clause will take precedence over any/all other estimated quantity clauses that conflict with this clause.

For bidding purposes, if there is a conflict between the extended total of an item and the unit price, the unit price shall prevail and be considered as the amount of the Bid. All unit prices shall include all necessary overhead and profit. Items not listed in the Bid Form such as overhead, profit, mobilization, de-mobilization, bonding, etc. shall be distributed throughout the Bidder's Unit Prices for the items listed on the Bid Form.

1.11 NUMBER OF COPIES

Bidders shall submit one electronic copy of each required document on the BidNet Direct Procurement Platform (www.bidnetdirect.com. Upon submission, all Bid documents shall become and remain the property of the City.

1.12 IDENTIFICATION OF BID

Bids must be submitted to the BidNet Direct Procurement Platform (www.bidnetdirect.com). The solicitation number and Offeror name must be clearly marked within the Bid.

Bid No.: B23-103CA
Due Date and Time: September 7, 2023 by 10:00AM

1.13 SALES TAX

The successful Offeror, if awarded a contract, shall apply to the Colorado Department of Revenue for a tax-exempt certificate for this project. The certificate does not apply to City of Colorado Springs Sales and Use Tax which shall be applicable and should be included in all bids and proposals. The tax exempt project number and the exemption certificate only apply to County, PPRTA (Pikes Peak Rural Transportation Authority), and State taxes when purchasing construction and building materials **to be incorporated into this project**.

Furthermore, the exemption **does not** include or apply to the purchase or rental of equipment, supplies or materials that **do not become a part of the completed project or structure**. In these instances, the purchase or rental is subject to full taxation at the current taxation rate.

The Offeror and all subcontractors shall include in their Offer City of Colorado Springs Sales and Use Tax on the work covered by the offer, and all other applicable taxes. Any increase in applicable sales or use tax occurring after the contract has been let shall be borne by the contractor and not passed through to the City.

Forms and instructions can be downloaded at the City of Colorado Springs Website:https://coloradosprings.gov/sales-tax. Questions can be directed to the City Sales Tax Division at (719) 385-5903 or Construction_SalesTax@ColoradoSprings.gov.

Our Registration Numbers are as follows:
City of Colorado Springs
Federal I.D.: 84-6000573
Federal Excise: A-138557
State Sales Tax: 98-03479

1.14 PREPARATION OF BID OFFER

A. Bidders are expected to examine the drawings, specifications, bid documents, proposed contract forms, terms and conditions, and all other instructions and solicitation documents. Bidders are expected to visit the job-site to determine all requirements and conditions that will affect the work. Failure to do so will not relieve a Bidder from their responsibility to know what is contained in this Invitation for Bid, or site conditions affecting the work.

B. The Bidder certifies that it has checked all of its figures and understands that the City will not be responsible for any errors or omissions on the part of the Bidders in preparing its Bid.

C. All items, (unless the invitation specifically states otherwise) including any additive or deductive alternates on the Bid Form, must be completely filled out or the Bid will be determined non-responsive and ineligible for consideration for award.

D. The Bidder declares that the person or persons signing this Bid is/are authorized to sign on behalf of the firm listed and to fully bind the Bidder to all the requirements of the IFB.

E. The Bidder certifies that no person or firm other than the Bidder or as otherwise indicated has any interest whatsoever in the Bid or the contract that may be entered into as a result of the Bid and that in all respects the Bid is legal and firm, submitted in good faith without collusion or fraud.

F. By submitting a Bid the Bidder certifies that it has complied and will comply with all requirements of local, state, and federal laws, and that no legal requirements have been or will be violated in making or accepting this Bid. Bidders are expected to review the City's Procurement Rules and Regulations, which will be used when determining whether a Bidder is responsive and responsible and awarding contracts in the best interest of the City.

G. If there is a discrepancy between the unit price and the total price, the unit price shall be used to determine the applicable total price. Bidders are responsible for including profit and overhead associated with the project when determining their unit prices.

1.15 BASIS OF AWARD

A. The City of Colorado Springs intends to award a contract to the lowest responsive and

responsible Bidder whose Bid meets the requirements and the criteria set forth in the Invitation for Bids and is determined to be in the best interest of the City.

B. The City reserves the right to reject any or all Bids and to waive informalities and/or irregularities in a Bid. Whether or not a contract is awarded as a result of this Invitation for Bid, as stated above, Bid preparation costs are not reimbursable.

C. Total Bid will be evaluated and awarded as follows: It is the City's intent to award this bid based on the TOTAL BASE BID, not on a line item by line item basis.

1.16 PERIOD OF ACCEPTANCE

The Bidder agrees that its Bid shall remain open for acceptance by the City for a period of sixty (60) calendar days from the date specified in the IFB for receipt of Bids.

1.17 CONTRACT AWARD

The signature of the Bidder indicates that within ten (10) calendar days from acceptance of its Bid, it will execute a contract with the City and, if indicated in this IFB, furnish a project specific Certificate of Insurance naming the City as Additional Insured, furnish Performance, Labor and Materials, Payment and Maintenance Bonds and any other documents required by the Specifications or Contract Documents.

1.18 NOTICE TO PROCEED

Work may not start under any awarded contract until a written notice to proceed is issued by the City. The City may issue the Notice to Proceed any time after the contract is signed and, if required, insurance and bonds have been provided in accordance with 1.22 below. After the contract is signed and, if required, insurance and bonds have been provided in accordance with 1.22 below, the City's Procurement Specialist will issue a 'Notice to Proceed' to the Contractor. The Contractor may then proceed to apply for permits, initiate sub-contracts, source materials, etc. as may be necessary to prepare for the work. Work may not start under any awarded contract until a pre-construction meeting has been held and a written 'Notice to Proceed to Construction' is issued by the Engineer.

1.19 AMENDMENTS TO THE SOLICITATION

Amendments are also referred to as addendum or addenda; and these terms shall be considered synonymous. It is the Bidder's responsibility to contact the Contracts Specialist listed in 1.21 below to confirm the number of Amendments which have been issued.

A. If this solicitation is amended, then all specifications, terms and conditions, which are not specifically amended, remain unchanged.

B. Bidders shall acknowledge receipt of any amendment to this solicitation by signing and returning the amendment and by identifying the amendment number and date in the space provided on the form for submitting a Bid.

C. Acknowledged amendments must be received prior to Bid opening. Bidders are encouraged to include signed addenda or initialed acknowledgment with returned Bids.

1.20 EXPLANATIONS TO PROSPECTIVE OFFERORS

Any prospective Bidder desiring an explanation or interpretation of the IFB documents, drawings, specifications, etc., must request it in writing within ten days of the Bid due date to allow enough time for a reply to reach all prospective offerors before the time for submission of offers. Oral explanations or instructions given before the opening of Bids will not be binding. Any information provided to a prospective Bidder during the Bid preparation stage will be promptly furnished to all other prospective Bidders as an amendment to the solicitation, if that information is necessary in submitting Bids or if the lack of it would be prejudicial to other prospective Bidders.

1.21 QUESTIONS AND OTHER REQUESTS FOR INFORMATION

All questions must be submitted electronically via the Bidnet Direct platform (www.bidnetdirect.com). All questions must be received no later than **3:00PM August 25, 2023**.

Requests for support shall be directed to:

CONTRACT SPECIALIST NAME: Crystal Abeyta
CONTRACT SPECIALIST EMAIL: crystal.abeyta@coloradosprings.gov

DO NOT CONTACT ANY OTHER INDIVIDUAL AT THE CITY OF COLORADO SPRINGS REGARDING THIS SOLICITATION.

1.22 SECURITY REQUIREMENTS

A. Bid Security

1. If the total amount of the accumulative Bid is more than $50,000, or a bond is required elsewhere in this IFB, the Bidder is required to furnish with their Bid a bid security in the form of a bank certified check, bank cashier's check or a one-time bid bond underwritten by a company licensed to issue bonds in the State of Colorado and acceptable to the City in an amount equal to at least 5% of the total amount of the Bid payable without condition to the City.
2. The Bid security shall guarantee that the Bid will not be withdrawn or modified for a period of sixty (60) calendar days after the time set for the receipt of Bids, and, if the Bid is accepted within those sixty (60) calendar days, that the person, firm or corporation submitting same shall within ten (10) calendar days after being notified of the acceptance of its Bid, enter into a Contract and furnish the required bonds and all insurance certificates called for under this Invitation for Bid.
3. The Bid bonds of unsuccessful Bidders will not be returned to the respective Bidders unless a self-addressed, stamped envelope is provided along with a written request for bid bond return. However, if a certified check or a cashier's check is submitted as Bid security, it will be returned as soon as possible after the lowest responsive and responsible Bidder is determined and a contract is executed.
4. In the event the Bidder whose Bid is accepted fails to enter into the contract and/or furnish the required contract bonds, its certified check, cashier's check or bid bond will be forfeited in full to the City.

B. Performance, Labor and Materials Payment, and Maintenance Bonds

1. For contracts in excess of $50,000, the Contractor shall furnish to the City each of the following: a Performance Bond, a Labor and Materials Payment Bond, and a Maintenance Bond. Each such bond shall be in the amount of one hundred percent (100%) of the contract price. Bonds shall be submitted within ten (10) calendar days after notification of award of a Contract. The cost of all bonds shall be included in Contractor's Bid.
2. Bonds shall:
    a. Be for the full amount of the Contract price.
    b. Guarantee the Contractor's faithful performance of the work under the Contract, and the prompt and full payment for all labor and materials involved therein.
    c. Guarantee protection to the City against liens of any kind.
    d. Be from a surety company operating lawfully in the state of Colorado and accompanied by an acceptable "Power-of-Attorney" form attached to each bond copy.
    e. Be issued from a surety company that is acceptable to the City.
    f. Be submitted using the forms in the Exhibit section of this IFB or such forms as are approved by the City Attorney's Office.

1.23 SPECIFICATIONS AND DRAWINGS

No Fee solicitations: Specifications and Drawings are normally included in the IFB. If Specifications and Drawings are too large to be included in the IFB, all interested Bidders may obtain one copy of the Project Specifications and a set of the Project Drawings for use in preparing Bids from the City Procurement Services Division office. If the Bidder requires additional sets, it is the Bidder's responsibility to duplicate any additional copies, at its own expense.

1.24 TYPE OF CONTRACT

As a result of this Invitation for Bids, it is the City's intention to award a fixed unit price Contract based on the prices offered by the lowest responsive and responsible bidder. Contract prices shall remain firm and fixed throughout the Contract performance period.

1.25 F.O.B. DESTINATION

Unless otherwise specified in the Invitation for Bid, all goods, materials, supplies, equipment or services covered by this IFB shall be delivered F.O.B. Destination shall be the location indicated in the awarded Contract or Purchase Order.

1.26 BID RESULTS

The City does not mail Bid results or tabulations. However, Bid tabulations are posted and can be downloaded from BidNet. Bidders submitting Bids in response to this solicitation may also request the Bid tabulation for this solicitation via email to the Contracts Specialist indicated as the point of contact for this solicitation.

1.27 APPROPRIATION OF FUNDS

A. In the event funds are not appropriated in whole or in part sufficient for performance of the City's obligations under this IFB, or appropriated funds may not be expended due the City Charter spending limitations, then the City, without compensation to Bidders, may terminate or cancel this IFB or not award any contracts under this IFB.
B. In accordance with the Colorado Constitution and City Charter, performance of the City's obligations under any resultant Contract will be expressly subject to appropriations of funds

by the City Council, and, in the event the budget or other means of appropriation for any year of the Contract fails to provide funds in sufficient amounts to discharge such obligations, such failure (i) shall act to terminate the Contract at such time as the then-existing and available appropriations are depleted, and (ii) neither such failure nor termination shall constitute a default or breach of the Contract, including any sub-agreement, attachment, schedule, or exhibit thereto, by the City.

1.28 PERIOD OF PERFORMANCE

The Contractor shall complete all work by **December 31, 2023**. The Contractor shall start work promptly after receipt of the Notice to Proceed and Pre-Construction Meeting and continue to work diligently until all work is completed and accepted by the City.

1.29 FUNDING

This project is being funded by a Federal-aid grant and the City of Colorado Springs.

1.30 DAVIS BACON WAGES

Davis Bacon wages APPLY to this solicitation.

1.31 DBE GOAL

This is a Federal-Aid construction project. As described in the CDOT DBE Standard Special Provision, the Bidder shall make good faith efforts to meet the following contract goal:

4% DBE Participation

1.32 ON THE JOB TRAINING

This project shall meet the CDOT OJT Standard Special Provisions and the Bidder shall meet the following OJT goal:

320 Hours On the Job Training

1.33 BID DOCUMENTS

The following comprise this Invitation for Bid.

Schedule A – Bid Form
Schedule B – General Construction Terms and Conditions
Schedule C – Scope of Work
Schedule D – General Project Special Provisions
Schedule E – Technical Project Special Provisions
Schedule F -- CDOT Revised Standard Special Provisions
Schedule G – Clauses for Contracts Subject to Federal Requirements
Schedule H – Construction Plan Set
Schedule I – 404 Permit
Schedule J – Geotechnical Report
Schedule K – Minimum Insurance Requirements
Schedule L – Exhibits

The following listed documents must be included with your Bid in order for your Bid submittal to be considered responsive.

Schedule A – Bid Form
Schedule K – Minimum Insurance Requirements Form
Exhibit 2 – Qualification Statement
Exhibit 3 – Bid Certification and Representations and Certifications
Exhibit 4 – Bid Bond if applicable (see 1.23)
Exhibit 5 – CDOT Forms
Exhibit 6 – Federal Forms
Acknowledged Addenda, if issued

SECTION II – SCHEDULES

Schedule A – Bid Form
Schedule B – General Construction Terms and Conditions
Schedule C – Scope of Work for Fairfax Full Spectrum Pond
Schedule D – General Project Special Provisions
Schedule E – Technical Project Special Provisions
Schedule F – CDOT Revised Standard Special Provisions
Schedule G – Clauses for Contracts Subject to Federal Requirements
Schedule H – Construction Plan Set
Schedule I – 404 Permit
Schedule J – Geotechnical Report
Schedule K – Minimum Insurance Requirements
Schedule L – Exhibits

SCHEDULE A – BID FORM

Please Fill Out and Submit Excel Version of Schedule A – Bid Form Uploaded in Bidnet (www.bidnetdirect.com)

SCHEDULE B – GENERAL CONSTRUCTION TERMS AND CONDITIONS

Schedule B -- General Construction Terms and Conditions, Version 100316 are hereby incorporated by reference, with the same force and effect as if they were given in full text. Upon request, the City will make their full text available. Also, the full text of a clause may be accessed electronically at this address:

https://www.coloradosprings.gov/finance/page/procurement-regulations-and-documents

The referenced General Construction Terms and Conditions will be incorporated in the resultant Contract.

SCHEDULE C – SCOPE OF WORK

The work to be done by the Contractor shall consist of the work described below and performing all operations necessary for the construction of this work as described in the plans and specifications, including restoration of all areas disturbed by the construction activities in accordance with the specifications.

The project consists of constructing a new full spectrum detention and water quality pond. Work includes, but is not limited to, construct concrete trickle channels, two concrete forebays with impact stilling basins, an outlet structure, maintenance access roads, and a soil riprap spillway. Work also includes removal of existing riprap, inlets, RCP and plastic storm sewer pipe, and onsite earthwork. The project is located on the northwest corner of SH 21 (Powers Boulevard) and Research Parkway. The project is a partner project to the recently completed Powers and Research Interchange Project. As a result, the pond was rough graded by the Interchange Project.

SCHEDULE D – GENERAL PROJECT SPECIAL PROVISIONS

SPECIFICATIONS

Standard Construction Specifications for this project shall be the City of Colorado Springs; Engineering Division "Standard Specifications" revised March 2005, and the Colorado Department of Transportation (CDOT) "Standard Specifications for Road and Bridge Construction" adopted in 2022 and as hereinafter modified.

The City of Colorado Springs; Engineering Division "Standard Specifications" revised March 2005 shall prevail over any conflicting provisions of the CDOT "Standard Specifications for Road and Bridge Construction", except as noted in the project special provisions.

The CDOT Standard Special Provisions revise and prevail over the 2022 CDOT "Standard Specifications for Road and Bridge Construction".

The Project Special Provisions prevail over the CDOT Standard Special Provisions and the 2022 CDOT "Standard Specifications for Road and Bridge Construction" and City of Colorado Springs; Engineering Division "Standard Specifications"

DETAILS

Details contained in the Plans prevail over City of Colorado Springs standard details and CDOT standard details.

Details for items in the City of Colorado Springs standard details shall prevail over any conflicting CDOT details, expect as noted in the plans or specifications.

The edition as noted in the CDOT M&S Standard Plans List contained in the plans shall be utilized when CDOT Standard Plans are referenced.

DESCRIPTION OF WORK

The work to be done by the Contractor shall consist of the work described below and performing all operations necessary for the construction of this work as described in the plans and specifications, including restoration of all areas disturbed by the construction activities in accordance with the specifications.

The project consists of constructing a new full spectrum detention and water quality pond. Work includes, but is not limited to, construct concrete trickle channels, two concrete forebays with impact stilling basins, an outlet structure, maintenance access roads, and a soil riprap spillway. Work also includes removal of existing riprap, inlets, RCP and plastic storm sewer pipe, and onsite earthwork. The project is located on the northwest corner of SH 21 (Powers Boulevard) and Research Parkway.

The project is a partner project to the recently completed Powers and Research Interchange Project. As a result the pond was rough graded by the Interchange Project. This project uses the proposed contours from the Interchange Project as the existing contours. We anticipate some discrepancies between the proposed grading design and actual grading that was completed, therefore as a part of the work the contractor will be required to perform a pre-project topographic survey of the project site and submit the CAD file to the Engineer.

DRAINAGE AND EROSION CONTROL

The Contractor shall provide for the drainage of storm water and such water as may be applied or discharged on the site in performance of the work. Drainage facilities shall be adequate to prevent damage to the work, the site and adjacent property.

The Contractor shall prevent the pollution of drains and watercourses by sanitary waste, sediment, debris or other substances resulting from this work. The Contractor shall be required to clean up and isolate such materials on a continuing basis to prevent risk of washing into such drainage ways.

The Contractor shall obtain a copy of and follow the language of the MS4 permit and all other state and local permits.

For specific items of work, the Erosion Control Specifications shall be the “COLORADO DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION”, 2022. Additional information is included in the technical specifications and plans.

WORK SITE RESTRICTIONS/PERMITS

The Contractor shall confine the work activities to the area shown in the construction drawings. The Engineer will furnish the contractor with copies of all executed ROW and easement documents for the project. The established work zone shall be marked and secured with an appropriate fence. Approved temporary fences are required at all locations that require removal of an existing fence. Temporary fences are to be considered incidental to the work and will not be paid for separately. Temporary easements on private property are not to be used for stockpiling or storage of materials or equipment. Any additional work area required within adjoining private properties must be acquired by the Contractor by written permission from the property owner. The Contractor shall restore any damage or disruption to other properties utilized in the performance of this project to an equal or better than pre- construction condition at no cost to the City. The Contractor shall hold the City harmless from any claims to damage or disruption of private property.

Contractor personnel shall not unnecessarily enter upon private property without the express written consent of the landowner. The Contractor shall provide the Engineer with a copy of the written permission. The City will be held harmless of Contractor negligence in matters of trespassing.

There is a 404 permit for this project. The Contractor shall comply with the stipulations identified in the permit.

1. USACOE Nationwide Permit 43 (NWP43) Verification – Action No. SPA-2019-00278-SCO, Fairfax Pond Project, Colorado Springs, Colorado

There is a CDOT Special Use Permit in place for this project. The Contractor shall comply with the stipulations identified in the permit.

SOIL CONDITIONS

The Contractor assumes all risks connected with the surface and subsurface conditions actually encountered in performing the work even though such actual conditions may result in the Contractor performing more or less work than originally estimated.

The Contractor shall perform whatever independent exploratory excavations and tests deemed as necessary to determine the site conditions.

The Contractor shall utilize all suitable excavated material as approved by the Engineer for raising grades and backfilling the new construction. Additional imported material shall be a well graded non-expansive inorganic soil or as herein after specified.

There is a geotechnical report for this area.

1. Final Geotechnical Engineering Study Proposed Interchange at Research Parkway and Powers Boulevard, Colorado Springs, Colorado, dated June 9, 2020, by Kumar & Associates, Inc.

UTILITIES

The following utility companies are believed to have facilities within or near the project limits:

UTILITY	CONTACT/EMAIL	PHONE
Academy School District 20	Scott Harrison Scott.Harrison@asd20.org	719-234-1478
Colorado Springs Parks	Kiev Andrassy Kiev.Andrassy@coloradosprings.gov	719-491-3491
Colorado Springs (CS) Traffic	Bryan Curtis Bryan.Curtis@coloradosprings.gov	719-385-7611
Colorado Springs Utilities (Gas. Electric)	Dylan Quintana Dquintana@csu.org	719-668-8330
Colorado Springs Utilities (Elec. Transmission) (ELT)	Sarah Labarre Slabarre@csu.org	719-668-4993
Colorado Springs Utilities (Fiber)	Chance Daves cdaves@csu.org	719-668-3913
Colorado Springs Utilities (Water/Sanitary)	Adam Baker Abaker@csu.org	719-668-8251
Comcast	Tod Bell Tod_Bell@comcast.com	719-442-4733
Lumen (formerly CenturyLink)	Nicholas Reed Nicholas.Reed@Lumen.com	719-650-3200
Lumen (Terra Tech)	Robert McCleod Rmcleod@terratechllc.net	630-267-6711

In no way shall the contents of this utility specification contradict the City of Colorado Springs Standards and Criteria. Any discrepancies identified by the Contractor shall be brought to the attention of the Project Engineer for clarification and resolution. All construction work shall adhere to the best practices and guidelines mandated by the City of Colorado Springs.

All utility installations within CDOT Right of Way (ROW) shall be collected using CDOT's mobile application (PointMan). Please contact CDOT at cdotpointman@gmail.com to obtain new login and password information, if required. Download the PointMan mobile application through the Apple Store (iOS) or Google Play (Android). Finally, please watch the following quick start guide; the video can be found at the following link: https://youtu.be/X-tMvnK7vZw.
All new underground facilities, including laterals up to the structure or building being served, installed as part of this project must be electronically locatable when installed, in compliance with Colorado Revised Statutes, Title 9, Article 1.5**PART 1 – THE CONTRACTOR SHALL PERFORM THE WORK LISTED BELOW:**

Coordinate project construction with performance by the utility owner of each utility work element listed in Part 2 below. Perform preparatory work specified in Part 2 for each utility work element. Provide an accurate construction schedule that includes all utility work elements to the owner of each impacted utility.

Provide each utility owner with periodic updates to the schedule. Conduct necessary utility coordination meetings and provide other necessary accommodations as directed by the Engineer. Notify each utility owner in writing, with a copy to the Engineer, before the time each utility work element is to be performed by the utility owner. Provide a notice, as specified in Part 2, immediately before the time the utility work must begin to meet the project schedule.

Provide traffic control, as directed by the Engineer, for any utility work performed by the utility owner within the project limits expected to be coordinated with construction. However, traffic control for utility work outside of typical project work hours shall be the responsibility of the utility owner.

Perform each utility work element for every utility owner listed in Part 1. Notify each utility owner in advance of any work being done by the Contractor to its facility so that the utility owner can coordinate its inspections for final acceptance of the work with the Engineer. Obtain written approval from the utility owner for work performed by the Contractor.

All Utility Companies

The Contractor shall contact each utility company a minimum of two business days, unless otherwise noted, before working in the vicinity of the utility company's facilities so that the utility company can provide an inspector and complete any necessary adjustments or relocations.

If a need for utility work by either the Contractor or a utility company arises, the following shall apply:

> The Contractor shall coordinate the adjustment of utilities on this project. The Contractor shall keep each utility company advised of any work being performed in the vicinity of their facilities so that each utility company can coordinate any needed locates, adjustments, or inspections. The contractor shall provide the appropriate utility company ample notice, but not less than two (2) weeks, before commencing activities in the vicinity of their facilities. Any additional work performed by the Contractor on behalf of the impacted utility company shall not be paid for by the City but shall be paid by the utility company requiring the work unless otherwise agreed to in writing by the Engineer.

Project Limits – All Utility Owners

The Contractor shall identify existing utilities by potholing and protecting the existing buried utilities when constructing the project, including sub-excavation work. If existing utilities are within close proximity horizontally or vertically, the Contractor shall alter the sub-excavation work limits, construction methods, or equipment to avoid impacting existing utilities.

Academy School District 20 – The Contractor shall protect in place all Academy School District 20 facilities. The Contractor shall notify the owner 7 days in advance of work near facilities.

Colorado Springs Parks - The Contractor shall protect in place all Colorado Springs Parks facilities. The Contractor shall notify the owner 7 days in advance of work near facilities.

Colorado Springs (CS) Traffic - The Contractor shall protect in place all Colorado Springs Traffic facilities. The Contractor shall notify the owner 7 days in advance of work near facilities.

Colorado Springs Utilities (Gas. Electric)-The Contractor shall protect in place all Colorado Springs Utilities facilities. The Contractor shall notify the owner 7 days in advance of work near facilities.

Colorado Springs Utilities (Elec. Transmission) (ELT) The Contractor shall protect in place all Colorado Springs Utilities facilities. The Contractor shall notify the owner 7 days in advance of work near facilities.

Colorado Springs Utilities (Fiber)- The Contractor shall protect in place all Colorado Springs Utilities facilities. The Contractor shall notify the owner 7 days in advance of work near facilities.

Colorado Springs Utilities (Water/Sanitary) - The Contractor shall protect in place all Colorado Springs Utilities facilities. The Contractor shall notify the owner 7 days in advance of work near facilities.

Comcast - The Contractor shall protect in place all Comcast facilities. The Contractor shall notify the owner 7 days in advance of work near facilities.

Lumen (formerly CenturyLink) - The Contractor shall protect in place all Lumen facilities. The Contractor shall notify the owner 7 days in advance of work near facilities.

PART 2 - UTILITY OWNERS SHALL PERFORM THE WORK LISTED BELOW:

Although the Contractor shall provide traffic control for utility work expected to be coordinated with construction, traffic control for utility work outside of typical project work hours or outside of project limits shall be the responsibility of the utility owner. The utility owner shall prepare and submit to the Engineer a Method of Handling Traffic for utility work to be performed outside typical project work hours or project limits. The utility owner shall obtain acceptance of the Method of Handling Traffic from the Engineer before beginning the utility work to be performed outside typical project work hours or project limits.

The utility owners will perform this work as necessary to avoid conflicts with construction activities. New locations shall be as indicated in the plans. Utility owners shall comply with the schedule requirements of the Contractor and make every effort not to impact the overall construction schedule. Unless otherwise approved by the Engineer, abandoned aboveground appurtenances such as pedestals shall be removed, and abandoned underground utilities and maintenance holes/handholds shall be abandoned.

Utility owners are responsible for obtaining all necessary permits from the City of Colorado Springs, as required.

Academy School District 20 - No work anticipated.

Colorado Springs Parks - No work anticipated.

Colorado Springs (CS) Traffic - No work anticipated.

Colorado Springs Utilities (Gas. Electric) - No work anticipated.

Colorado Springs Utilities (Elec. Transmission) (ELT) - No work anticipated.

Colorado Springs Utilities (Fiber) - No work anticipated.

Colorado Springs Utilities (Water/Sanitary) - No work anticipated.

Comcast - No work anticipated.

Lumen (formerly CenturyLink) - No work anticipated.

GENERAL:
The Contractor shall comply with Article 1.5 of Title 9, CRS ("Excavation Requirements") when excavating or grading is planned around underground utility facilities. The Contractor shall notify all affected utilities at least two (2) business days before commencing such operations, not including the actual day of notice. The Contractor shall contact CO811 at phone no. **811 or 1-800-922-1987**, to have locations of CO811 registered lines marked by member companies. All other underground facilities shall be located by contacting the respective owner. Utility service laterals shall also be found before beginning excavation or grading.

Utilities are depicted on these plans in accordance to their achieved “Quality Levels” as defined in the American Society of Civil Engineers’ document ASCE 38, “Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data.” The Contractor’s attention is directed to subsection 105.11 of the Standard Specifications concerning utilities.

The locations of utility facilities, as shown on the plan and profile sheets, were obtained from the best available information. No warranty is made for the adequacy or accuracy of the subsurface information provided. The Contractor shall cooperate with the utility owners in their relocation operations.

All costs incidental to the preceding requirements will not be paid separately but shall be included in the work.

SCHEDULE

General Provision Section 104 of the City of Colorado Springs Engineering Division Standard Specifications is hereby revised for this project as follows:

In General Provision 104.02 Schedule, the software requirements in the first paragraph shall be revised as follows:

All CPM schedules submitted for review by the Project Engineer shall include capability of being read and manipulated by Microsoft Project.

General Provision 104.02 Schedule shall include the following:

Upon approval of the baseline schedule by the Engineer, no changes to schedule task durations or schedule logic ties shall be permitted without prior written approval by the Engineer.

SHOP DRAWINGS AND SUBMITTALS

The Contractor shall use a system to track various types of submittals. This system shall be submitted to the Engineer for approval at the pre-construction meeting. The system used shall have the information shown below, at a minimum.

- Unique identification # for each submittal and resubmittal
- Date submitted
- Date response required
- Reference to design plan or specification
- Description
- Supplier
- Action
- Date returned

This system will be used by the selected contractor, consultant and City staff to post, review, track, and approve items such as:

- Schedules
- Requests for Information (RFI's),
- Submittals
- Shop drawings
- Change orders
- Materials testing data
- Project pay estimates
- Project photos/Video
    - Preconstruction Drone Aerial Pictures
    - Post Construction Drone Aerial Pictures
    - Stationary Time-Lapse Video
- Meeting agenda and minutes

General Provision Section 108 of the City of Colorado Springs Engineering Division Standard Specifications is hereby revised for this project as follows:

In General Provision Subsection 108.19 Shop Drawings and Submittals, delete the first sentence in paragraph A and replace with the following:

The Contractor shall submit to the Engineer all shop drawings, working drawings, and submittals in a timely manner, considering the 14-day review period for shop drawings. Colorado Springs Utilities review of submittals requires a minimum of 21 days. At no time shall shop drawings be submitted less than 30 days prior to the anticipated construction of that element. The Contractor shall submit to the Engineer all project schedules within 21 calendar days of Notice of Award for review. The Contractor shall include Engineer review time in the work schedule. Failure of the Contractor to deliver submittals in sufficient time for the Engineer's review shall not constitute a delay on the part of the City. Submittals which may require a review beyond the first submittal shall not constitute a delay on the part of the City. Shop drawings and submittals shall be at a minimum of those items listed in Table 108-1 and 108-2 and any other additional submittals which may be required by the Engineer. The submittals shown in the tables are not all inclusive. Other submittals may be required.

In General Provision Subsection 108.19 Shop Drawings and Submittals, delete the first sentence of paragraph B and replace with the following:

If submittals are made in the form of hard copies, then the Contractor shall submit a minimum of five copies. One of these will be returned to the Contractor after review. If the Contractor wants more than one copy returned he shall submit the desired number of additional copies.

The Contractor may elect to make submittals electronically. If this is done, the submittals shall be made in clear, readable color electronic files in the PDF format. If this is done, the reviewed submittals will be returned in the same format.

The Contractor shall not begin work until shop drawings and schedules are approved by the Engineer.

General Provision Subsection 108.19 Shop Drawings and Submittals shall include the following:

Shop Drawings, Working Drawings, Other submittals, and Construction Drawings.

A. Shop drawings, Working Drawings, and Other Submittals -General. All work shall be performed in accordance with the plans, reviewed shop drawings, working drawings, or other submittals. Specific requirements for the required shop drawings, working drawings, and other submittals for this project are contained in the specifications.

The Contractor shall be responsible for the accuracy of all dimensions and quantities shown on the shop drawings, working drawings, and other submittals. The Contractor shall correlate all information in the Contract, in the submittals, and in all revisions at the project site to ensure that there are no conflicts and that the work can be constructed as shown. The Contractor shall be responsible for all information that pertains to the fabrication processes and methods of construction.

Shop drawings, working drawings, and other submittals shall be delivered to the Engineer. The Contractor shall notify the Engineer, in writing, at the time of submittal of shop drawings, working drawings, and other submittals, of any information submitted that deviates from the requirements of the plans and specifications. In addition, specific notation of the deviations or changes from the plans and specifications shall be placed on the shop drawing, working drawing, or other submittal.

The first sheet or page of each set of shop drawings, working drawings, and other submittals shall be reviewed by the Contractor for conformance with the other work on the project, and stamped with a stamp indicating review of the submittal. Submittals shall be made in complete packages which will allow the Engineer to properly review them for general compliance with the Contract and to effectively evaluate the proposed methods of construction. The allowed time for review shall not begin until such submittals are complete.

The format of the shop drawings, working drawings, and other submittals shall be as follows:

1. All manually drafted shop drawings and working drawings shall be either 34-inches long by 22-inches wide overall, or 17-inches long by 11-inches wide overall. There shall be a 2-inch margin on the left side of the sheet and a 1/2 inch margin on the other three sides. A blank space, 4 inches long by 3 inches wide, shall be left available near the lower right-hand corner of shop drawings, for the Engineer's review stamp.

2. A title block shall be located in the lower right-hand corner of each sheet, and shall show the project number, structure name, contents of the sheet, designer/engineer, sheet number, and revision number.

3. Design notes, calculations, lists, reports, descriptions, catalog cuts, and other on-drawing submittals shall be submitted on 8 1/2 inch by 11 inch sheets.

4. The shop drawings, working drawings, other submittals and all revisions shall be signed and sealed for the Contractor, by a professional engineer registered in the state of Colorado when required by the specifications. Submittals without the required signature and seal will not be accepted and will be returned to the Contractor without action.

Table 108-1 summarizes the minimum required submittals and is included at the end of this subsection. Table 108-1 lists submittals in one location for information. The table clarifies the type of submittal and whether the Contractor's Engineer must sign and seal the submittal. Table 108-1 may not be all inclusive. The Contractor shall provide all submittals required by the Contract, including those not listed in the table.

B. Shop Drawings. The Contractor shall provide shop drawings to adequately control the work. The Contractor shall submit shop drawings to the Engineer for formal review.

The Engineer will review the shop drawings to evaluate that general conformance with the design concept and that general compliance with the information given in the plans and specifications has been achieved. The review does not extend to accuracy of dimensions, means, methods, techniques, sequences, schemes, procedures of construction, or to safety precautions. The review by the Engineer is not a complete check. Review of the shop drawings does not relieve the Contractor of the responsibility for the correctness of the shop drawings. All work done prior to the Engineer's review of shop drawings shall be at the Contractor's sole risk.

The Engineer may request additional details and require the Contractor to make changes in the shop drawings which are necessary to conform to the provisions and intent of the plans and specifications without additional cost to the project.

After review, the Engineer will return three sets of shop drawings, for use by the Contractor and the Fabricator or Supplier. Returned shop drawings will be stamped with the Engineer's review stamp to indicate one of the following:

Reviewed, no exception taken	Shop drawings or submittals have been reviewed and do not require resubmittal.
Reviewed, revise as noted	Shop drawings or submittals have been reviewed and the Contractor shall incorporate the comments noted in the shop drawings into the work. The shop drawings do not require resubmittal.
Resubmit, revise as noted	Shop drawings or submittals require correction or redrawing and shall be resubmitted for review. Corrections shall be made and the shop drawings shall be resubmitted by the Contractor in the same manner as the first submittal. Specific notation shall be made on the shop drawing to indicate the revisions.
Rejected	Submittal may or may not have been reviewed, but does not meet the minimum requirements for a review. Rejected submittals shall be repackaged and resubmitted after the submittal meets minimum requirements for review.
Submit Specified Item	Shop drawings or submittals have been reviewed and are not approved without the submittal of the specified item. Engineer is not responsible for project delays when additional items are required for approval.

The time required for the Engineer's review of each submittal will not exceed 14 days after a complete submittal of shop drawings is received by the Engineer, except reviews performed by Colorado Springs Utilities which will not exceed 21 days. It is the intent of these specifications that no more than one submittal of shop drawings shall be required for anyone particular item. If additional submittals are required by actions of the Contractor, resulting delays shall be the responsibility of the Contractor. If additional submittals are required by the Engineer's actions or if shop drawing review is delayed by the Engineer, and if the resulting delay is material to the project schedule critical path, the Contractor may request an extension of time equal to the number of days exceeding the 14 or 21 day review per submittal for review performed by the Engineer.

All revisions made to the shop drawings after the Engineer's initial review process require re-submittal and will be required to follow time frames as set forth for the initial submittal.

C. Working Drawings. The Contractor shall supplement the plans with working drawings to detail the construction or to provide the Engineer with information on the proposed methods of construction. Unless otherwise specified, the Contractor shall submit six sets of working

drawings to the Engineer for information only, who after acknowledging receipt of the working drawings, will retain three copies and return three copies to the Contractor. These drawings will not be formally reviewed by the Engineer. The Contractor shall submit working drawings to the Engineer 21 days before the start of work.

D. Other Submittals. Other submittals shall be prepared and submitted by the Contractor as defined for working drawings. Unless otherwise specified, two copies shall be submitted to the engineer for information only. The plans or specifications will indicate which submittals require formal review by the Engineer. One record set of all design work performed by the Contractor's Engineer shall be submitted to the Project Engineer.

E. Construction Drawings. The Contractor shall keep one set of plans, reviewed shop drawings, working drawings, and other submittals available on the project site at all times. This set shall be defined as the construction drawings." The Contractor shall note on these construction drawings all changes and deviations from the work shown on the plans, shop drawings, working drawings, and other submittals. The construction drawings shall be kept current as the work progresses and notations shall be made within seven days of the change or deviation. Requests for Information (RFIs) and the answer/response shall be attached to the construction drawings.

At the completion of the project, the first sheet or page of each set of construction drawings shall be stamped "As Constructed" and signed by the Contractor’s Surveyor. CDOT and City of Colorado Springs requirements apply for as-built drawings related to the water quality pond. The pond must be certified by the City and CDOT.

Upon completion of the work and prior to final payment, the construction drawings shall be submitted to the Engineer.

F. Furnishing the shop drawings, working drawings, construction drawings, and other submittals will not be measured and paid for separately, but shall be included in the work.

G. Failure of the Contractor to comply with the requirements for shop drawings, working drawings, other submittals, and construction drawings may be considered unsatisfactory contract progress. Monthly progress payments maybe withheld until the requirements are met.

H. Except as specifically noted, all time required for review of shop drawings, working drawings, and other submittals shall be included in the work and shall not be the basis for any claim for a time extension or monetary adjustment except as provided for herein.

Table 108-1

Summary of Contractor Submittals (not all-inclusive)

SPEC SECTION	DESCRIPTION	TYPE	CONTRACTOR P.E. SEAL REQUIRED?
	Structure Backfill	Certification/Testing	No
	Pipe Railing	Material Certification, Shop Drawing	No
	Temporary Diversion (Special)	Method Statement, Schedule	No

SPEC SECTION	DESCRIPTION	TYPE	CONTRACTOR P.E. SEAL REQUIRED?
	Structural Concrete	Mix Designs, Material Certifications, Testing	No
	Reinforcing Steel	Working Drawing	No
	Riprap	Material Data	No
	Grout mix	Shop Drawing, Material Certifications	No
	Seed mix	Material certification	No
	Turf Reinforcement	Material Data	No
	Outlet Structure Trash Racks and Appurtenances.	Shop Drawings	No
	Pre-Project Topographic Survey	CAD Drawing	No
	Depth Gauge	Shop Drawings	No

* A PE seal is required where the Contractor has provided the design for the item, or performed engineering to modify the details shown on the plans. The PE seal is not required where complete details are provided on the plans.

PAYMENTS AND RETAINAGE

General Provision Section 109 of the City of Colorado Springs Engineering Division Standard Specifications is hereby revised for this project as follows:

Delete General Provision Subsection 109.01 Payments, and replace with the following:

Payments will be made, and required retainage withheld if applicable, in accordance with this section as the work progresses at the end of each month or as soon thereafter as practicable in compliance with Title 24, Article 91, Section 103 and Section 110, Colorado Revised Statutes, on statements made and approved by the Engineer.

Payment for work performed by the contractor under these contract documents will be made at the approved unit price or lump sum price for each of the several items as listed in the bid and measured as hereinafter specified. Such payment shall compensate the Contractor for all costs in connection with furnishing all labor, equipment and material required and performing the operations necessary to complete the item in accordance with the contract documents. There will be no partial payments for delivered materials. All incidental work essential to the completion of the project in a workmanlike manner, and including cleanup and disposal of waste or surplus material, shall be accomplished by the contractor without additional cost to the City. The cleanup and disposal of waste or surplus material shall be performed during construction or as soon after as is reasonably possible in order to better maintain the aesthetics and safety of

the construction area. The quantities listed in the bid are estimated quantities, and are listed only for convenience in comparing bids. Payment will be made for the actual quantities constructed or installed, unless otherwise noted in these contract documents. However, any changes to plan quantity must be approved through proper change order procedures, said quantities being measured as specified in the contract documents.

211. If the contract exceeds ONE HUNDRED FIFTY THOUSAND DOLLARS ($150,000.00), and is for the construction, alteration, or repair of any highway, public work, or public improvement, structure, and; the contractor has provided Performance, and Payment Bonds: the City of Colorado Springs shall authorize partial progress payments of the amount due under this contract monthly, or as soon thereafter as practicable, to the contractor, if the contractor is satisfactorily performing the contract. If the City of Colorado Springs finds that satisfactory progress is being achieved during any period for which progress is to be made, the City of Colorado Springs may authorize payment to be made in full without withholding retainage. However, if satisfactory progress has not been made, the City of Colorado Springs may retain a maximum of five percent (5%) of the amount of the requested payment until satisfactory progress is achieved. When the work is substantially complete, the City of Colorado Springs may retain from the remaining unpaid balance that amount the City Contracting Manager, at the advice of the City's project manager, considers adequate for protection of the City, suppliers and subcontractors, and shall release to the Contractor all the remaining funds associated with completed and acceptable work.

The withheld percentage of the contract price of any such work, improvement, or construction shall be retained on an invoice-to-invoice basis and shall not be cumulative. In other words, if the contractor is not performing satisfactorily the City of Colorado Springs will hold ten percent (10%) of what is actually due to the contractor. For example, if the contractor is behind schedule and has successfully completed fifty percent (50%) of the work, the City of Colorado Springs will only pay forty percent (40%) of the invoice, withholding ten percent (10%) of what is due until the contractor gets back on schedule. Once the City of Colorado Springs determines that satisfactory progress Is being made in all phases of the contract, then no retainage will be held on successfully completed work.

211. Whenever a contractor receives payment pursuant to this section, the contractor shall make payments to each of the subcontractors of any amount actually received which were included in the contractor's request for payment to the City for such subcontracts. The contractor shall make such payments within seven (7) calendar days of receipt of payments from the City in the same manner as the City is required to pay the contractor under this section if the subcontractor is satisfactorily performing under the contract with the contractor. The subcontractor shall pay all suppliers, sub-subcontractors, laborers, and any other persons who provide goods, materials, labor, or equipment to the subcontractor any amounts actually received which were included in the subcontractor's request for payment to the contractor for such persons, in the same manner set forth in this subsection (2) regarding payments by the contractor to the subcontractor. If the subcontractor fails to make such payments in the required manner, the subcontractor shall pay those suppliers, sub-subcontractors, and laborers interest in the same manner set forth in this subsection (2) regarding payments by the contractor to the subcontractor.

At the time a subcontractor submits a request for payment to the contractor, the subcontractor shall also submit to the contractor a list of the subcontractor's suppliers, sub-subcontractors and

laborers. The contractor shall be relieved of the requirements of this subsection (2) regarding payment in seven (7) days and interest payment until the subcontractor submits such list. If the contractor fails to make timely payments to the subcontractor as required by this section, the contractor shall pay the subcontractor interest as specified by contract or at the rate of fifteen percent (15%) per annum, whichever is higher, on the amount of the payment which was not made in a timely manner. The interest shall accrue for the period from the required payment date to the date on which payment is made. Nothing in this subsection (2) shall be construed to affect the retention provisions of any contract.

211. CONTRACTS UNDER ONE HUNDRED FIFTY THOUSAND DOLLARS: If the contractor is not progressing in accordance with the project schedule or not performing quality work in accordance with the specifications, the Project Manager may, at that point start withholding retainage up to and including five percent (5 percent) of the total contract amount.

General Provision Subsection 109.03 Payments Withheld Prior to Final Acceptance of Work shall include the following:

E. Failure by the Contractor to submit all record drawings.

FINAL INSPECTION AND ACCEPTANCE

General Provision Section 109 of the City of Colorado Springs Engineering Division Standard Specifications is hereby revised for this project as follows:

General Provision Subsection 109.04 shall include the following:

Upon written notice that the Contractor considers all work complete, the Engineer shall make a final inspection with the Owner and Contractor and shall notify the Contractor in writing of incomplete or defective work revealed by the inspection. The Contractor shall promptly remedy such deficiencies.

After the Contractor has remedied all deficiencies to the satisfaction of the Engineer and delivered all construction records, as-built drawings, maintenance and operating instructions. Schedules, guarantees, bonds, certificates of inspection and other documents (all as required by the Contract Documents), the Owner and Contractor shall be promptly notified in writing by the Engineer that the work is acceptable.

Final Acceptance shall be obtained no more than 90 days after the date of Material Completion as defined in the RFP. If Final Acceptance is not obtained within 90 days of Material Completion, Liquidated Damages, as set forth in General Provision Section 108.02 of the City of Colorado Springs Engineering Division Standard Specifications, shall be applied for each calendar day over 90 days that the contractor has not received Final Acceptance.

DISADVANTAGED BUSINESS ENTERPRISE (DBE) CONTRACT GOAL

This is a federally-assisted construction project. As described in the CDOT DBE Standard Special Provision, the Bidder shall make good faith efforts to meet the following contract goal:

4 Percent DBE participation.

ON THE JOB TRAINING CONTRACT GOAL

The Department has determined that On the Job Training shall be provided to trainees with the goal of developing full journey workers in the types of trade or classification involved. The contract goal for On the Job Trainees working in an approved training plan in this Contract has been established as follows:

Minimum number of total On the Job Training required 320 hours

SCHEDULE E – TECHNICAL PROJECT SPECIAL PROVISIONS

Standard Construction Specifications for technical work for this project shall be the Colorado Department of Transportation (CDOT) "Standard Specifications for Road and Bridge Construction" adopted in 2022 and as hereinafter modified.

The following special provisions supplement or modify the City and State Standard Specifications and take precedence over the Standard Specifications and plans.

REVISION OF SECTION 202
CLEAN CULVERT

Revise Section 202 of the Standard Specifications for this project as follows:

Subsection 202.01 shall include the following:

This work consists of cleaning, removing, and disposing of sediment and other debris in the storm drain inlets and culverts at locations shown on the plans.

Subsection 202.10 shall include the following:

Before cleaning operations, remove and store all grates and other appurtenances from the inlet or culvert pipe.

Perform culvert cleaning using a vacuum truck method as approved. Use a high-pressure washer to strip off all soil sediment and other debris accumulated on the structure's walls. Suction the mix of water and debris out of the structure and into the vacuum truck. Dispose of removed material at a suitable facility located off the project site per applicable regulations and guidelines. The remaining material left in the structure after cleaning shall be removed at the Contractor's expense. Document and provide in writing the total 35mountt of material removed.

Replace all damaged or missing bolts for the grates and other appurtenances. Upon completing cleaning, treat existing and new bolts required for the grates and other appurtenances with anti-seize compound. Then, reinstall the grate and appurtenances using the treated bolts.

If debris accumulates in clean structures during construction, reclean structures at the Contractor's expense.

Subsection 202.11 shall include the following:

Measure Clean Culvert by the actual number of existing culvert pipes and inlets that are cleaned and accepted. Cleaning of drainage pipe between inlets, barrier drain holes, and flaps, when required, will not be measured or paid for separately; include it in the work price.

Subsection 202.12 shall include the following:

Pay under:

Pay Item	**Pay Unit**
Clean Culvert	Each

Payment will consist of full compensation for all labor, materials, and equipment required to clean, maintain, remove, and dispose of sediment and other debris from storm drain inlets and culverts prior to construction.

The amount of anti-seize compound and new bolts required will not be measured and paid for separately; include it in the work price.

The quantity of debris and water disposal will not be measured and paid for separately; include it in the work price.

The amount of water required for pressure washing will not be measured and paid for separately; include it in the work price.

REVISION OF SECTION 202
REMOVAL OF STRUCTURES AND OBSTRUCTIONS

Section 202 of the Standard Specifications is hereby revised for this project as follows:

Subsection 202.11 shall include the following:

Removal of inlet will be measured by the number of headwalls, inlets, manholes, and end sections removed.

Removal of pipe will be measured by the linear foot along the flowline before removal.

Removal of riprap will be measured by the square yard and will be calculated as the product of the length and width along the boundary of riprap before removal.

Subsection 202.12 shall include the following:

Payment will be made under:

Pay Item	**Pay Unit**
Removal of Pipe	Linear Foot
Removal of Riprap	Square Yard
Removal of Inlet	Each

REVISION OF SECTION 203
COMBINATION LOADER

Section 203 of the Standard Specifications is hereby revised for this project as follows:

Subsection 203.01 shall include the following:

This work consists of furnishing a combination loader (backhoe) including operator used as directed by the Engineer for unforeseen tasks.

Subsection 203.04 shall include the following:

Combination Loader – Defined as a combination loader with a standard loader bucket, rated for at least one cubic yard, and backhoe up to ¼ cubic yard; four-wheel industrial, utility, or general-purpose; with loader front and backhoe; in the 75 to 125 horsepower range, either gasoline, diesel engine, or an acceptable equivalent.

Furnish and maintain the combination loader in good operating condition. Do not use equipment if, in the Engineer's opinion, it is inadequate to produce the required results. Operate all equipment using experienced Operators, approved Apprentices, or approved competent Trainees. Use the equipment as directed by the Engineer.

Subsection 203.11 shall include the following:

Combination loader will be measured by the number of hours actively used as directed by the Engineer. Time for moving to or from the project site will not be measured. Time for moving within the project site will be measured. Time for moving a combination loader for work not directed by the Engineer under this pay item or for the Contractor's convenience will not be measured.

Combination loader will not be measured if the work accomplished by the combination loader is measured using another pay item and is included in payment for that item.

Subsection 203.12 shall include the following:

Pay under:

Pay Item	**Pay Unit**
Combination Loader	Hour

REVISION OF SECTION 208
TEMPORARY DIVERSION (SPECIAL)

Section 208 of the Standard Specifications is hereby revised for this project as follows:

Subsection 208.1 shall be revised to include the following:

Temporary Diversion (Special) is the temporary diversion of Fairfax Creek to facilitate the installation of the overflow spillway embankment riprap in Fairfax Creek.

The contractor will be required to submit a method statement and schedule to the engineer for approval prior to ordering any materials and beginning any work associated with the diversion. There are seasonal restrictions for diverting Fairfax Creek. This work must be performed between Oct 1 and April 1, during the typical low flow season. Any work planned outside of this window shall be approved by the engineer.

Subsection 208.11 shall be revised to include the following:

Delete paragraph 3 and replace with:

Temporary Diversion (Special) will not be measured and will include all necessary berms, pumps, hoses, pipe, liners, associated materials needed to construct, maintain, and remove a temporary diversion of Fairfax Creek necessary to accommodate installation of the overflow spillway embankment riprap in Fairfax Creek. Also, include is all associated labor and maintenance to facilitate the installation, maintenance while in operation, and subsequent removal of the diversion.

Subsection 208.12 shall be revised to include the following:

Payment shall be made under:

Pay Item	**Pay Unit**
Temporary Diversion (Special)	Lump Sum

SECTION 211
DEWATERING

Section 211 is hereby added to the Standard Specifications for this project as follows:

DESCRIPTION

1. This work consists of dewatering groundwater to facilitate construction activities.

Information regarding ground water levels at time of the subsurface geotechnical investigation can be found in the Geotechnical Engineering Study.

CONSTRUCTION REQUIREMENTS

211.02 The Contractor shall submit a Dewatering Plan to the Engineer at least 4 weeks prior to the proposed start of dewatering operations. This Plan shall detail the Contractor's method of dewatering for all major excavations and caisson construction. The Dewatering Plan shall be stamped "Approved for Construction" and signed by the Contractor. The Dewatering Plan will not be approved by the Engineer.

The Dewatering Plan shall provide complete details of the Contractor's method for construction dewatering including:

2. Copies of all permits required for dewatering, treatment of and (or) disposing of water.

3. Method and details for minimizing dewatering in excavations and during caisson construction.

4. Method of measuring groundwater discharge.

5. Equipment descriptions including size, number, type, capacity, and location of equipment during dewatering operations.

6. Detailed methods for disposal of water.

7. If applicable, copies of agreements for disposing of water in storm sewers, sanitary sewers etc.

METHOD OF MEASUREMENT

211.03 Dewatering will not be measured and will be paid by lump sum. Included in the cost of dewatering is all work, materials, equipment, and labor required for dewatering during construction. Permanent dewatering will be paid by force account.

BASIS OF PAYMENT

211.04 Payment will be made under:

Pay Item	**Pay Unit**
Dewatering	Lump Sum

REVISION OF SECTION 214
BRUSH LAYER CUTTING

Section 214 of the Standard Specifications is hereby revised for this project as follows:

Subsection 214.03 (h) shall be revised to include the following:

Brush Layer Cutting shall be furnished by the Contractor and cut on site per the specifications. The Contractor shall place brush layer cutting per the details in the plans to mitigate work in wetland areas.

Subsection 214.05 shall be revised to include the following:

Brush Layer Cutting will be measure by each area of wetland protection placed, as determined by the engineer and regardless of size.

Subsection 214.06 shall be revised to include the following:

Payment shall be made under:

Pay Item	**Pay Unit**
Brush Layer Cutting	Each

REVISION OF SECTION 217
HERBICIDE TREATMENT

Section 217 of the Standard Specifications is hereby revised for the project as follows:

Delete Subsection 217.01 and replace with the following:

All areas to be disturbed within the project area, regardless of final disposition, shall be treated with herbicide before disturbance. After seeding and near the end of the project, if noxious weed species persist, seeded areas shall receive an additional application of herbicide. All applications shall target noxious weeds designated by the Colorado Department of Agriculture including List A, B, and C species. Recommended treatments for noxious weeds identified in the project area are summarized in the following table. Additional recommended treatments for noxious weeds including those not listed in the table below, can be found on the Colorado Department of Agriculture's website at https://www.colorado.gov/pacific/agconservation/noxious-weed-species

REVISION OF SECTION 217
HERBICIDE TREATMENT

Noxious Weed	Plant Growth Characteristics	State List*	Recommended Treatments
Canada thistle (*Cirsium arvense*)	Aggressive rhizomatous perennial of moist/wet sites; seeds and plant parts easily transported by construction equipment.	B	**Mechanical Control:** Due to the species' extensive root system, hand-pulling and tilling stimulate the growth of new plants and are not recommended. Mowing every 10 to 21 days during the growing season can be effective. **Herbicide Control:** Aminopyralid (Milestone), Clopyralid + Triclopyr, Amiocyclopyracholor + chlorosulfur, or Picloram applied in spring before flowering and/or during fall regrowth. **Cultural Control:** Reseed with native seed mix and prevent bare ground.
Musk thistle (*Carduus nutans*)	Aggressive biennial weed that produces only from seed. Typically produces rosette in first year of growth then flowers and produces seed in second year.	B	**Mechanical Control:** sever the root below the soil surface. Mowing is most effective when plants are at full bloom. **Herbicide Control:** Aminopyralis, Metsulfuron, or Chlorsulfuron primarily in spring. Aminopyralis and Cloyralid can be used on fall rosettes. **Cultural Control:** Reseed with native seed mix.
Russian olive (*Elaeagnus angustifolia*)	Deciduous tree with a deep tap root.	B	**Herbicide and Mechanical Control:** Cut the trunks and apply herbicide applications of Triclopyr or Glyphosate to cut trunks or cut stems. Treat seedlings in spring with picloram, dicamba or glyphosphate in combination with mechanical control. Triclopyr + Aminopyralid can be use as foliar treatment May to September. **Cultural Control:** Replant with native cottonwoods or willows with native grasses.

*__List A__ Species in Colorado that are designated by the Commissioner for eradication.

List B Species are species for which the Commissioner, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, develops and implements state noxious weed management plans designed to stop the continued spread of these species.

REVISION OF SECTION 217
HERBICIDE TREATMENT

List C Species are species for which the Commissioner, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, will develop and implement state noxious weed management plans designed to support the efforts of local governing bodies to facilitate more effective integrated weed management on private and public lands.
Dicamba may injure woody plants.
Glyphosate may be used in riparian areas
2,4-D and Transline should not be used in riparian areas or near water.
Picloram is persistent in the soil and should not be used in areas to be re-seeded.

CONSTRUCTION REQUIREMENTS

Section 217.03 shall include the following:

The Contractor shall comply with the following best management practices in all construction areas to prevent the spread of noxious weeds and minimize potential effects from treatment:

• Minimization of soil disturbance to the greatest extent possible

• Clean all construction-related equipment thoroughly before off-loading at the project site and after working with weed-contaminated soils

• Coordination of weed management efforts with adjacent landowners to the extent possible

• Avoidance of non-target injury to passing pedestrians and motorists, adjacent native plant communities, landscaping, sensitive wildlife habitat (prairie dogs), and nearby beekeeping operations (if present)

• Herbicides can be used immediately adjacent to wetlands, riparian areas, and/or water bodies only if the label indicates its use is appropriate for such areas

• Application of herbicides immediately adjacent to active prairie dog colonies will not be permitted

• Noxious weeds observed in and near the construction area will be treated with herbicides or mechanically removed prior to the start of construction to minimize spread

• Monitor all areas treated for noxious weeds during construction and re-treat, if necessary, to prevent re-establishment of noxious weeds

Delete the last paragraph in Subsection 217.03, "Herbicides shall not be…"

REVISION OF SECTION 217
HERBICIDE TREATMENT
METHOD OF MEASUREMENT

Delete Subsection 217.04 and replace with the following:

Herbicide Treatment shall be measured by the number of person-hours required to apply herbicide, as approved by the Engineer.

Mechanical control shall be included in the cost of Clearing and Grubbing.

Seeding shall be included in the cost of 212 Seeding (Native) or Seeding (Wetland) Broadcast. Locations of which area applies are located in the plans.

METHOD OF MEASUREMENT

Section 217.05 shall include the following:

Payment shall be made under:

Pay Item	**Pay Unit**
Herbicide Treatment	Hour

SECTION 240
PROTECTION OF MIGRATORY BIRDS
BIOLOGICAL WORK PERFORMED BY THE CONTRACTOR'S BIOLOGIST

Add Section 240 to the Standard Specifications for this project as follows:

DESCRIPTION

240.01 This work consists of protecting migratory birds during construction.

MATERIALS AND CONSTRUCTION REQUIREMENTS

240.02 The Contractor shall schedule clearing and grubbing operations and work on structures to avoid taking (pursue, hunt, take, capture, or kill; attempt to take, capture, kill or possess) migratory birds protected by the Migratory Bird Treaty Act (MBTA). The Contractor shall retain a qualified wildlife biologist for this project. The wildlife biologist shall have a minimum of three years' experience conducting migratory bird surveys and implementing the requirements of the MBTA. The Contractor shall submit documentation of the biologist's education and experience to the Engineer for acceptance. A biologist with less experience may be used by the Contractor subject to the approval of the Engineer based on review of the biologist's qualifications.

The wildlife biologist shall record the location of each protected nest, bird species, the protection method used, and the date installed. A copy of these records shall be submitted to the Engineer.

(a) *Vegetation Removal.* When possible, vegetation shall be cleared before the time when active nests are present. Vegetation removal activities shall be timed to avoid the migratory bird breeding season which begins on April 1 and runs to August 31. All areas scheduled for clearing and grubbing between April 1 and August 31 shall first be surveyed within the work limits for active migratory bird nests. The Contractor's wildlife biologist shall also survey for active migratory bird nests within 50 feet outside work limits. Contractor personnel shall enter areas outside CDOT right of way only if a written, signed document granting permission to enter the property has been obtained from the property owner. The Contractor shall document all denials of permission to enter property. The Contractor shall avoid all active migratory bird nests. The Contractor shall avoid the area within 50 feet of the active nests or the area within the distance recommended by the biologist until all nests within that area have become inactive. Inactive nest removal and other necessary measures shall be incorporated into the work as follows:

1. Tree and Shrub Removal or Trimming. Tree and shrub removal or trimming shall occur before April 1 or after August 31 if possible. If tree and shrub removal or trimming will occur between April 1 and August 31, a survey for active nests shall be conducted by the wildlife biologist within the seven days immediately before the beginning of work in each area of tree and shrub removal or trimming. The survey shall be conducted for each phase of tree and shrub removal or trimming.

If an active nest containing eggs or young birds is found, the tree or shrub containing the active nest shall remain undisturbed and protected until the nest becomes inactive. The nest shall be protected by placing fence (plastic) a minimum distance of 50 feet from each nest to be undisturbed. This buffer dimension may be changed if determined appropriate by the wildlife biologist and approved by the Engineer. Work shall not proceed within the fenced buffer area until the young have fledged or the nests have become inactive.

If the fence is knocked down or destroyed by the Contractor, the Engineer will suspend the work, wholly or in part, until the fence is satisfactorily repaired at the Contractor's expense. Time lost due to such suspension will not be considered a basis for adjustment of time charges but will be charged as contract time.

2. *Grasses and Other Vegetation Management.* Due to the potential for encountering ground nesting birds' habitat, if work occurs between April 1 and August 31, the area shall be surveyed by a wildlife biologist within the seven days immediately before ground disturbing activities. The undisturbed ground cover to 50 feet beyond the planned disturbance, or to the right of way line, whichever is less, shall be maintained at a height of 6 inches or less beginning April 1 and continuing until August 31 or until the end of ground disturbance work, whichever comes first.

   If birds establish a nest within the survey area, an appropriate buffer of 50 feet will be established around the nest by the CDOT biologist. This buffer dimension may be changed if determined appropriate by the CDOT biologist and approved by the Engineer. The Contractor shall install fence (plastic) at the perimeter of the buffer. Work shall not proceed within the buffer until the young have fledged or the nests have become inactive.

   If the fence is knocked down or destroyed by the Contractor, the Engineer will suspend the work, wholly or in part, until the fence is satisfactorily repaired at the Contractor's expense. Time lost due to such suspension will not be considered a basis for adjustment of time charges but will be charged as contract time.

(b) *Work on structures*. The Contractor shall prosecute work on structures in a manner that does not result in a taking of migratory birds protected by the Migratory Bird Treaty Act (MBTA). The Contractor shall not prosecute the work on structures during the primary breeding season, April 1 through August 31, unless he takes the following actions:

(1) The Contractor shall remove existing nests before April 1. If the Contract is not awarded before to April 1 and CDOT has removed existing nests, then the monitoring of nest building shall become the Contractor's responsibility upon Notice to Proceed.

(2) During the time that the birds are trying to build or occupy their nests, between April 1 and August 31, the Contractor shall monitor the structures at least once every three days for any nesting activity.

(3) If the birds have started to build any nests, they shall be removed before the nest is completed. Water shall not be used to remove the nests if nests are located within 50 feet of any surface waters.

(4) Installation of netting may be used to prevent nest building. The netting shall be monitored and repaired or replaced as needed. Netting shall consist of a mesh with openings that are ¾ inch by ¾ inch or less.

If an active nest become established, i.e., there are eggs or young in the nest, all work that could result in abandonment or destruction of the nest shall be avoided until the young have fledged or the nest is unoccupied as determined by the wildlife biologist and approved by the Engineer. The Contractor shall prevent construction activity from displacing birds after they have laid their eggs and before the young have fledged.

If the project continues into the following spring, this cycle shall be repeated. When work on the structure is complete, the Contractor shall remove and properly dispose of netting used on the structure.

(c) *Taking of a Migratory Bird.* The taking of a migratory bird shall be reported to the Engineer. The Contractor shall be responsible for all penalties levied by the U. S. Fish and Wildlife Service (USFWS) for the taking of a migratory bird.

METHOD OF MEASUREMENT

240.03 Wildlife Biologist will be measured by the actual authorized number of hours a wildlife biologist is on site performing the required tasks.

Removal of nests will be measured by the actual number of man-hours spent removing inactive nests just before and during the breeding season, April 1 through August 31. During this period, the Contractor shall submit to the Engineer each week for approval a list of the workers who removed nests and the number of hours each one spent removing nests.

Netting will be measured by the square yard of material placed to keep birds from nesting on the structure. Square yards will be calculated using the length of netting measured where it is attached to the ground and the average height of the netting where it is attached to the structure.

SECTION 240
PROTECTION OF MIGRATORY BIRDS
BIOLOGICAL WORK PERFORMED BY THE CONTRACTOR'S BIOLOGIST

BASIS OF PAYMENT

240.04 The accepted quantities measured as provided above will be paid for at the contract unit price for each of the pay items listed below that appear in the bid schedule.

Payment will be made under:

Pay Item	**Pay Unit**
Wildlife Biologist	Hour
Removal of Nests	Hour
Netting	Square Yard

Payment for Wildlife Biologist will be full compensation for all work and materials required to complete the item, including wildlife biologist, wildlife survey, and documentation (record of nest location and protection method)

Payment for Removal of Nests will be full compensation for all work and material required to complete the work.

Payment for netting will be full compensation for all work and material required to complete the item. Overlaps of netting will not be measured and paid for separately but shall be included in the work. Maintenance and replacement, removal, and disposal of netting will not be measured and paid for separately but shall be included in the work.

Clearing and grubbing will be measured and paid for per Section 201. Mowing will not be measured and paid for separately but shall be included in the work.

Removal and trimming of trees will not be measured and shall be included in the cost of the work.

Fence (Plastic) will be measured and paid for per Section 607

REVISION OF SECTION 304
AGGREGATE BASE COURSE (SPECIAL)

Section 304 of Standard Specification is hereby revised for this project as follows:

Subsection 304.01 shall include the following:

Aggregate Base Course (Special) consists of placing on-site aggregate to locations as shown in the plans for Access T.

Subsection 304.07 shall include the following:

Aggregate Base Course (Special) will be measured by the ton compacted in place.

Subsection 304.08 shall include the following:

Payment shall be made under:

Pay Item	**Pay Unit**
Aggregate Base Course (Special)	Ton

REVISION OF SECTION 412
CONCRETE PAVEMENT (6.5 INCH) (REINFORCED)

Section 412 of Standard Specification is hereby revised for this project as follows:

Subsection 412.02 shall include the following:

Concrete Pavement (6.5 inch) (Reinforced) shall conform to the details for concrete access as shown in the plans.

Subsection 412.24 shall include the following:

Payment shall be made under:

Pay Item	**Pay Unit**
Concrete Pavement (6.5 Inch) (Reinforced)	Cubic Yard

REVISION OF SECTION 506
SOIL RIPRAP

Section 506 of Standard Specification is hereby revised for this project as follows:

Subsection 506.02 shall include the following:

Existing riprap removed during construction may be reused for "soil riprap" if it is free from deleterious materials and satisfies the specifications herein as determined by the Engineer.

Soil Riprap includes excavation, grading, and installation of Soil Riprap and shall be installed at the locations shown on the Contract Drawings. Excavation in Fairfax Creek may encounter unsuitable material.

Subsection 506.03 shall include the following:

Elevation tolerance for the soil riprap shall be 0.10 feet. Thickness of soil riprap shall be no less than thickness shown and no more than 2-inches greater than the thickness shown.

Adjacent stockpiles of riprap and soil shall be created and mixing done at the stockpile location, not at the location where soil riprap is to be placed.

Mix thirty-five percent (35%) soil by volume with stockpiled riprap, using additional moisture and control procedures that ensure a homogenous mixture; where the soil fills the inherent voids in the riprap without displacing riprap.

With prior approval of the Project Engineer, layering the riprap and soil instead of premixing may be allowed in the native soil is granular.

Place a first layer of smaller soil riprap of approximate d_{50} thickness. Then place the top layer with surface rocks that are largely $_{d50}$ or greater, filling voids as necessary with smaller planted riprap and create a smooth plane. The mixture shall be consolidated by large vibratory equipment or backhoe bucket to create a tight, dense interlocking mass.

The soil shall be further wetted to encourage void filling with soil. Any large voids shall be filled with rock and small voids filled with soil. Excessively thick zones of soil prone to washing away shall not be created, no thicknesses greater than six (6) inches. For buried soil riprap, the top surface shall be covered with six (6) inches of topsoil such that no rock points are protruding.

The final surface shall be thoroughly wetted for good compaction, smoothed and compacted by vibrating equipment; the surface shall then be hand raked to receive seeding.

The Contractor shall install a test section of at least 60 square feet of soil riprap for the review and approval of the Engineer prior to installation of the remaining soil riprap.

REVISION OF SECTION 506
SOIL RIPRAP

Subsection 506.05 shall include the following:

Payment shall be made under:

Pay Item	**Pay Unit**
Soil Riprap (Type M, 12 inch)	Cubic Yard

Excavation, grading, mixing and installation for soil riprap and soil material used in riprap voids shall not be paid for separately but will be considered part of the work. Any unsuitable material encountered during excavation in Fairfax Creek shall be included in the cost of soil riprap.

REVISION OF SECTION 604
INLET TYPE D (SPECIAL)

Section 604 of the Standard Specifications is hereby revised for this project as follows:

Subsection 604.04 (c) shall include the following:

Inlet Type D (Special) is the pond inlet and shall be constructed as shown in the details and other information provided in the plans in locations as shown.

Subsection 604.07 shall include the following:

Payment will be made under:

Pay Item	**Pay Unit**
Inlet Type D (Special)	Each

Payment will be full compensation for all labor, material, and equipment necessary to completely construct the Inlet Type D (Special) shown on the plans and as required by these specifications, including, but not limited to: concrete, reinforcing steel, channels, fabrication, grates, trash racks, steel members, flow control plates, bolts and connections.

REVISION OF SECTION 609
GUTTER (SPECIAL)

Section 609 of the Standard Specifications is hereby revised for this project as follows:

Subsection 609.01 shall be revised to include the following:

Gutter (Special) is the work related to the trickle channel.

Subsection 609.02 shall be revised to include the following:

Gutter (Special) shall be constructed per the details in the plans.

Subsection 609.11 shall be revised to include the following:

Payment will be made under:

Pay Item	**Pay Unit**
Gutter (Special)	Linear Feet

FORCE ACCOUNT ITEMS

DESCRIPTION

This special provision contains the City's estimate for force account items included in the Contract. The estimated amounts marked with an asterisk will be added to the total bid to determine the amount of the performance and payment bonds. Force Account work shall be performed as directed by the Engineer.

BASIS OF PAYMENT

Payment will be made in accordance with the contract documents. Payment will constitute full compensation for all work necessary to complete the item.

Force account work valued at $5,000 or less, that must be performed by a licensed journeyman in order to comply with federal, state, or local codes, may be paid for after receipt of an itemized statement endorsed by the Contractor.

Force Account Item	Quantity	Estimated Amount
F/A Minor Contract Revisions	F.A.	$ 75,000*
F/A On the Job Trainee	F.A.	$ 10,000
F/A Erosion Control	F.A.	$ 35,000*
F/A Dewatering (Permanent)	F.A.	$100,000*

F/A Minor Contract Revisions – This work consists of minor work authorized and approved by the Engineer, which is not included in the contract plans or specifications and is necessary to accomplish the scope of work of this contract.

F/A On The Job Trainee – This work is described in Standard Special Provision for On The Job Training.

F/A Erosion Control – This work shall include all necessary work and materials for erosion control items not identified in the plans and at the Engineer's direction. All items shall be approved by the Engineer prior to installation or they will be at no cost to the project. Payment will be made based on time and materials used to perform the work. Work must be performed in a workmanlike manner and properly scheduled to minimize cost and inconvenience to the City and or adjacent property owners. The Force Account shall also be used to pay for any additional BMPs or testing which may become required by future changes to the current stormwater regulations by either EPA or CDPHE and could include future effluent limits.

F/A Dewatering (Permanent) – This work shall include all necessary work and materials for permanent dewatering of the pond not identified in the plans and at the Engineer's discretion. Seasonal groundwater has been observed in the pond. The approach to control the groundwater must be coordinated, reviewed and approved by the Engineer, prior to construction. Payment will be made based on time and materials used to perform the work necessary to control groundwater within the pond to allow for maintenance of the pond. Work must be performed in a workmanlike manner and properly scheduled to minimize cost and inconvenience to the City and CDOT.

SCHEDULE F – CDOT REVISED STANDARD SPECIAL PROVISION

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[For 2022 Spec Book]

COLORADO DEPARTMENT OF TRANSPORTATION SPECIAL PROVISIONS
STANDARD SPECIAL PROVISIONS

REVISION OF SECTION 105
CONTROL OF WORK

Revise Section 105 of the Standard Specifications as follows:

Revise Paragraphs 4, 5 and 6 of Subsection 105.20 as follows:

If damage occurs to an existing structure through improper maintenance per 105.19, the Contractor shall submit a repair procedure to the Engineer to repair the defect(s).

The repair categories and requirements are defined as follows:

a) *"In-kind" repairs*. In-kind repairs are repairs where the As-Built or Advertised plans are utilized to replace or repair damaged components with identical dimensions and materials used plans and where no plan modifications are made. In-kind repair procedures shall be reviewed and accepted by the Engineer before any repair. The use of approved repair grouts or doweled reinforcing with epoxy adhesive is permitted in in-kind repairs. Doweled reinforcing shall meet or exceed the strength requirements of the original design.

a) "*Modified repairs*". Modified repairs are those which deviate in dimensions and/or materials from the As-Built or Advertised plans or where plans are not available. Modified repair procedure submittals shall include calculations, independent design calculations, shop drawings, and/or working drawings per 105.02, and any other applicable section of the specifications for the needed repair. The Contractor's Engineer shall electronically seal Modified repair submittals.

Damage to new structures or modified structures, shall be repaired per the contract documents. The Engineer of Record shall be notified and review all corresponding submittals before any repairs.

REVISION OF SECTION 109
MEASUREMENT AND PAYMENT

Revise Section 109 of the Standard Specifications as follows:

Replace Subsection 109.06(b):

109.06 Partial Payments Partial payments will be made once each month as the work progresses, when the Contractor is performing satisfactorily under the Contract. Payments will be based upon progress estimates prepared by the Engineer, of the value of work performed, materials placed per the Contract, and the value of the materials on hand per subsection 109.07. The amount of the progress estimate paid to the Contractor will be subject to the following:

(b) *Securities in Lieu of Standard Amount Retained.* When the original contract amount exceeds $150,000, the Contractor may withdraw all or any portion of the standard amount retained if acceptable securities are assigned to the Department, and deposited as set forth in Section 24-91-105, CRS and the implementing regulations. The securities shall at all times have a market value at least equal in value to the sums withdrawn. If at any time the Department determines that the market value of the securities has fallen below the sums withdrawn, the Contractor, shall deposit additional acceptable securities in an amount sufficient to reestablish a total deposit of securities equal in value to the sums withdrawn. This security substitution shall not apply if a part of the contract price is paid from federal, or other sources, and the federal or other source has requirements that are inconsistent with this subsection.

REVISION OF SECTION 109
PROMPT PAYMENT
(LOCAL AGENCY)

Section 109 of the Standard Specifications is hereby revised for this project as follows:

Delete subsection 109.06(e) and replace with the following:

(e) *Prompt Payment*. The Contractor shall pay subcontractors and suppliers for all work which has been satisfactorily completed within seven calendar days after receiving payment for that work from the Local Public Agency (LPA). For the purpose of this section only, work shall be considered satisfactorily complete when the LPA has made payment for the work. The Contractor shall include in all subcontracts a provision that this requirement for prompt payment to subcontractors and suppliers must be included in all subcontracts at every tier. The Contractor shall ensure that all subcontractors and suppliers at every tier are promptly paid. If the Contractor or its subcontractors fail to comply with this provision, the Engineer will not authorize further progress payment for work performed directly by the Contractor or the noncompliant subcontractor until the required payments have been made. The Engineer will continue to authorize progress payments for work performed by compliant subcontractors.

Delete subsection 109.06(f)5 and replace with the following:

5. In determining whether satisfactory completion has been achieved, the Contractor may require the subcontractor to provide documentation such as certifications and releases, showing that all laborers, lower-tiered subcontractors, suppliers of material and equipment, and others involved in the subcontractor's work have been paid in full. The Contractor may also require any documentation from the subcontractor that is required by the subcontract or by the Contract between the Contractor and the LPA or by law such as affidavits of wages paid, material acceptance certifications and releases from applicable governmental agencies to the extent that they relate to the subcontractor's work.

Delete subsection 109.06(f)8 and replace with the following:

8. If additional quantities of a particular item of work are required at a later date after final measurement has been made, the Contractor shall perform this work in accordance with Contract requirements and at unit bid prices.

   For this subsection only, satisfactory completion of all work described on CDOT Form No. 205 is when all tasks called for in the subcontract as amended by changes directed by the Engineer have been accomplished and documented as required by the LPA.

   The requirements stated above do not apply to retainage withheld by the LPA from monies earned by the Contractor. The LPA will continue to process the release of that retainage based upon the completion date of the project as defined in the Commencement and Completion of Work special provision.

Delete subsection 109.06(f)9 and replace with the following:

9. If during the prosecution of the project a portion of the work is partially accepted in accordance with subsection 105.21(a), the Contractor shall release all subcontractors' retainage on the portion of the partially accepted work performed by subcontractors. Prior to the LPA releasing the Contractor's retainage on work that has been partially accepted in accordance with subsection 105.21(a), the Contractor shall submit to the Engineer a certified statement for each subcontractor that has participated in the partially accepted work. The statement shall certify that the subcontractor has been paid in full for its portion of the partially accepted work including release of the subcontractor's retainage. The statement shall include the signature of a legally responsible official for the Contractor, and the signature of a legally responsible official for the subcontractor.

REVISION OF SECTION 109
PROMPT PAYMENT
(LOCAL AGENCY)

Delete subsection 109.06(g) and replace with the following:

(g) *Good Cause Exception.* If the Contractor has "good cause" to delay or withhold a subcontractor's progress payment, the Contractor shall notify the LPA and the subcontractor in writing within seven calendar days after receiving payment from the LPA. The notification shall specify the amount being withheld and provide adequate justification for withholding the payment. The notice shall also clearly state what conditions the subcontractor must meet to receive payment. "Good cause" shall include but not be limited to the failure of the subcontractor to make timely submission of required paperwork.

Delete subsection 109.06(h) and replace with the following:

(h) *Monthly Reporting.* On a monthly basis, the Contractor shall submit the Form 1418, Monthly Payment Report, to the Engineer along with the project schedule updates, in accordance with subsections 108.03(g). Failure to submit a complete and accurate Form 1418 shall be grounds for CDOT to withhold subsequent payments or retainage from the Contractor.

REVISION OF SECTION 207
TOPSOIL

Section 207 of the Standard Specifications is hereby deleted for this project and replaced with the following:

DESCRIPTION

207.01 This work consists of salvaging topsoil from onsite locations, stockpiling, maintaining, and preparing the subsoils for the placement of the topsoil at locations shown on the plans. It also includes creating seeding media by amending subsoils, and importing offsite topsoil when shown on the plans.

Substitutions from this specification will not be allowed unless submitted in writing to the Engineer and approved by the Region or Headquarters Landscape Architect.

MATERIALS

207.02 General. Topsoil shall be salvaged onsite, imported, or produced as shown on the plans. Topsoil shall be free of refuse and litter along with noxious weed seed and reproductive plant parts, as listed in current State of Colorado A and B Noxious Weed List and local agency weed lists. Topsoil shall not include heavy clay, hard clods, toxic substances, pathogens, or other material, which would be detrimental to growing native vegetation. All required amendments shall be thoroughly incorporated to parent material, onsite. All amendments shall conform to Section 212. Topsoil and parent material shall be free of clods, sticks, stones, debris, concrete, and asphalt in excess of 4 inches in any dimension for all material used within the designed clear zone for the project. Topsoil outside of the clear zone may contain rock larger than 4 inches in any dimension. For slopes with no structures being used to protect areas from falling rocks the Contractor shall remove or secure any rocks deemed unstable and could pose a safety hazard.

Topsoil shall be generated from one or more of the following as shown on the plans:

(a) *Topsoil (Onsite).* Topsoil shall consist of the upper 6-inch layer of the A horizon, as defined by the Soil Science Society of America, or at the depths and locations shown on the Stormwater Management Plan (SWMP). It shall consist of loose friable soil, salvaged from onsite and stockpiled or windrowed. Litter and duff (layer of partially decomposed plant material) shall be collected as part of the salvaging of topsoil unless specified to be removed and hauled offsite on the plans.

(b) *Topsoil (Wetland).* Wetland topsoil shall consist of moist, organic soil obtained from delineated wetlands, including any existing wetland vegetation and seeds. Wetland topsoil shall be extracted from the project site at locations shown on the plans or as directed, to a minimum depth of 12 inches or at the depths as shown on the plans.

(c) *Seeding Media.* Seeding Media shall consist of one or all of the following approved materials: sub-soil, overburden, or material generated from rock. Contractor shall select onsite or offsite locations to generate material that meet the requirements of Table 207-1. The Contractor shall provide a Certified Test Report (CTR) in accordance with subsection 106.13, excluding lot, heat, and batch confirming that the excavated material conforms to Table 207-1.

(d) *Topsoil (Offsite).* The Contractor shall submit a CTR for Topsoil (Offsite) for approval a minimum of 60 days prior to import in accordance with subsection 106.13. The Contractor shall include with the CTR a complete Soil Nutrient Analysis for the properties listed in Table 207-2 from an independent laboratory that participates in the National Association for Proficiency Testing (NAPT). If topsoil nutrient analysis is deficient, an Amendment Protocol shall be submitted by the Contractor for approval. The Amendment Protocol shall contain a complete list of amendments and associated quantities to produce topsoil that conforms to Table 207-2.

REVISION OF SECTION 207
TOPSOIL

The Contractor shall submit a Certificate of Compliance (COC) for Topsoil (Offsite) for approval a minimum of 60 days prior to import that the source has controlled noxious weeds in accordance with the State of Colorado Noxious Weed Act 35-5.5-115.

Table 207-1
PHYSICAL PROPERTIES OF SEEDING MEDIA

Property	Range	Test
Soil pH (s.u.)	5.6 – 7.5	ASA Mono. #9, Part 2, Method 10-3.2 or TMECC 04.11-A
Soil Electrical Conductivity (EC) (mmhos/cm or ds/m)	< 5.0	ASA Mono. #9, Part 2, Method 10-3.3
Soil SAR (s.u.)	0 - 10	ASA Mono. #9, Part 2, Method 10-3.4
Rock Content (%)	≤ 25	USDA NRCS Rock Fragment Modifier Usage
Trace Contaminants (Arsenic, Cadmium, Copper, Mercury, Selenium, Zinc, Nickel, and Lead)	Meets US EPA, 40 CFR 503 Regulations	TMECC 04.06 or EPA6020/ASA (American Society of Agronomy)
Rock Content (%) greater than 3” diameter	≤ 25	USDA NRCS Rock Fragment Modifier Usage
USDA Soil Texture	No more than 70% clay, silt, and sand by percentage volume of topsoil.	ASA Monograph #9, Part 1, Method 15-4 or ASA 1 43-5
All Particle Sizes	< 6 Inches	
Physical contaminants (man-made inerts) (%)	< 1	TMECC 03.08-C
C:N ratio	<20	TMECC 05.02-A
* Fines % when manufacturing material from rock	>25% material passing through #4 sieve	ASTM D6913

Amendments to the base imported material shall have the quantities of material verified onsite prior to incorporation into parent material, either at the stockpiles or after placement of parent material. Topsoil amended at the stockpiles shall be distributed to the site within seven days. * Substitute this requirement for USDA Soil Texture requirement when project are approved to use material manufactured from native rock material on site.

Table 207-2
TOPSOIL (OFFSITE) PROPERTIES

Property	Range	Test Methods
Soil pH (s.u)	5.6 – 7.5	ASA Mono. #9, Part 2, Method 10-3.2 or TMECC 04.11-A
Salt by Electrical Conductivity (EC) (mmhos/cm or ds/m)	< 2.0	ASA Mono. #9, Part 2, Method 10-3.3
Soil SAR (s.u.)	0 – 10	ASA Mono. #9, Part 2, Method 10-3.4
Soil OM (%)	3 – 5	Methods of Soil Analysis, Part 3, Method 34
Soil N (NO_3-n, ppm)	≥ 20.0	Methods of Soil Analysis, Part 3. Chemical Methods. Ch. 38 Nitrogen – Inorganic Forms
Soil P (ppm)	≥ 13.0	ASA Mono. #9, Part 2, Method 24-5.4 or others as required based on soil pH
Soil K (ppm)	≥ 80	ASA Mono. #9, Part 2, Method 13-3.5
Rock Content (%) greater than 3" diameter	≤ 25	USDA NRCS Rock Fragment Modifier Usage
Bioassay (seedling emergence and relative vigor)	> 80% of control	TMECC 05.05-A or Approved Germination Test
Soil Texture	No more than 70% clay, silt and sand by percentage volume of topsoil	ASA Mono. #9, Part 1, Method 15-4
Physical contaminants (man-made inerts) (%)	< 1	TMECC 03.08-C
Trace Contaminants (Arsenic, Cadmium, Copper, Mercury, Selenium, Zinc, Nickel, and Lead)	Meets US EPA, 40 CFR 503 Regulations	TMECC 04.06 or EPA6020/ASA (American Society of Agronomy)
All Particle Sizes	< 6 Inches	
C:N ratio	<20	TMECC 05.02-A

The Contractor shall utilize a rod penetrometer for determining subgrade soil preparation and determining looseness of soil after ripping. The penetrometer shall have a psi pressure gage, and shall meet the following requirements:

(1) Steel rod with a minimum diameter of ½ inch with graduations (tick marks) every 6 inches.

(2) The rod shall be made of stainless steel or other metal that will not bend when weight is applied.

(3) The end of the rod shall have a 30-degree cone tip.

(4) The diameter of the cone at its tip shall be no more than 0.1 inch.

(5) The top of the rod shall be a T-handled configuration.

REVISION OF SECTION 207
TOPSOIL

CONSTRUCTION REQUIREMENTS

207.03 Site Pre-vegetation Conference. Prior to the start of the initial Subgrade Soil Preparation for the project, the Contractor shall request a Site Pre-vegetation Conference. The Engineer will set up the conference and will include: the Engineer or designated representative, the Superintendent or designated representative, the sub-contractor(s) performing the subgrade soil preparation and soil amendments, and the CDOT Landscape Architect representing the Region. Only one meeting is required for the project unless a new sub-contractor is brought on that did not attend the previous meeting.

The Agenda of the Pre-vegetation Conference can be found in Appendix A of the Construction Manual and includes the following:

(1) Final review of the Topsoil (Offsite) Amendment Protocol

(2) Review of the Method Statement detailing the equipment which will be used for the subgrade soil preparation operations

(3) Review of rod penetrometer which will be used to determine subgrade soil preparation of topsoil

(4) Permanent Stabilization Phasing Plan (identify strategies and site management measures to protect de-compacted, topsoil amended, seeded, and blanketed areas from foot, vehicle loads, and other disturbances).

(5) Seeding. See subsection 212.03 for submittal requirements.

(6) Meeting attendee sign-in log

207.04 Topsoil Stockpiling. Stockpiles of topsoil shall be created as shown on the plans or as approved by the Engineer. All Stockpiles of topsoil which are scheduled to remain in place for 14 days or more shall receive interim stabilization in accordance with subsection 208.04. All topsoil stockpiles shall be identified using white pin flags with “TOPSOIL” printed in black letters and shall have their locations shown on the SWMP Plans. Each individual stockpile shall require at least one flag, and one additional flag for each 10 cubic yards of salvaged topsoil. The contractor shall provide only perimeter flags for stockpile larger than 100 cubic yards with a minimum spacing of 25 feet.

Topsoil may be placed in stockpiles or windrowed at the edge of the disturbance. Windrowed topsoil shall not be used as perimeter erosion control or extensively compacted. When topsoil is windrowed, all stockpile requirements still apply.

(1) Upland Topsoil. If included on the plans, stockpiles shall be treated with herbicide, in accordance with Section 217, or as directed.

(2) Wetland Topsoil. Wetland stockpiles shall not be treated with herbicide. Weeds shall be hand pulled. Wetland topsoil shall be placed within 24 hours from excavation, unless otherwise approved by the Engineer. Wetland topsoil shall not be stockpiled for more than six months.

207.05 Subgrade Soil Preparation. Before placement of topsoil, the subgrade shall be ripped to a minimum depth of 14 inches. Subgrade shall be mostly dry and friable. Subgrade shall crumble without sticking together, yet not be so dry and hard that it does not break apart easily.
Underground utilities shall be located prior to soil preparation.

Subgrade soil preparation equipment shall meet the requirements for either winged tip or parabolic shanks. Operation shall be performed to fracture the soil uniformly without lifting or furrowing the surface excessively. The Contractor shall submit a method statement for subgrade soil preparation other equipment will be considered.

1. Winged tip shanks (dozer equipment) shall be a minimum of 6 inches wide and have 2 inches of vertical profile change on the blade with a 40 – 60-degree sweep angle.

The Contractor shall calibrate the subgrade soil preparation equipment using a minimum 30 linear feet of the initial pass. The Contractor shall utilize the rod penetrometer to verify that that de-compaction was successfully done. The Contractor shall take penetration measurements every 6 inches across a transect perpendicular to the direction of the tractor and spanning the width of the subgrade soil preparation. Depths of penetration shall confirm that a minimum of 12 inches can be achieved without reaching 300 psi on the rod penetrometer pressure gage (approximately 30 pounds of pressure on the T-handle).

Existing subgrade shall be de-compacted to a depth of 14 inches. If multiple passes are needed, the subsequent passes shall be positioned so that the ripping equipment (subsoilers) from the previous pass are split by the subsequent pass. Following ripping, the Contractor shall remove all sticks, stones, debris, clods, and all other substances greater than 6 inches in diameter. The Contractor shall restrict motorized vehicle and foot traffic from passing over the ripped area since this would recompact the areas that received subgrade soil preparation.

The first 4 feet from the edge of pavement shall be ripped to a depth of 6 inches. If the project is going to use aggregate base course or recycled asphalt as a shouldering technique, those areas will not require subgrade soil preparation. Depth of soil ripping for the subgrade soil preparation shall be checked with the rod penetrometer.

The Contractor shall verify adequate de-compaction of the entire area to have topsoil placed using a rod penetrometer in the presence of the Engineer. Tests shall be performed at a minimum of ten random locations per each acre as selected by the Engineer. The Test shall verify that a depth of 12 inches of penetration into the soil can be achieved without reaching 300 psi on the rod penetrometer pressure gage (approximately 30 pounds of pressure on the T-handle). If this depth cannot be achieved for 80 percent of the penetrations, the Contractor shall re-rip the area at no additional cost to the Department.

207.06 Placement of Topsoil and Seeding Media. Topsoil and Seeding Media shall be hauled and placed at the locations disturbed and will be re-vegetated or as shown on the plans. The contractor shall place a minimum thickness of 6 inches and should only be handled when it is dry enough to work without damaging soil structure. Topsoil and Seeding Media shall be placed a minimum depth of twelve (12) inches when placed over riprap as required on the plans. No Topsoil or Seeding Media shall be placed below ordinary high water mark except as otherwise specified in bio-stabilization bank treatments.

Salvaged topsoil placement deeper than 6 inches is allowed if additional approved material is on-site.

Contractor shall place topsoil in a method that does not re-compact subgrade material using low ground-contact pressure equipment, or by excavators and/or backhoes operating adjacent to it.

The final grade shall be free of all materials greater than 4 inches in diameter within the designed clear zone for the project. Equipment not required for revegetation work will not be permitted in the areas of placed topsoil.

Soil amendments, seedbed preparation, and permanent stabilization mulching shall be accomplished within four working days of placing the topsoil on the de-compacted civil subgrades. If placed topsoil is not mulched with permanent stabilization mulch within four working days, the Contractor shall complete interim stabilization methods in accordance with subsection 208.04(e), at no additional cost to the Department. Time to perform the work may be extended for delays due to weather.

REVISION OF SECTION 207
TOPSOIL

METHOD OF MEASUREMENT

207.07 Topsoil material will be measured by the actual number of cubic yards of topsoil placed and accepted. Subgrade soil preparation will be measured by the square yards of subgrade which is ripped and accepted for adequate de-compaction.

BASIS OF PAYMENT

207.08 The accepted quantities measured will be paid for at the Contract unit price for each of the pay items listed below that appear in the bid schedule.

Payment will be made under:

Pay Item	**Pay Unit**
Topsoil (Onsite)	Cubic Yard
Seeding Media	Cubic Yard
Topsoil (Offsite)	Cubic Yard
Topsoil (Wetland)	Cubic Yard
Subgrade Soil Preparation	Square Yard

Amendments for Topsoil (Onsite) and Seeding Media will be measured and paid for in accordance with Section 212.

Amendments for Topsoil (Offsite) will not be measured and paid for separately, but shall be included in the work.

Noxious Weed Management will be measured and paid for in accordance with Section 217.

Stockpiling or windrowing of topsoil will not be measured and paid for separately, but shall be included in the work.

Testing of Seeding Medial and Topsoil (Offsite) will not be measured and paid for separately but shall be included in the work.

Rod penetrometer and associated verification testing of random locations will not be measured and paid for separately, but shall be included in the work.

The Site Pre-vegetation Conference will not be paid for separately, but shall be included in the work.

Additional passes with the ripping equipment to achieve the desired de-compaction will not be measured and paid for separately, but shall be included in the work.

Removing of clods, sticks, stones, debris, concrete, and asphalt in excess of 4 inches in any dimension for all topsoil and Seeding Media used within the designed clear zone for the project will not be measured and paid for separely, but shall be included in the work.

REVISION OF SECTION 208
AS-CONSTRUCTED SURVEY

Revise Sections 208 of the Standard Specifications as follows:

Add the following to Subsection 208.10(b):

(b) As-Constructed Survey. The Contractor shall complete an as-constructed survey of each Permanent Water Quality (PWQ) control measure (CM). Surveys are conducted on all PWQ CM for two reasons:

1. To provide initial location information for CDOT PWQ CM inventory, and
2. To provide necessary data for completion of the Pond Information Certification (PIC) for PWQ CM designed using the Water Quality Capture Volume (WQCV) Standard (Extended Detention Basin (EDB), Retention Pond, etc.).

The Contractor shall submit the as-constructed survey to the Project Engineer before payment for and final acceptance of any items required to construct the PWQ features. The electronic as-constructed survey shall conform to the requirements of Section 625, use Terrain Modeling Survey System (TMOSS) codes, and shall include the following information:

1. The Contractor's Professional Land Surveyor's (PLS) digital terrain model with the electronically sealed field-collected information report.
2. The PWQ survey shall include all horizontal and vertical reference points for all PWQ features as determined by the Contractor's surveyor.
3. The contours shall be shown at 1-foot intervals with major contours labeled at 5-foot increments.
4. The bottom of the EDB elevations along the toe of embankment slope and top and bottom of trickle channel elevations, to verify positive drainage throughout the basin with labels of features, elevation, and the WQCV elevation as shown on the plans.
5. The top of wall or dam elevation on the survey to verify freeboard (distance between high- water mark and top of wall or dam elevation) along the EDB, and the top width of the embankment along the perimeter of the EDB.
6. A detail of each forebay located at the outfall of each incoming storm drain into the EDB, including plan dimensions with tops of walls, tops of slabs, pipe invert elevations, and pipe diameters.
7. The basin location related to property lines (measured distances), right-of-way lines, buildings, roads, access paths, and other easements.
8. The details of the outlet control structure, including labels of features and elevations, and notes indicating if the features are the same as the design plan, or the reason they are different in the as-constructed survey.
9. The details, including labels and elevations of all grates, racks, screens, and any other materials intended to prevent clogging of the outlet structure orifices by debris of any kind. Label all features and elevations on the as-constructed deliverable CADD 3D model and Survey report.

10. The access and maintenance easements per the ROW plans around the EDB, including the maximum slope of the access easement.

11. The submitted CADD 3D model shall include the following:

    a. All control marks set per item 2, and other Project Controls as shown on the sealed Project Control diagram; ensure that contour lines are continuous, closed, unbroken polylines.

    b. Grade spot elevations and breaklines used to create the contours.

    c. Elevations for all applicable items listed in 2-10 above.

    d. Correct contours.

    e. Initial /EDB volume calculation report sealed by the PLS of the data collection.

    f. Geocoordinate system that conforms to project datum.

    g. Survey information shall be compatible with the latest 3D digital modeling software.

Submit the as-constructed survey, including field survey data, survey report, and electronic model files as a complete package to the Engineer. Allow 10 days for CDOT review of the field survey data.

If the field survey data, survey report or electronic model files indicate the control measure was incorrectly constructed, the Contractor shall perform necessary corrective work to the PWQ CM to ensure compliance with design, at no cost to the project, as directed by the Engineer. Payment will not be made for any PWQ items until corrections have been made and another survey has been completed, compared, and accepted.

The Contractor shall clean all Permanent Water Quality Control Measures before the PWQ Survey, final walkthrough and final acceptance.

Subsection 208.12 shall include the following:

Payment for the as-constructed survey of EDBs and associated items, including creating the electronic 3D CADD model and report, shall be included in Item 625 Construction Surveying.

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

Section 212 of the Standard Specifications is hereby deleted for this project and replaced with the following:

DESCRIPTION

212.01 This work consists of application of fertilizer, soil amendments, seedbed preparation, and placing seed and sod.

Substitutions from this specification will not be allowed unless submitted in writing to the Engineer and approved by the Region or Headquarters Landscape Architect.

MATERIALS

212.02 Seed, Fertilizers, Soil Conditioners, Mycorrhizae, Elemental Sulfur, and Sod.

(a) *Seed.* Seed shall be delivered to the project site in sealed bags tagged by a registered seed supplier conforming to the requirements of the Colorado Seed Act, CRS 35-27-111(1). Seed used on the project shall not be in the Contractor's possession for more than 30 days from the date of pickup or delivery on the seed vendors packing slip. Bags which have been opened or damaged prior to Engineer inspection will be rejected. The State required legal tags shall remain on the bag until opened and the seed is placed in either the drill or hydraulic seeders in the presence of the Engineer. The Engineer shall remove all tags after seed has been planted. Each seed tag shall clearly show the following:

(1) Name and address of the supplier

(2) Botanical and common name for each species

(3) Lot numbers

(4) Percent by weight of inert ingredients

(5) Guaranteed percentage of purity and germination

(6) Pounds of Pure Live Seed (PLS) of each seed species

(7) Total net weight in pounds of PLS in the sealed bag

(8) Calendar month and year of test date

Seeds shall be free from all noxious weed seeds in accordance with Colorado Seed Act (CRS 35-17) prohibited noxious weed seed list.

Weed seed content shall not exceed the requirements in part 7.2 of the Colorado Department of Agriculture's Seed Act Rules and Regulations.

Seed which has become wet, moldy, or damaged in transit or in storage will not be accepted.

Seed and seed labels shall conform to all current State regulations and to the testing provisions of the Association of Official Seed Analysis. Computations for quantity of seed required on the project shall include the percent of purity and percent of germination.

The Contractor shall store seed under dry conditions, at temperatures between 35 °F to 90 °F, under low humidity and out of direct sunlight. The Contractor shall provide the location of where seed is stored and access to stored seed locations to the Engineer. Seed stored by the Contractor for longer than 30 days will be rejected.

(b) *Organic Fertilizer*. Fertilizer derived directly from plant or animal sources shall conform to Colorado Revised Fertilizer Rules 8 CCR 1202-4. Fertilizer shall be uniform in composition and shall be delivered to the site in the original, unopened containers, each bearing the manufacturer's name, address, and nutrient analysis. Fertilizer bags (containers) which arrive at the project site opened, damaged, or lacking a label will be rejected. The Contractor shall only use bulk shipments such as tote bags or super sacks that have a manufacturer's original label and sealed at the manufacturing facility. Fertilizer which becomes caked or damaged will not be accepted. Fertilizer shall be stored according to manufacturer's recommendations in a dry area where the fertilizer will not be damaged.

Organic fertilizer formulation being submitted for use must be registered with the Colorado Department of Agriculture.

Verification tests may be conducted by CDOT on grab samples of organic fertilizer delivered to the site to determine the reliability of bag label analysis and for ingredients which are injurious to plants. If a product of any supplier is found to consistently deviate from the bag level analysis, the acceptance of that product will be discontinued. Copies of the failing test reports will be furnished to the Colorado State Board of Agriculture for appropriate action under the "Colorado Fertilizer Law".

Fertilizer shall be supplied in one of the following physical forms:

(1) A dry free-flowing granular fertilizer, suitable for application by agricultural fertilizer spreader.

(2) A homogeneous pellet, suitable for application by agricultural fertilizer spreader. Pellet size shall be 2-3 mm. Smaller may be allowed when Seeding (Native) Hydraulic is shown on the plans.

(3) A soluble form that will permit complete suspension of insoluble particles in water, suitable for application by power sprayer.

The application rate of the organic fertilizer shall be either as high or low nitrogen (N) fertilizer as shown on the plans.

High N organic fertilizer chemical analysis shall conform to Table 212-1.

Table 212-1
Chemical Analysis for High N Fertilizer

Ingredient	Range	Test Method
Nitrogen (N) (%)	6 - 10	AOAC Official Method 993.13 Nitrogen (Total) in Fertilizers Combustion Method
Phosphorus (P) (%)	1 - 8	AOAC Official Method 960.03 Phosphorus (Available) in Fertilizers
Potassium (K) (%)	1 - 8	AOAC Official Method 983.02 Potassium in Fertilizers

Low N organic fertilizer chemical analysis shall conform to Table 212-2.

Table 212-2
Chemical Analysis for Low N Fertilizer

Ingredient	Range	Test Method
Nitrogen (N) (%)	2 -5	AOAC Official Method 993.13 Nitrogen (Total) in Fertilizers Combustion Method
Phosphorus (P) (%)	3 - 8	AOAC Official Method 960.03 Phosphorus (Available) in Fertilizers
Potassium (K) (%)	1 - 8	AOAC Official Method 983.02 Potassium in Fertilizers

Organic fertilizers shall conform to Table 212-3.

Table 212-3
Organic Fertilizer Properties

Criteria	Range
Moisture content by weight	< 6%

(c) *Compost (Mechanically Applied)*. Compost shall be suitable for use in Erosion Log (Type 2) and permanent seeding applications. Compost shall not contain visible refuse, other physical contaminants, or substances considered harmful to plant growth. Compost shall be used in accordance with all applicable EPA 40 CFR 503 standards for Class A biosolids including the time and temperature standards. Materials that have been treated with chemical preservatives as a compost feedstock will not be permitted.

The Contractor shall provide material that has been aerobically composted in a commercial facility. Compost shall be from a producer that participates in the United States Composting Council's (USCC) Seal of Testing Assurance (STA) program. The Department will only accept STA approved compost that is tested in accordance with the USCC Test Methods for Examining of Composting and Compost (TMECC) manual.

Verification tests may be conducted by CDOT on grab samples of compost delivered to the site to determine the gradation and physical properties. Testing may be done for indication of ingredients which are injurious to plants. Sampling procedures will follow the STA 02.01 Field Sampling of Compost Materials and 02.01-B Selection of Sampling Locations for Windrows and Piles. If a product is found to consistently deviate from the gradation and property analysis, the acceptance of that product will be discontinued. Copies of the failing test reports will be furnished to the USCC.

1. Compost for permanent seeding soil conditioner locations onsite and application rates shall be as shown on the plans.

Organic matter in compost shall be no more than 2 inches in length.

Compost (Mechanically Applied) for permanent seeding shall meet the gradation and physical properties as shown in Table 212-4 and Table 212-5. The Contractor shall provide a written explanation for compost tested parameters not within the acceptable requirements for review and consideration.

The Contractor shall provide documentation from the composting facility confirming that the material has been tested in accordance with USCC TMECC.

Table 212-4
Gradation for Permanent Seeding Compost

Sieve Size	Percent Passing		
	Minimum	Maximum	Test Method
25.0 mm (1")	100		TMECC 02.02-B, "Sample Sieving for Aggregate Size Classification"
19.0 mm (3/4")	90	100	
6.25 mm (1/4")	70	100	

Note: Compost shall be from a producer that participates in the USCC STA program.

Table 212-5
Properties for Permanent Seeding Compost

Compost Parameters	Reported as	Requirements	Test Method
pH	pH units	6.0 - 8.5	TMECC 04.11-A
Soluble Salts (Electrical Conductivity)	dS/m (mmhos/cm)	< 5.0	TMECC 04.10-A
Moisture Content	%, wet weight basis	25% - 50%	TMECC 03.09-A
Organic Matter Content	%, dry weight basis pounds per cubic yard	20% - 50% >240	TMECC 05.07-A
Carbon to Nitrogen Ratio (C:N)		< 15:1	
Man-made Inert Contamination (plastic, concrete, ceramics, metal, etc.)	%, dry weight basis	< 1%	TMECC 03.08-A
Stability (respirometry)	mg CO_2-C per g TS per day mg CO_2-C per g OM per day	8 or below	TMECC 05.08-B
Select Pathogens and weed free	(PASS/FAIL) Limits: Salmonella < 3 MPN/4 grams of TS, or Coliform Bacteria < 1000 MPN/gram	Pass	TMECC 07.01-B Fecal Coliforms, or 07.02 Salmonella
Trace Metals	(PASS/FAIL) Limits (mg $kg^{-1,}$ dw basis): Arsenic (As) 41, Cadmium (Cd) 39, Copper (Cu)1500, Lead (Pb) 300, Mercury (Hg) 17, Nickel (Ni) 420, Selenium (Se) 100, Zinc (Zn) 2800	Pass	TMECC 04.06
Maturity (Bioassay) Percent Emergence Relative Seedling Vigor	 %, (average) %, (average)	 > 80% > 80%	TMECC 05.05-A
Use the STA Lab bulk density lb/cu ft as received, multiplied by organic matter % as received, multiplied by 27 to calculate pounds per cubic yard of organic matter.			

2. Compost for Erosion Log (Type 2) shall meet the gradation and physical properties as shown in Table 212-6 and Table 212-7.

Table 212-6
Gradation for Erosion Log (Type 2) Compost

Sieve Size	Percent Passing		
	Minimum	Maximum	Test Method
75.0 mm (3")	100		TMECC 02.02-B, "Sample Sieving for Aggregate Size Classification"
25.0 mm (1")	90	100	
9.5 mm (3/8")	10	50	

Note: Organic matter for erosion log compost shall be no more than 4 inches in length. Compost shall be from a producer that participates in the USCC STA program.

Table 212-7
Properties for Erosion Log (Type 2) Compost

Compost Parameters	Reported as	Requirements	Test Method
pH	pH units	6.0 - 8.5	TMECC 04.11-A
Soluble Salts (Electrical Conductivity)	dS/m (mmhos/cm)	< 5.0	TMECC 04.10-A
Moisture Content	%, wet weight basis	< 60%	TMECC 03.09-A
Organic Matter Content	%, dry weight basis	25% - 100%	TMECC 05.07-A
Man-made Inert Contamination (plastic, concrete, ceramics, metal, etc.)	%, dry weight basis	< 0.5%	TMECC 03.08-A
Stability (respirometry)	mg CO_2-C per g TS per day mg CO_2-C per g OM per day	N/A	TMECC 05.08-B
Select Pathogens and weed free	(PASS/FAIL) Limits: Salmonella < 3 MPN/4 grams of TS, or Coliform Bacteria < 1000 MPN/gram	Pass	TMECC 07.01-B Fecal Coliforms, or 07.02 Salmonella
Trace Metals	(PASS/FAIL) Limits (mg $kg^{-1,}$ dw basis): Arsenic (As) 41, Cadmium (Cd) 39, Copper (Cu)1500, Lead (Pb) 300, Mercury (Hg) 17, Nickel (Ni) 420, Selenium (Se) 100, Zinc (Zn) 2800	Pass	TMECC 04.06
Maturity (Bioassay)			
Percent Emergence	%, (average)	N/A	TMECC 05.05-A
Relative Seedling Vigor	%, (average)	N/A	

(d) *Biotic Soil Amendments (Hydraulically Applied*). Soil amendments shall be a combination of natural fibers, growth stimulants, and other biologically active material designed to improve seed germination and vegetation establishment as shown in Table 212-8. Biotic soil amendments shall be pre-packaged in ultraviolet and weather resistant packaging and labeled from the manufacturer. Bags (containers) which arrive at the project site opened, damaged, or lacking a label will be rejected. Bulk shipments such as tote

bags will be rejected. Biotic soil amendments shall be stored in locations not exceeding 80 °F. Acceptance of material shall be subject to the requirements of the Department's Approved Product List (APL).

The application rate of the biotic soil amendments shall be in accordance with the rates shown on the plans. Use of mulch tackifier (Plantago Insularis or pre-gelatinized corn starch polymer) shall be in accordance with Section 213. It shall be used as a wetting agent at a rate of 30 pounds per acre. Biotic soil amendments shall provide a continuous and uniform cover and shall consist of one of the components in Table 212-8 and all of the performance and physical properties in Table 212-9.

Table 212-8
Required Percentage Ranges of Biotic Soil Amendments

Components	Units	Requirement
Professional grade sphagnum peat moss, professional grade reed sedge peat moss or compost that meets the Seal of Testing Assurance Program of the US Composting Council	%, dry weight basis	> 41%
Mechanically processed straw consisting of weed free agricultural straw, flexible flax fiber or rice hulls	%, dry weight basis	< 57%

Table 212-9
Performance and Physical Requirements of Biotic Soil Amendments

Parameters	Reported as	Requirement	Test Method
pH	pH units	5.0 – 7.5	ASTM D1293
Moisture content	%, wet weight basis	10% - 50%	ASTM D 2974
Organic matter content	%, dry weight basis	> 85%	ASTM D586
Carbon Nitrogen Ratio	Ratio C:N	< 38:1	ASTM E1508
Man-made inert contamination	%, dry weight basis	< 1.0%	
Acute Toxicity	(Pass/Fail)	Pass (non-toxic)	ASTM E729-96(2014) or EPA Method 2021.0 or EPA Method 2002.0
Vegetative Minimum		> 400%	ASTM 7322
The Contractor shall provide a CTR with independent laboratory analysis for the required parameters in accordance with subsection 106.13.			

(e) *Humate*. The Contractor shall provide a screened dry granular form of organic humic and fulvic acid substance. Humate shall be pre-packaged and labeled from the manufacturer. Bags (containers) which arrive at the project site opened, damaged, or lacking label will be rejected. The Contractor shall only use bulk shipments such as tote bags or super sacks that have a manufacture's original label and sealed at the manufacturing facility. Humate shall be stored in locations not exceeding 80 °F. Humate shall be provided in accordance with the rates shown on the plans. Product shall conform to the parameters in Table 212-10 and Table 212-11.

Table 212-10
Screened Size Requirements for Humate

Seeding Method	Reported as	Requirement
Seeding (Native) Drill, Hydraulic and Broadcast	inches	< 1/4

Table 212-11
Performance and Physical Requirements of Humate

Parameters	Reported as	Requirement	Test Method
Organic Matter	%, dry weight basis	>70%	
Fines (material that is finer than the No. 200 (75-µm) sieve)	%, dry weight basis	<2%	ASTM D7928
pH	pH units	3.0 - 4.5	ASTM D1293
Acute Toxicity	Pass / Fail	Non Toxic	ASTM 7101 or EPA Method 2021 or 2002
Humic and Fulvic Acids	%, dry weight basis	> 70%	A & L Western method; total alkali extractable
Carbon Content	%, dry weight basis	40% - 50%	
Moisture Content	%, dry weight basis	< 20%	
Heavy Metal / Ash Content	%, dry weight basis	< 15%	
The Contractor shall provide a CTR with independent laboratory analysis for the required parameters in accordance with subsection 106.13.			

(f) *Mycorrhizae*. Mycorrhizae shall arrive onsite in original and undamaged packaging. Handling of this material shall follow manufacturer's safety recommendations. Mycorrhizae shall be stored onsite in such a way as to avoid exposure to direct sunlight for more than four hours and to prevent package temperatures to rise above 85 °F. The endo mycorrhizal inoculum shall provide at least 60,000 propagules per pound and shall contain all of the following species and conform to the parameters in Table 212-12:

(1) Glomus intraradices (a.k.a. Rhizophagus intraradices)

(2) Glomus mosseae (a.k.a. Funneliformis mosseae)

(3) Glomus aggregatum (a.k.a. rhizophagus aggregatus)

(4) Glomus etunicatum (a.k.a. Claroideoglomus etunicatum)

Table 212-12
Physical Requirements of Endo Mycorrhizae

Parameters	Reported as	Requirement	Test Method
Acute Toxicity	Pass or Fail	Non Toxic	ASTM 7101 or EPA Method 2021 or 2002
The Contractor shall provide a CTR with independent laboratory analysis has been done on the product for the required parameters in accordance with subsection 106.13.			

The following rates shall be used for Seeding Methods:

(1) For Seeding (Native) Drill, the mycorrhizae product shall be provided as a dry free-flowing granular material, suitable for application by agricultural drill seeder. Application rate shall be 8 pounds per acre.

(2) For Seeding (Native) Hydraulic, the mycorrhizae product shall be provided as a fine granular (< 2 mm) or powdered form (particle size less than 300 microns) that will permit complete suspension and used with hydro-seeder equipment. Application rate shall be 20 pounds per acre.

(3) For Seeding (Native) Broadcast, the mycorrhizae product shall be provided as a dry free-flowing granular material, suitable for application by fertilizer spreader. Application rate shall be 20 pounds per acre.

(g) *Elemental Sulfur.* The Contractor shall provide a free-flowing granular material consistent in size suitable for application by agricultural spreader and conform to the parameters in Table 212-13. Elemental sulfur shall arrive onsite in original and undamaged packaging.

Table 212-13
Physical Requirements of Elemental Sulfur

Parameters	Reported as	Requirement
Guaranteed Analysis of Elemental Sulfur (S)	%	> 90
Bulk Density	Lbs per cu. ft.	> 75

(h) *Sod.* Sod shall be nursery grown and 99 percent weed free. Species shall be as shown on the plans. The 1 percent allowable weeds shall not include undesirable perennial or annual grasses or plants defined as noxious by current State statute or county noxious weed list. Soil thickness of sod cuts shall not be less than ¾ inch or more than 1 inch. Sod shall be cut in uniform strips with minimum dimensions of 18 inches in width and 48 inches in length. The Contractor shall submit a sample of the sod proposed for use, which shall serve as a standard if approved. Sod furnished, whether in place or not, that is not up to the standard of the sample will be rejected. CDOT will reject all sod that was cut more than 72 hours prior to installation.

Each load of sod shall be accompanied by a certificate from the grower stating the type of sod and the date and time of cutting. The Contractor shall submit the certificate to the Engineer prior to application of the sod. Only sod that is accompanied by the certificate from the grower will be accepted and paid for.

CONSTRUCTION REQUIREMENTS

212.03 Submittals. The Contractor shall provide the name and contact information of the seeding contractor 30 days prior to start of seeding work. The Contractor shall provide two copies of items (1) - (14) listed below to the Pre-vegetation Conference in accordance with Section 207. When the Contractor provides resubmittals to meet Contract requirements, the Region or Headquarters Landscape Architect shall be copied on all correspondence.

(1) Written confirmation from the registered seed supplier, on the Contractor's letterhead, that the Contract specified seed has been secured. No substitutions of the contract specified seed will be permitted unless evidence is submitted, from one of the registered seed suppliers that the Contract specified seed is not available and will not become available during the anticipated construction period.

(2) Seed vendor's "seed dealer" endorsement.

(3) A copy of each seed species germination report of analysis that verifies the lot has been tested by a recognized laboratory for seed testing within 13 months prior to the date of seeding.

(4) A copy of each seed species purity laboratory report of analysis that verifies that the lot has been tested by a recognized laboratory for seed testing. The report shall list all identified species, seed count, and date of test.

(5) Manufacturer's documentation stating that the fertilizer meets the Contract requirements.

(6) Organic fertilizer documentation showing manufacturer and chemical analysis.

(7) Permit issued from CDPHE confirming that the vendor can produce or sell compost in accordance with House Bill (HB) 1181.

(8) Documentation from the compost manufacturer that it is a participating member of in the U.S. Composting Council's Seal of Testing Assurance Program (STA).

(9) Results of compost testing on an STA Compost Technical Data Sheet confirming all required test methods are met using the STA Program.

(10) Sample of physical compost (at least one cubic foot of material).

(11) Manufacturer's documentation confirming that biotic soil amendment meets the required physical and performance criteria based on independent testing by the manufacturer.

(12) Manufacturer's documentation confirming that humate meets the required physical and performance criteria based on independent testing by the manufacture.

(13) Manufacturer's documentation confirming that mycorrhizae meets the physical criteria based on independent testing and that the minimum required species is provided.

(14) Pictures and descriptions of seeding equipment proposed to be used on the project. Based on the seeding methods required at a minimum this should include the drill seeder, hydraulic seeder, cultipacker or seed bed roller implements.

(15) Instructions and documentation on how seeders will be calibrated onsite, in accordance with subsection 212.05(a).

212.04 Seeding Seasons. Seeding in areas that are unirrigated shall be restricted according to the parameters in Table 212-14.

Table 212-14
Seeding Seasons

Zone	Spring Seeding	Fall Seeding
Areas other than the Western Slope		
Below 6000’	Spring thaw to June 1	September 15 until consistent ground freeze
6000’ - 7000’	Spring thaw to June 1	September 1 until consistent ground freeze
7000’ - 8000’	Spring thaw to July 15	August 1 until consistent ground freeze
Above 8000’	Spring thaw to consistent ground freeze	
Western Slope		
Below 6000’	Spring thaw to May 1	August 1 until consistent ground freeze
6000’ - 7000’	Spring thaw to June 15	September 1 until consistent ground freeze
Above 7000’	Spring thaw to consistent ground freeze	

(1) "Spring thaw" is the earliest date in a new calendar year in which seed can be buried ½ inch into the surface soil (topsoil) through normal drill seeding methods.

(2) "Consistent ground freeze" is the time during the fall months in which the surface soil (topsoil), due to freeze conditions, prevents burying the seed ½ inch through normal drill seeding operations. Seed shall not be sown, drilled, or planted when the surface soil or topsoil is in a frozen or crusted state.

Seeding accomplished outside the time periods listed above will be allowed only when the Contractor's request is approved by the Engineer in writing, with coordination from the Region Landscape Architect. If requested by the Contractor, the Contractor must agree to perform the following work at no cost to the Department: reseed, remulch, and repair areas which fail to produce species indicated in the Contract.

If seeding is ordered by the Engineer outside the time periods listed above, the cost to repair areas that fail to produce species will be paid for by the Department.

212.05 Native Seeding Methods. Areas to be seeded shall be installed in accordance with SWMP Permanent Stabilization Plan.

All amendments and seeding shall be applied based on the seeding method and rates specified on the plans.

The Contractor shall complete the Amendments Verification Prerequisite for each of the seeding methods described herein. This shall be done by completing a Seed and Amendment Quantities Worksheet for each work area. This worksheet shall have a list of all amendments and the seed labels for each of the areas to be worked on. The State required legal tags shall remain on the bag until opened and the seed placed in either the drill or hydraulic seeders in the presence of the Engineer. Seeding work shall not begin until written approval of the worksheet has been received from the Engineer.

In determining the weight of seed required for each work area, the Contractor shall use the Pure Live Seed (PLS) weight shown on each bag of seed. Calculations based on net weight will not be accepted.

The Contractor shall submit a proposed Permanent Stabilization Phasing Plan to the Engineer prior to the Pre-revegetation Conference for approval showing how the SWMP Permanent Stabilization Plans will be implemented to minimize traffic loading damage to subgrade soil prepared and seeded areas. The proposed

sequencing shall consider and identify strategies and site management control measures to protect seeded areas from foot, vehicle, and other disturbances. The strategic planning of the permanent seeding and mulch shall consider all other phasing of construction activities including traffic management and utility work. Areas damaged due to the Contractor's failing to protect the seeded areas shall be repaired at no cost to the Department. Seeded areas damaged due to circumstances beyond the Contractor's control shall be repaired and reseeded as ordered. Payment for corrective work, when ordered, shall be at the Contract prices shown and in accordance with subsection 109.04.

The following seeding application methods shall not be implemented during winds which are consistently higher than 20 MPH, or when the ground is frozen, excessively wet, or otherwise untillable. The Engineer may test to see if the moisture level in the soil is acceptable to work the soil by performing a Soil Plasticity Test as described in the Construction Manual. Multiple seeding operations shall be anticipated, based on acceptable seeding conditions. The seeding methods to be implemented shall be one or more of the following, as shown on the plans:

(a) *Seeding (Native) Drill.*

(i) *Fertilizer, Compost, Humates and Elemental Sulfur.* The Contractor shall uniformly apply compost and elemental sulfur on the surface of the topsoil using an agricultural spreader at the rate of application specified on the plans. All competitive, non-native vegetation shall be uprooted and hauled offsite prior to spreading amendments. Prior to starting incorporation of compost and elemental sulfur, the Contractor shall receive written acceptance from the Engineer on the Seed and Amendment Quantities Worksheet. Verification Prerequisite for this method also requires documentation on the Permanent Stabilization SWMP Site Maps with the approved areas outlined, signed, and dated by the Engineer to track progress. If SWMP Site Maps are not included in the Contract, the Contractor shall use the Contract grading or roadway plan sheets.

Once the Quantities Verification Prerequisite is completed for an area, the Contractor shall homogenously incorporate the compost and elemental sulfur into the top 6 inches of topsoil. Tillage of the amendments shall be completed using a disc and harrow, field cultivator, vibra-shank, or other method suitable to site conditions. For small areas tillage shall be completed using rotary tillers. No measurable depth of organic amendment shall be present on the surface.

The shanks on the back of a grader or dozer shall not be used for tillage. Tillage may take multiple passes to achieve the desired harmonious incorporation. If multiple passes are required, the Contractor shall cross till the soil with the second pass occurring at a 30-degree angle to the first pass. On slope areas, all tillage shall be parallel to the contour. For project that will utilize aggregate or recycled asphalt shouldering material amendments, tillage is not required under shouldering material. Projects seeding up to the edge of pavement, tillage is not required for first 12" from the edge of pavement.

Once incorporation of compost and elemental sulfur is approved, the Contractor shall uniformly apply fertilizer and humates on the surface of the topsoil using an agricultural spreader, as shown in the Contract documents.

(ii) *Seedbed Preparation.* Amended topsoil shall be cultivated to a firm but friable seedbed using cultipacker or seed bed roller implements. Crusted hard soils shall be broken up and all areas shall be free of clods, sticks, stones, debris, concrete, and asphalt in excess of 4 inches in any dimension in accordance with Section 207. Areas shall be left in a rough and uncompacted condition with a surface variance of 2 to 4 inches.

(iii) *Seed and Mycorrhizae.* Prior to seeding, the finished grade of the soil shall be 1 inch below the top of all curbs, junction and valve boxes, walks, drives and other structures. Seeding shall be done within two

days of seedbed preparation efforts (tilling or scarifying). If a rain event occurs that compacts or erodes the seedbed prior to performing seeding, the seedbed shall be re-prepared as directed by the Engineer.

Areas shall be seeded by mechanical power drawn drills suitable for area soils, topography, and size followed by packer wheels. Mechanical power drawn drills shall have furrow openers and depth bands set to maintain a planting depth of at least ¼ inch and not more than ½ inch and shall be set to space the rows not more than 8 inches apart. Seeding equipment shall have a double disk opener, seed box agitator, and seed metering device.

The seeder shall be calibrated by collecting seed from a single drop tube in the presence of the Engineer based on the following procedure. The Contractor shall provide the tape measure, scale, collection cup, and seed bag with complete label from the supplier. The Contractor may submit an alternative method for approval at the site Pre-vegetation Conference.

(1) Measure the total width (W) of the drill seeder in feet.

(2) Count the number of drill rows (N) on the seeder.

(3) On drill seeders that the tire drives the seeding mechanism, measure the tire circumference (C) in feet.

(4) Calculate the number of rotations the tire will complete per acre using the following equation:

A = one acre or 43,560 square feet (SF)

A /W = feet (F) the drill seeder needs to travel for each acre

F/C = number of rotations (R) of the tire per acre

(5) Reduce the amount of tire rotations by one tenth.

.90R = # Tire rotations to calibrate seeder (RCS)

(6) Find the seeding rate (LBS PLS / Acre) on the Stormwater Management Plan.

(7) Using the information from the seed tag, convert the PLS seed rate to a bulk seeding rate using the following equations:

% PLS = (% purity (in decimal form) from seed label) x (% germination (in decimal form) from seed label)

(LBS PLS / Acre) from the SWMP / % PLS = Required bulk seed per acre in LBS

(8) Reduce the required bulk seed per acre based on the number of seeder tubes.

Required bulk seed per acre / N = Weight in LBS of bulk seed from one tube

(9) Reduce the required bulk seed rate from the tube by one tenth.

0.90 x Weight of bulk seed from one tube = Collected bulk seed weight (CBS) in LBS

(10) Set the drill seeder to the correct seeding rate using the manufacturer's recommendation.

(11) With the collection cup under one tube and the driving wheel jacked up, rotate the tire the RCS amount of times. Use the value stem to count the rotations.

(12) Using the scale, weigh the seed in the collection cup.

(13) Adjust the drill calibration until the weight of bulk seed in the collection cup equals the CBS in LBS.

Drill seeders shall be recalibrated every time the drill is mobilized onsite. The Contractor shall submit a written statement that the equipment is calibrated, and shall provide the correct depth based on conditions before seeding actions are initiated. The Contractor shall continuously monitor equipment to ensure that it is providing a uniform seed application.

If mycorrhizae is called for on the plans, the granules shall be included with the seed in the drill seeder such that the mycorrhizae is placed at or below the seed.

The distance between furrows produced using the drill shall not be more than 8 inches. If rows on the drill exceed 8 inches, the Contractor shall drill the areas twice (if achievable at 30-degree angles to each other) at no additional cost to the Department.

After seeding, the furrows that were created by the drill shall be maintained in place. Construction traffic, other than what is needed to mulch the areas, shall not be permitted on the areas completed.

Permanent stabilization mulching shall be accomplished within 24 hours of drill seeding.

(b) *Seeding (Native) Hydraulic.*

This method utilizes water as the carrying agent and mixes biotic soil amendments, seed, organic fertilizer, humates, mycorrhizae and elemental sulfur into a single slurry for hydraulic application. The Contractor shall furnish and place combined slurry with a hydro-seeder that will maintain a continuous agitation and apply homogenous mixture through a spray nozzle. The pump shall produce enough pressure to maintain a continuous, non-fluctuating spray that will reach the extremities of the seeding area. Water tanks shall have a means of measuring volume in the tank. Seed shall be added to the slurry onsite, no more than 60 minutes before starting application. Slurry shall be applied from a minimum of two opposing directions to achieve complete soil coverage.

The application of the single slurry shall be applied within four hours of adding Mycorrhizae.

The Contractor shall prevent seed, fertilizer, and mulch from falling or drifting onto areas occupied by rock base, rock shoulders, plant beds, or other areas where grass is detrimental. The Contractor shall remove material that falls on plants, roadways, gravel shoulders, structures, and other surfaces where material is not specified.

(i) *Seedbed Preparation*. All areas shall be loosened to at least 6 inches, leaving the surface in rough condition with a surface variance of 6 to 8 inches. On steep slopes, tillage shall be accomplished with appropriate equipment as the slope is constructed. Soil areas shall be tilled to produce loose and friable surfaces with crusted hard soils broken up. All slopes shall be free of clods, sticks, stones, debris, concrete, asphalt and all other materials in excess of 4 inches in any dimension. All competitive, non-native vegetation shall be uprooted and hauled offsite prior to spreading amendments. Under no circumstances shall the ground surface be smooth and compacted.

(ii) *Biotic Soil Amendment, Fertilizer, Humate, Mycorrhizae and Seed*. The Contractor shall assemble all materials for proposed areas to hydro-seed and review quantities with area of coverage with the Engineer as the Quantities Verification Prerequisite for this method. Prior to mixing in the tank, the Contractor shall receive written acceptance from the Engineer on the Seed and Amendment Quantities Worksheet that the correct quantities are onsite. This quantities verification prerequisite also requires documentation on the Permanent Stabilization SWMP Site Maps with the approved areas outlined, signed, and dated by the Engineer to track progress. If SWMP Site Maps were not included in the Contract, grading or roadway plan sheets shall be used. For the verification process, the Contractor shall provide the Engineer

with all documentation for materials in unopened packaging.

After the Quantities Verification Prerequisite has been approved, the hydro-seeder shall be filled with water to 1/3 of its required volume. Following this, water and biotic soil amendments shall be added to the hydro-seeder at a consistent rate. The ratio of water to Biotic Soil Amendments shall be in accordance with manufacturer's recommendations. Fertilizer, humates and mycorrhizae shall then be added until the tank has reached 3/4 of its required volume. The tank shall then be filled with water to the required volume. Uniform slurries shall be agitated or mixed for a minimum of ten minutes after all water and materials are in the tank.

Hydraulic seeding equipment shall include a pump capable of being operated at 100 gallons per minute and at 100 pounds per square inch pressure. The equipment shall have a nozzle adaptable to hydraulic seeding requirements. Storage tanks shall have a means of estimating the volume used or remaining in the tank.

Seed shall be added to the slurry onsite no more than 60 minutes before starting application. The Contractor shall increase the Seed Plan rates (LBS PLS / Acre) as shown on the plans by 1.5 times at no additional cost to the Department. The Contractor may be required to apply slurry using multiple hoses to ensure uniform application to all areas of the site. Coverage rates shall be based on the volume of material in the tank, as verified by the Engineer. Areas of lighter applications (covering more area than what is calculated) will require additional application, as directed.

An appropriate curing period shall be in accordance with manufacturer's recommendations, and shall consider forecasted weather conditions.

Permanent stabilization mulching shall be accomplished within 24 hours of hydraulic application of native seed.

(c) *Seeding (Native) Broadcast.*

This method utilizes hand equipment to broadcast spread amendments and seed over prepared seedbeds.

(i) *Fertilizing, Compost, Humate and Elemental Sulfur*. The Contractor shall uniformly apply compost and elemental sulfur on the surface of the placed topsoil using an agricultural spreader at the rate of application specified on the plans. All competitive non-native vegetation shall be uprooted and hauled offsite prior to spreading amendments. Prior to starting incorporation, the Contractor shall receive written acceptance from the Engineer on the Seed and Amendment Quantities Worksheet that the correct quantities will be applied. The Quantities Verification Prerequisite for this method also requires documentation on the Permanent Stabilization SWMP Site Maps with the approved areas outlined, signed, and dated by the Engineer to track progress. If SWMP Site Maps are not included in the Contract, the grading or roadway plan sheets shall be used.

Once the Quantities Verification Prerequisite is completed for an area, the Contractor shall homogenously incorporate the Compost into the top 6 inches of soil. Tillage of the amendments shall be completed using appropriate tools depending on the size of the area to be worked. Contractor shall use hand tillers or approved small space implements.

Once incorporation of compost and elemental sulfur is approved, the Contractor shall uniformly apply organic fertilizer and humates on the surface of the topsoil using an agricultural spreader.

(ii) *Seedbed Preparation.* Amended topsoil shall be cultivated to a firm but friable seedbed using tractor implements. Crusted hard soils shall be broken up and all areas shall be free of clods, sticks, stones, debris, concrete, and asphalt in excess of 4 inches in any dimension in accordance with Section 207. Areas shall be left in a rough condition with a surface variance of 2 to 4 inches. Under no circumstances shall the ground surface be smooth and compacted.

(iii) *Seed and Mycorrhizae.* Prior to seeding, the finished grade of the soil shall be 1 inch below the top of all curbs, junction and valve boxes, walks, drives and other structures. Seeding shall be accomplished within two days of seedbed preparation efforts (tilling or scarifying) to make additional seedbed preparation unnecessary. If a rain event occurs that compacts or erodes the seedbed prior to performing seeding, the seedbed shall be re-prepared as directed.

Areas shall be seeded by broadcast-type seeders (cyclone or approved mechanical seeders). The Contractor shall increase the Seed Plan rates (LBS PLS / Acre) as shown on the plans by 1.5 times at no additional cost to the Department.

After seeding, mycorrhizae shall be evenly hand-distributed across the area. Seed and mycorrhizae shall be covered by hand raking and covering with ¼ to ½ inch of topsoil. To ensure seeds have a firm contact with the soil the Contractor shall use a heavy roller as approved in the Site Pre-vegetation Conference. Mycorrhizae shall not be exposed to sunlight for more than four hours. Using equipment with continuous cleat tracks (cat-tracking) to cover seed is not permitted.

Permanent stabilization mulching shall be accomplished within 24 hours of broadcast seed application of native seed.

212.06 Seeding (Temporary). Areas of topsoil shall be seeded with annual grasses in accordance with SWMP Interim Site Maps or as directed by the Engineer.

Seeding may take place at any time during the year as long as the ground is not covered in snow and topsoil is not frozen. Topsoil may be placed in a stockpile or distributed on-grade after receiving subgrade soil preparation.

Interim stabilization for areas that receive temporary seeding shall be in accordance with subsection 208.04(e)2. Seed shall not be included with interim hydraulic mulch applications.

The Contractor shall wait to amend topsoil until the area is ready for permanent seeding with native seed mix shown on the SWMP. The Contractor shall use either the drill, hydraulic, or broadcast method of seeding. Seeding rates (LBS PLS / Acre) shall be increased by 1.5 times for hydraulic and broadcast methods at no additional cost to the Department.

Seed shall meet the requirements of 212.02(a) and shall be selected from Table 212-1 based on the application time.

Table 212-1
Temporary Seed Mixes

Common Name	Botanical Name	Application Time	Seeding Rates (LBS PLS / Acre)	Planting Depth (inches)
Oats	Avena sativa	October 1 - May 1	35	1 - 2
Foxtail Millet	Setaria italica	May 2 - September 30	30	1/2 - 3/4

The Contractor shall restrict motorized vehicle and foot traffic from areas that have received temporary seeding.

212.07 Seeding (Lawn). Lawn grass seeding shall be accomplished in the seeding seasons in accordance with subsection 212.03.

(a) *Fertilizing and Soil Conditioning.* The first application of fertilizer, soil conditioner, or both shall be incorporated into the soil immediately prior to seeding, and shall consist of a soil conditioner, commercial fertilizer, or both as designated in the Contract. Fertilizer called for on the plans shall be worked into the top 4 inches of soil at the rate specified in the Contract. Biological nutrient, culture, or humate based material called for on the plans shall be applied in a uniform application onto the soil service. Organic amendments shall be applied uniformly over the soil surface and incorporated into the top 6 inches of soil.

The second application of fertilizer shall consist of a fertilizer having an available nutrient analysis of 20-10-5 applied at the rate of 100 pounds per acre. It shall be uniformly broadcast over the seeded area three weeks after germination or emergence. The area shall then be thoroughly soaked with water to a depth of 1 inch.

Fertilizer shall not be applied when the application will damage the new lawn.

(b) *Seedbed Preparation.* In preparation of seeding lawn grass, irregularities in the ground surface, except the saucers for trees and shrubs, shall be removed. Measures shall be taken to prevent the formation of low places and pockets where water will stand.

Immediately prior to seeding, the ground surface shall be tilled or hand worked into an even and loose seedbed to a depth of 6 inches, free of clods, sticks, stones, debris, concrete, and asphalt in excess of 2 inches in any dimension, and brought to the desired line and grade.

(c) *Seeding.* Seed shall be drilled with mechanical landscape type drills. Broadcast type seeders or hydraulic seeding will be permitted only on small areas not accessible to drills. Seed shall not be drilled or broadcast during windy weather or when the ground is frozen or untillable.

212.08 Sodding.

(a) *Fertilizing and Soil Conditioning*. Prior to laying sod, the 4 inches of subsoil underlying the sod shall be treated by tilling in fertilizer, compost, or humates as specified on the plans. Amendments shall be applied uniformly over the soil surface and incorporated into the top 6 inches of soil.

After laying the sod, it shall be fertilized with a fertilizer having a nutrient analysis of 20-10-5 at the rate of 200 pounds per acre. Fertilizer shall not be applied when the application will damage the sod.

(b) *Soil Preparation.* Prior to sodding, the ground shall be tilled or hand worked into an even and loose sod bed to a depth of 6 inches, and irregularities in the ground surface shall be removed. Sticks, stones, debris, clods, asphalt, concrete, and other material more than 2 inches in any dimension shall be removed. Depressions or variances from a smooth grade shall be corrected. Areas to be sodded shall be smooth before sodding occurs.

(c) *Sodding.* Sod shall be placed by staggering joints with all edges touching. On slopes, the sod shall run approximately parallel to the slope contours. Where the sod abuts a drop inlet, the subgrade shall be adjusted so that the sod shall be 1-½ inches below the top of the inlet.

Within one hour after the sod is placed and fertilized it shall be watered. After watering, the sod shall be permitted to dry to the point where it is still wet enough for effective rolling. The Contractor shall roll the sod in two directions with a lawn roller capable of applying between 50 - 80 pounds per square inch of surface

pressure to eliminate air pockets.

METHOD OF MEASUREMENT

212.09 The quantities of lawn seeding and the three native seeding types will not be measured but shall be the quantities designated in the Contract, except that measurements will be made for revisions requested by the Engineer, or for discrepancies of plus or minus five percent of the total quantity designated in the Contract.

The quantity of sod will be by the actual number of square feet, including soil preparation, water, fertilizer, and sod, completed and accepted.

Organic Fertilizer, Compost (Mechanically Applied), Humates, Mycorrhizae soil amendments for Seeding (Native) methods drill, hydraulic, and broadcast will be measured by the actual quantity of material applied and accepted.

Measurement for acres will be by slope distances.

BASIS OF PAYMENT

212.10 The accepted quantities of lawn seeding, native seeding, soil conditioning, and sod will be paid for at the contract unit price for each of the pay items listed below that appear in the bid schedule. Rejected seed that has been stored longer than 30 days shall be re-ordered at the expense of the Contractor.

Payment will be made under:

Pay Item	Pay Unit
Organic Fertilizer	Pound
Compost (Mechanically Applied)	Cubic Yard
Biotic Soil Amendments (Hydraulic Applied)	Pound
Humate	Pound
Mycorrhizae	Pound
Elemental Sulfur	Pound
Seeding (Native) Drill	Acre
Seeding (Native) Hydraulic	Acre
Seeding (Native) Broadcast	Acre
Seeding (Wetland) Drill	Acre
Seeding (Wetland) Hydraulic	Acre
Seeding (Wetland) Broadcast	Acre
Seeding (Temporary)	Acre
Seeding (Lawn)	Acre
Sod	Square Foot

Topsoil preparation including incorporating and applying amendments, seedbed preparation, water, and seed mix (LBS PLS / Acre) will not be measured and paid for separately but shall be included in the work.

Calibrating, adjusting, or readjusting seeding or fertilizing equipment will not be measured and paid for separately but shall be included in the work.

No additional cost will be accepted for approved substitution of specified seed mix.

No payment will be made for areas seeded using one of the seeding methods without receiving signed Seed and Amendment Quantities Worksheet from the Engineer.

Additional seedbed preparation prior to seeding to correct compaction or erosion from storm events will not be measured and paid for separately but shall be included in the work.

Additional mobilizations as needed to complete seeding within allowed seeding seasons will not be measured and paid for separately but shall be included in the work.

Removal of all competitive, non-native vegetation prior to spreading amendments will not be measured and paid for separately but shall be included in the work.

REVISION OF SECTION 214
NURSERY STOCK CONTAINERS AND UNROOTED CUTTINGS

Delete and replace Section 214 of the Standard Specifications with the following:

DESCRIPTION

214.01 This work consists of furnishing all plants, labor, materials and equipment to install herbaceous and woody plant material, hereinafter referred to as "nursery stock". The work may also consist of obtaining live "unrooted cuttings" from approved donor plants and installing them on the site as shown on the plans.

All approvals and direction required from the Engineer in this specification will involve the Engineer working directly with Region or Headquarters Environmental Staff, as identified in the Contract.

MATERIALS

214.02 Nursery Stock and unrooted cuttings shall be of the minimum sizes and species as designated on the plans, in healthy condition with normal well-developed branch and root systems and shall conform to the requirements of the *American Standard for Nursery Stock* (ANSI Z60.1-2014). For specified deep rooted container stock the container class volume ranges shall be substituted with the requirements of this specification. See subsection 1.1.3.3 of the American Standard for Nursery Stock regarding unclassified containers.

All nursery stock and unrooted cuttings shall be free from plant diseases and insect pests. All shipments of plants shall comply with all nursery inspection and plant quarantine regulations of the State of origin and destination, and the Federal regulations governing Interstate movement of nursery stock. The Contractor shall submit proof of deposit that nursery stock, Contract species and Contract quantity have been secured 30 days post Environmental Pre-Construction Conference. For multi-year projects (two or more continuous years) the contractor shall submit a schedule for approval documenting when proof of deposits on nursery stock will be provided.

The minimum acceptable sizes of all nursery stock, with branches in normal position, shall conform to the measurements specified in the Landscape/Mitigation Plans.

Hardiness zones are defined in U.S. Department of Agriculture (USDA) 2012 Plant Hardiness Zone Map publications. Only Nursery Stock rated for USDA Hardiness Zones 2, 3, 4, and 5 will be accepted.

Other than approved unrooted cuttings or as otherwise approved by the Engineer, plants shall be nursery grown for at least one growing season, or plants that have established themselves in accordance with definitions set forth in the Colorado Nursery Act, Title 35, Article 26, CRS.

Field collected trees and shrubs shall have been root-pruned during their growing period in the nursery in accordance with standard nursery practice outlined in the American Standard for Nursery Stock.

No species substitutions are permitted without written approval. If nursery stock of acceptable quality and specified variety or size are not available, before any species substitutions will be approved the Contractor shall supply to the Engineer three written letters from nurseries verifying that a species or plant size is not available. Once three letters are provided, the Contractor Shall with Engineer's written approval:

(1) Substitute acceptable nursery stock that are larger than specified at no change in Contract price. For deep rooted nursery stock, the minimum depth requirement of the container must be maintained as stated in this specification.
(2) Substitute smaller plants than those specified on the Landscape/Mitigation Plans at the adjusted price or ratio stated in the written approval.

(3) Substitute of plants of different genus, species or variety shall be submitted to the Engineer for approval 30 days prior to installation at the adjusted price stated in the written request.

At the Environmental Pre-construction Conference, the Contractor shall name the nursery stock supplier for all items. Nursery stock will be rejected for not meeting the Contract at any of the four following times and locations:

(1) At the nursery stock supplier's location during inspection. The Engineer will notify the contractor when the nursery stock will be inspected.
(2) On the project site at the time of delivery, prior to planting.
(3) At the time of installation.
(4) At the partial or final acceptance walkthroughs on the project site.

Plant materials supplied by the Contractor shall be inspected by the Engineer at the growing site and tagged or otherwise approved for delivery. Inspection at nursery does not preclude right of rejection at construction site. Contractor shall remove rejected materials immediately from the site at Contractors expense. The Contractor shall ensure that all nursery materials meet the requirements of this Section prior to delivery.

Proposed materials shall be flagged at the nurseries by the Contractor prior to viewing by the Engineer. The Contractor shall schedule with the Engineer a time for viewing plant material at the nursery. Trips to nurseries shall be efficiently arranged to allow Engineer to maximize their viewing time. A minimum of two weeks shall be allowed for this viewing prior to time that plants are to be dug. When requested by the Engineer photographs of plant material or representative samples of plants shall be submitted. Viewing of plant materials by the Engineer at the nursery does not preclude their right to reject material at the site of planting.

The Contractor shall notify the Engineer at least three working days in advance of the anticipated delivery date of any plant material. The Contractor shall submit an invoice for each shipment of plants showing the quantities, kinds, and sizes of materials along with the certificate of inspection. Evidence of inadequate protection of plant material following digging, transit, storage or other handling will be cause for rejection. Upon arrival at the temporary storage location or work site, plants shall be inspected for proper handling (including but not limited to shipping procedures) in the presence of the Engineer for damage, including but not limited to dried out roots, broken branches, broken or loosened root balls, or torn bark. The Contractor shall replace the damaged material at their own expense.

Container grown nursery stock shall have a well-established root system reaching the sides and bottom of the container to provide a firm mass of growing medium, but shall not be root bound (i.e., have excessive root growth encircling the inside of the container). Bare root material will not be accepted as a substitution for nursery stock specified as container or balled and burlapped specified nursery stock.

Each species shall be identified by means of grower's label affixed to the plant. The grower's label shall include the data necessary to indicate conformance to specifications. For minimum plant requirements of height, width, minimum multi stems and root ball diameter as appropriate for the specified species type see the Plant Schedule on the Plans.

(a) *Nursery stock.* Contractor shall file copies of certificates after acceptance of material. Evidence of inadequate protection following digging, carelessness while in transit, or improper handling or storage, will be cause for rejection. When a plant has been rejected, the Contractor shall remove it from the area of the work and replace it with one of the required size and quality conforming to one of the following:

REVISION OF SECTION 214
NURSERY STOCK CONTAINERS AND UNROOTED CUTTINGS

(1) Deep Rooted Containers (DRC) shall be containers for growing native plants that are narrower in diameter and longer than standard nursery pots of equal volume. Containers must have physical "anti-spiraling" features such as vertical ribs on the inside walls or side slits in the sidewalls that will air-prune roots. Containers that have been treated with compounds such a copper to chemically prune the roots will not be accepted. Deep rooted container classifications shall have the following properties:

Deep Rooted Container Class Specification	**Minimum Height (Inches)**	**Minimum Volume (Cubic Inches)**
#10	8	10
#40	9	40
#60	13	60
#180	14	180
#300	29	300

(2) Standard Nursery Containers shall conform to the recommended specification in the *American Standard for Nursery* Stock (ANSI Z60.1-2014). For minimum plant requirements of height or width as appropriate for the specified species type see the Plant List on the drawings. Standard nursery container classifications shall have the following properties:

Standard Nursery Container Class	Acceptable Volume Range (Cubic Inches)
#1	152-251
#5	785-1242
#10	2080-2646
#20	4520-5152

(3) Balled and burlapped or large container shall conform to the recommended specifications in the *American Standard for Nursery Stock* (ANSI Z60.1-2014). Single stem deciduous tree caliper measurements shall be taken six inches above the ground for field grown stock and from soil line for container grown stock. Multi-stem deciduous tree and evergreen tree height measurement shall be from ground level for field grown and from soil line for container grown stock.

(b) *Unrooted Cuttings*. Unless otherwise authorized, the Contractor shall notify the Engineer at least five working days in advance of the anticipated start of harvesting cuttings. All cuttings shall be harvested from approved parent material. Approval of parent material shall be in writing from the Engineer. This approval will include a detailed description of the approved locations. The Contractor shall select a site, and if outside of the construction boundary, provide written approval from the Owner, when applicable, for access and harvesting the required number of cuttings. The harvesting site shall be left clean and tidy, to the satisfaction of the Engineer and the Owner, when applicable. Unused material including trimmings shall be cut up to 2 feet in length and evenly distributed around the wetland mitigation site.

Unrooted cuttings shall be harvested and planted in early spring (March 1st to April 15th) while the plants are still dormant. However, the Engineer may authorize an alternative harvesting and planting timeframe based on project timing. Immediately upon harvesting, all cuttings shall be placed in water so that the cut ends are covered in water, and the cuttings shall be stored in a cool location. Plants shall be completely submerged in containers with water if not planted within 24 hours of harvesting. The containers shall be continuously shaded and protected from the wind. Cuttings shall be protected from drying at all times.
During transportation, the cuttings shall be kept completely submerged in containers with water in orderly fashion to prevent damage and to facilitate handling. Cuttings should be bundled using natural twine or flexible staking tape (and not with wire) in uniform groups of 25-100 to allow for easy tracking of quantities.

(1) Live Willow Stakes –Shall be unrooted cuttings approximately 3 feet long and between ½ and 1-inch in diameter. All side branches must be trimmed. Willow cuttings shall be cut from branches with smooth undamaged bark. Branches with thick, cracked bark shall not be used because they will not re-sprout effectively. Cuttings shall be cut about one foot from the ground using sharp loppers or pruning tools. Cuts shall be clean, without stripping the bark or splitting the wood. The base cuts shall be at a 45-degree angle to identify the root end of the cutting. The top shall be cut off with a square cut so that the top of the stake is easily distinguishable from the bottom. If willow stakes are to be planted in the second half of the growing season (June 15th to October 15th), then the cut top end shall be dipped into latex paint (covering approximately 1 inch at the top of the stake) to seal and reduce desiccation in hot/dry establishment conditions.

(2) Live Brush Mattress– Live willow unrooted cuttings to be used in brush mattress as a bioengineering application. The primary branch shall be approximately 6 – 15 feet long and between ½ and 2 inches in diameter at the base. Side branches are not trimmed unless a side branch is large enough to be used as a primary branch itself. Brush cuttings shall be cut at a height of between six to twelve inches above the ground. Cuts shall be clean, without stripping the bark or splitting the wood. Live brush cuttings should be composed primarily of willow cuttings, but may include up to 20% cottonwood branch cuttings

(3) Live Brush Fascines - Live willow unrooted cuttings to be used in fascines as a bioengineering application. Unrooted cuttings diameter shall vary and shall be a minimum 5 feet long and between ¼ and 2 inches in diameter. Up to 30 percent of the bundle may be plant material that does not root easily or dead plant material. The remaining 70 percent of the bundle shall consist of younger wood between 1 to 4 years old (at a minimum 25 willow cuttings per fascines). Fascines bundles may be stored submersed in water for no longer than two weeks, if necessary.

(c) *Wood Stakes.* Wood stakes for deciduous tree support shall be 2 inches' x 2 inches square, or 2 ½ inch diameter and 6 feet long free from bends. One end of all wood posts shall be pointed. Metal stakes for deciduous tree support shall be studded 6 feet long T-Post with a minimum weight of 1.25 lbs. per linear foot. Metal stakes for evergreen tree support shall be 24 inches long and consist of either minimum weight 1.25 lbs. per linear feet T-Post or #4 or larger rebar. Wood stakes shall be made of untreated wood guaranteed to last in the ground at least two growing seasons.

(d) *Backfill*. Backfill material consists of topsoil in accordance with the Contract requirements of 207 and additional compost material thoroughly mixed together and reasonably free of rocks and plant material. All other foreign material shall be removed. Do not use subsoil removed from planting pits as backfill unless accepted by CDOT Project Engineer. Compost shall be mixed into the backfill material at a rate of 25 percent by volume.

Live Willow Stake applications do not require additional compost in the backfill material, but holes must be backfilled with topsoil or native fine alluvium (sand or gravel).

Compost for planting pits shall be in accordance with section 212.

(e) *Wood Mulch*. Mulch shall consist of virgin moist wood product with shavings having approximate dimensions of: Width: ¼ to ½ inch, Length 3 to 4 inches. Mulch shall be free of material injurious to plant growth. Sources of mulch should be free of weeds and invasive plant parts or seeds. Sawdust, dirt, garbage, or other debris mixed in the mulch is not acceptable. Contractor shall submit one pound of proposed mulch for approval.

(f) *Flex Pipe Bark Protector*. Bark Protector shall be made of flexible UV stabilized plastic that shall be able to push off and separate with tree growth, without harming the bark, stem, wood or any part of the tree.

(g) *Wildlife Protection Fencing*. When specified on plans fencing shall be made of 20-gage steel with black-vinyl coating, with a maximum opening of 1 inch.

(h) *Deciduous Tree Wrapping Materials*. Wrapping material shall be horticulturally standard waterproof corrugated cardboard material that allows stretching over time to prevent girdling of the tree.

(i) *Tree Straps.* Breathable nylon webbing 18 inches long and 1 ½ inches wide with metal grommets at each end.

CONSTRUCTION REQUIREMENTS

214.03 All nursery stock shall be protected from drying out or other injury with acceptable practices within the industry. Broken and damaged roots shall be pruned before planting.

(a) *Planting Seasons.* Nursery stock shall be planted in accordance with the Contract.

Areas to be planted shall be brought to the lines and grades designated or approved. The Contractor shall place all plant material according to the approved Landscape/Mitigation Plans to the degree that unsuitable planting locations shall be avoided. Trees shall be planted outside of the clear zone, except when guardrail or vertical curb exists, this distance may be reduced to 20 feet. Shrubs shall not be planted closer than 6 feet from the edge of pavement. Locations of all nursery stock and unrooted cuttings shall be staked in the field prior to planting. Plants and planting locations shall be checked in the field by CDOT Region Biologist or CDOT Landscape Architect and shall be adjusted to the position as approved before planting begins. Planting holes shall not be constructed until written approval has been received from the Engineer.

(b) *Excavation.* Planting pits shall be circular in outline with vertical or sloped sides. The Contractor shall roughen sides of the pit to remove any compacting or glazing. When conditions detrimental to plant growth are encountered, such as over compacted topsoil, rubble fill, debris, or obstructions, notify the Engineer before planting. Use of a tree spade to dig plant pits is prohibited.

(c) *Planting.* Planting shall be done in accordance with good horticultural practices and only after topsoil has been placed. Plants of upright growth shall be set plumb and plants of prostrate type shall be set normal to the ground surface. Plants with dry, broken, or crumbling roots will not be accepted for planting. When conditions detrimental to plant growth are encountered, such as over compacted topsoil, rubble fill, debris, or obstructions, notify the Engineer before planting. Use of a tree spade to dig plant pits is prohibited. Pits excavated with a backhoe shall be scarified as needed.

For automated irrigated areas planting pits shall be dug 2 to 4 inches shallower than the height of the rootball for trees, and 2 inches shallower for shrubs. In non-irrigated areas, planting pits shall be dug so that the top of the rootball is 2-4 inches depressed from surrounding final grades. The nursery stock shall be set in the center of the planting pit on undisturbed soil.
Trees shall be stabilized and then the top third of the wire basket, any twine and burlap shall be removed before the pit is backfilled. Shrubs shall be planted in the center of the pit. All of the plastic, metal and fabric, containers shall be removed. Peat containers shall be removed if directed by the Engineer. If the nursery stock is root-bound (roots circle the root ball) shallow scores with a sharp knife ¼ to ½ inch deep shall be made along the edges and the bottom of the rootball.

Areas to be planted with ground cover shall be prepared by placing topsoil and a ½ inch layer of soil conditioner on the ground surface, and rototilling to a depth of 6 inches. Ground cover shall be planted by excavating to a depth sufficient to accommodate the root structure of plant materials without crimping or bending roots. After planting, backfill shall be placed around the ground cover and compacted firmly around the roots. The planted areas shall be brought to a smooth and uniform grade, and then top dressed with a 2-inch-deep wood mulch.

(d) *Backfilling.* Backfill shall be thoroughly worked and watered-in to eliminate air pockets. For trees backfill ½ of the planting pit and saturate to remove air pockets. After settling finish backfilling and saturate again. After the soil has settled, nursery stock must be in the proper position and at the proper depth. Saucers shall be prepared around each plant to the dimensions shown on the planting details. For all nursery stock the excavated area shall be covered with a 4-inch-thick layer of wood mulch. After completion of all planting and before acceptance of the work, the Contractor shall water nursery stock installed under this Contract, as

needed to maintain a moist root zone optimum for plant growth. Nursery stock or prepared surfaces damaged during planting operations by the Contractor's operations shall be replaced at the Contractor's expense.

Surplus soil remaining after backfilling is completed shall be used for constructing water retention berms, or, if not needed for berms, shall be thinly distributed (wasted) in the vicinity, subject to approval of the Engineer.

(e) *Wood Mulch*. Mulch shall be placed to a minimum of 4-inch depth to cover nursery stock excavated areas, but not touching the trunk of trees.

(f) *Pruning.* All deciduous trees and shrubs shall be pruned in accordance with standard horticultural practice, preserving the natural character of the plant. Guidelines for pruning are indicated in the planting details. Pruning cuts shall be made with sharp clean tools.

All clippings shall become the property of the Contractor and be removed from the site.

(g) *Guying.* All deciduous trees 2-inch caliper and greater shall be staked as designated on the plans. Coniferous trees 4 feet or taller shall be staked as designated on the plans.

(h) *Deciduous Wrapping Materials.* Wrapping shall be applied from the base of the tree upward to the second scaffold branch and secured with arbor tape. Populus species shall be exempt from tree wrap. The Contractor shall submit the manufacturer's certification for the wrapping material requirements. Wrapping shall be done in the fall months prior to freeze and removed in the spring. Wrapping shall not remain on any trees throughout the summer months. Wrapping shall be removed by the Contractor.

All plant tags shall be removed from plants and all packing or other material used by the Contractor shall be removed from the site. Upon completion of work, the Contractor shall remove plant containers, bags and other debris and leave area in clean, acceptable condition.

(i) *Unrooted Cuttings.* Upon arrival at the construction site, cuttings shall be inspected for acceptability. Only healthy, undamaged material will be accepted. During installation activities, the cuttings shall be kept wet and out of the direct sun light. No cuttings shall be out of water for more than 10 minutes before planting. Water shall be applied to areas around the cuttings until the soil mass is saturated. Cuttings shall be watered thoroughly every day for a period of one month, unless natural soil saturation occurs within 12 inches of soil surface, as verified by the Engineer. Unrooted cuttings shall be used in the following:

1. *Live Willow Stakes*. Using a rock bar or other mechanical method such as a stinger backhoe attachment or trenching equipment, create a vertical hole or trench deep enough to reach a depth at which the water table will be present throughout the growing season, or deep enough to extend below the low summer flow, or groundwater elevation of the adjacent stream channel. Planting zones shall be surveyed and staked in the field for approval by the Engineer prior to planting. Insert 2/3 of the live cutting into the hole/trench, with the 45 degree cut end down, so that the end of the cutting maintains contact with the natural water table throughout the entire growing season; planting depth must consider the natural fall of the water table that typically occurs in late summer. Planting depth shall be verified by Engineer. The placement of these cuttings shall be in areas shown on the plans and at the spacing specified. Minor adjustments in placement and spacing may be necessary based on field conditions.

The root end of cuttings shall be tamped into the pilot hole or placed in a trench to a minimum depth of 2 feet, or until the root-end of the cutting meets elevation at which groundwater will be present at the driest point of the growing season. Note that some water tables will vary greatly from April to October; the Contractor shall consult with the Engineer and Region environmental staff for proper depth.

The top of the cutting shall protrude a minimum of 4 inches, but no more than 1/3 of its length with at least two live buds showing above ground. Dead blow hammers or rubber mallets shall be used to tamp in the cuttings into holes, in such manner as to not cause the wood to split. Trench planting should not require any tamping.

Live cuttings require direct contact with soil. Soil shall be placed/backfilled in any spaces around the cuttings and tamped into place to remove any air pockets; if necessary, a soil-water slurry should be used to ensure good soil contact with cutting.

Water shall be applied to the planted cutting stakes areas until the soil mass is saturated. Cuttings shall be watered thoroughly every day for a period of one month, unless natural soil saturation occurs within 12 inches of soil surface, as determined by the Engineer, in consultation with the Region environmental representative.

2. Live Brush Mattress. Live unrooted cuttings shall be evenly distributed in the dimensions shown on the plans and laid flat against sloped stream bank to create a continuous mat of brush. The cut-end of the *branches* shall be buried in the toe of the slope. At a minimum, the ends shall be buried 6 inches at the toe of slope or otherwise secured with willow fascines, log and/or rock as specified in plans. The Contractor shall ensure that the lower willow tips are in contact with soil that is saturated during normal low flow stream conditions. The mattress will be secured to the stream embankment with a network of wood stakes and twine. Utilize minimum length 24-inch-long wood stakes and 0.25-inch diameter machine spun bristle coil twine (tensile strength: 140 pounds).

The Contractor shall cover the mattress with a thin layer of clean topsoil and seed with wetland seed mix. Soil covering should cover 90 percent of the unrooted cuttings. Approximately 10 percent but no more than 20 percent of the cuttings should daylight above the soil covering once soil has settled into the voids of the mattress.

3. Live Brush Fascine. A fascine is a bundle of unrooted cuttings, fastened together with 0.25-inch diameter machine spun bristle coil twine (tensile strength: 140 lbs.) to keep the bundles tightly tied until placed in the ground and buried. Clean topsoil shall be worked over and around the bundles, no compaction is required. The length of the wattle bundle shall be placed parallel with the contour of the ground. Wood stakes shall be placed as shown on the plans centered along bundle. Utilize minimum length 24-inch wood stakes and 0.25-inch diameter machine spun bristle coil twine (tensile strength: 140 pounds). The Contractor shall puddle with water and allow soil to settle, then repeat backfill procedure until wattle bundle is covered to three-quarters of bundle height. Unrooted cuttings installed above reliable ground water supply shall be watered thoroughly every day for a period of one month. Watering shall be continued after the first month at a minimum of once a week until the completion of the project.

(j) *Watering*.

1. Watering for nursery stock in irrigated areas (projects with 623 pay items). Irrigation system shall be operating and supplying the correct amount of water to the immediate area prior to any nursery stock being planted. Plants shall be thoroughly watered within 15 minutes of planting.

2. Watering in newly planted nursery stock and unrooted cuttings in non-irrigated areas. The Contractor shall furnish and supply the correct amount of water to the area receiving unrooted cuttings and nursery stock to keep the plants in a healthy and vigorous condition. All plantings shall be watered within four hours of placement. All plant material shown on the plans (excluding seeded areas) shall be watered to ensure successful establishment of the plant. Rate of flow shall allow the water to soak into the soil adjacent to the planting. At no time shall watering operations be applied at a rate or intensity that causes surface run off.

(k) *Maintenance of landscape during construction*. Maintenance of landscaping shall start immediately upon placement of first permanent landscaping and continue until the Notice of Substantial Landscape Completion has been received. The Contractor shall maintain the seeded areas, nursery stock and unrooted cuttings in a healthy and vigorous growing condition to ensure successful establishment. Maintenance shall consist of the following:

Work Item	Function	Notes
Weed control of areas having native seed	Areas shall be kept free of harmful insects, disease and weeds	Weed management strategies shall be discussed during the Site Pre-Vegetation Conference.
Hand watering trees	All plant material shown on the plans (excluding seeded areas) shall be watered to ensure successful establishment of the tree. Rate of flow must allow the water to soak into the soil adjacent to the planting. At no time shall watering operations be applied at a rate or intensity that causes surface run off.	Trees shall be watered two times a month at a rate of 10 gallons for each diameter inch of the tree for the months of May through October, and one time per month for the months of November through April.
Hand watering trees, shrubs, herbaceous plants and unrooted cuttings	All plant material shown on the plans (excluding seeded areas) shall be watered to ensure successful establishment of the plant. Rate of flow must allow the water to soak into the soil adjacent to the planting. At no time shall watering operations be applied at a rate or intensity that causes surface run off.	All plant material shown on the plans (excluding seeded areas) shall be watered to ensure successful establishment of the plant. Rate of flow must allow the water to soak into the soil adjacent to the planting. At no time shall watering operations be applied at a rate or intensity that causes surface run off.

214.04 Nursery Stock Warranty Period. After all landscaping work in the Contract has been installed and completed, a Substantial Landscape Completion Inspection shall be held including the Contractor, Engineer and the Region Environmental Staff to determine acceptability of the landscaping work. During the inspection, an inventory of rejected material will be made, and corrective and necessary cleanup measures will be determined. The approval of the Notice of Substantial Landscape Completion will take place upon successful removal of rejected material and required cleanup measures.

The beginning of the Nursery Stock Warranty Period depends upon the time the receipt from the Engineer of a written Notice of Substantial Landscape Completion is issued. If the Notice of Substantial Landscape Completion is issued between March 20 and June 21, the Nursery Stock Warranty Period begins immediately and lasts for a period of 12 months. If the Notice of Substantial Landscape Completion is issued prior to this time (January 1 through March 19), Nursery Stock Warranty begins on March 20 of that year and lasts for the remaining months until March 20 of the following year. If the Notice of Substantial Landscape Completion is issued after this time (June 22 through December 31), the Nursery Stock Warranty Period begins on March 20 of the following year and lasts for a period of 12 months. Variations to these dates are permitted, and shall be as directed.

Dead, dying, or rejected material shall be removed each month during the Nursery Stock Warranty Period as directed. Deep rooted container #10 and standard nursery container #1 along with all larger nursery stock container sizer shall be replaced only one time during the spring calendar dates as shown above. Nursery stock containers smaller than deep rooted container #10 and standard nursery container#1 along with seeding and

unrooted cuttings will not be included in Nursery Stock Warranty Period. Nursery Stock replacements shall be planted in accordance with the Contract and shall be subject to all requirements specified for the original material.

Contractor access to private property for nursery stock replacement work will not be extended beyond the terms of the temporary construction easement(s) for the project, unless another temporary easement agreement or extension of the original temporary easement is granted.

The contract performance and payment bond, as required in subsection 103.03, shall include all required work involved during the Nursery Stock Warranty Period.

METHOD OF MEASUREMENT

214.05 The quantity of nursery stock to be measured will be the number of plants, of the types and sizes designated in the Contract that are actually planted and accepted.

Live Willow Stakes will be measured by the number actually installed and accepted.

Live Brush Mattress will be measured by the actual number of linear feet installed and accepted.

Live Brush Fascines will be measured by the actual number of linear feet installed per the detail on the plans and accepted.

BASIS OF PAYMENT

214.06 The accepted quantities of nursery stock and unrooted cuttings will be paid for at the contract unit price for each of the items listed below:

Payment for the total cost of the item will be made at the completion of the installation of each item.

Cost of the performance bond shall be included in the cost of the plant items.
Payment will be made under:

Pay Item	**Pay Unit**
Tree (Inch Caliper)	Each
Tree (Foot)	Each
Deep Rooted Container (DRC #)	Each
Standard Nursery Container (# Container)	Each
Live Willow Stakes	Each
Live Willow Fascine	Linear Feet
Live Brush Mattress	Linear Feet

Nursery Stock Warranty Period will not be measured and paid for separately but shall be included in the work. All costs associated with replacing nursery stock larger than deep rooted container#10 and standard nursery container #1 shall be at the Contractor’s expense.

Additional slow-release organic fertilizer for nursery stock shall be used as specified in the plans will not be measured and paid for separately but shall be included in the work.

Compost required for backfill of nursery stock will not be paid for separately but shall be included in the work.

REVISION OF SECTION 214
NURSERY STOCK CONTAINERS AND UNROOTED CUTTINGS

All water required for nursery stock and unrooted cuttings in projects without 623 pay items will be measured and paid for in accordance with Section 209 under Pay Item Water (Landscaping), up to the Notice of Substantial Completion.

Water required after the acceptance of the Notice of Substantial Completion will not be measured and paid for separately but shall be included in the work.

Standard waterproof tree wrap and flex pipe bark protector for nursery stock will not be measured and paid for separately, but shall be included in the work.

Cleaning or repair of site conditions from equipment used by the Contractor for planting operations will not be measured and paid for separately by shall be included in the work.
Wood mulch, stakes, guy wire, PVC protector, safety caps, wrapping, and all other materials required to install a tree will not be measured and paid for separately but shall be included in the work.

Wood stakes and other materials required to secure Live Brush Mattresses and Live Brush Fascines will not be measured and paid for separately but shall be included in the work.

Seeding will be measured and paid for in accordance with Section 212 and Topsoil will be measured and paid for in accordance with Section 207.

Maintenance of Landscaping during construction will not be measured and paid for separately but shall be included in the work.

October 1, 2022

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REVISION OF SECTION 601
CLASS DF CONCRETE

Section 601 of the Standard Specifications is hereby revised for this project to include the following:

Add the following to Table 601-1:

Concrete Class	Required Field Compressive Strength (psi)	Air Content: % Range (Total)	Slump	Maximum Water/Cementitious Material Ratio:
DF	4500 at 28 days	4 - 8	+/- 2" of Form 1373 Slump	w/cm on Form 1373

Add the following to subsection 601.02:

Class DF concrete is a macro fiber-reinforced concrete. Additional requirements are:

(1) The concrete mix shall include approved macro or hybrid polyolefin fibers at a minimum dosage of 4 lb/cy or the minimum dosage specified on the Department's Approved Product List (APL), whichever is greater.

(2) The unrestrained shrinkage shall not exceed 0.050 percent at 28 days when tested by CP-L 4103.

(3) The mix shall either have a permeability not exceeding 2,500 coulombs at an age of not more than 56 days when tested per ASTM C1202 or have a surface resistivity of at least 12 kΩ-cm at 28 days using AASHTO T358.

(4) The mix may use an OG with a nominal maximum aggregate size of at least 3/4 inch.

(5) The mix shall have a nominal maximum aggregate size of at least 3/4 inch if an OG is not used.

(6) When used in slip forming, an edge slump less than 6 mm (0.25 in.) and less than 30 percent surface voids (ranking of 2 or less) is required. The box test is described in CP 63.

(7) Shrinkage reducing admixtures may be incorporated into the mix.

(8) An expansive cement additive may be added to an ASTM C150 Type I/II cement and fly ash to produce an ASTM C845 Type K cement. The proportion of the expansive cement additive will be determined by testing the cementitious material blend per ASTM C806. The blended material shall have an expansion of 0.04 to 0.10 percent at 7 days when tested per ASTM C806. When an expansive cement is used, the w/cm ratio shall be 0.45 to 0.55 and the expansion of the laboratory trial mix shall be 0.05 to 0.09 percent at 7 days when tested per ASTM C878.

REVISION OF SECTION 601
STRUCTURAL CONCRETE

Revise Section 601 of the Standard Specifications as follows:

Revise Section 601.02 by deleting all references to Concrete Class G, as shown:

601.01 This work consists of furnishing and placing hydraulic cement concrete in accordance with these specifications and in conformity with the lines, grades and dimensions as shown on the plans or established.

This work includes preparing concrete surfaces designated in the Contract and applying an approved colored Structural Concrete Coating to them.

601.02 Classification. The classes of concrete shown in Table 601-1 shall be used when specified in the Contract.

REVISION OF SECTION 601
STRUCTURAL CONCRETE

Table 601-1
CONCRETE FIELD REQUIREMENTS

Concrete Class	Required Field Compressive Strength (psi)	Air Content: % Range (Total)	Slump[2]	Maximum Water/Cementitious Material Ratio:
B	4500 at 28 days	5 - 8	+/- 2" of Form 1373 Slump	w/cm on Form 1373
BZ	4000 at 28 days	N/A[1]	6" – 9"	w/cm on Form 1373
D	4500 at 28 days	5 – 8	+/- 2" of Form 1373 Slump	w/cm on Form 1373
DT	4500 at 28 days	5 – 8	+/- 2" of Form 1373 Slump	w/cm on Form 1373
PS (Girders)	8500 at 28 days	N/A[1]	9" maximum	0.45
PS (Deck Panels)	6000 at 28 days	N/A[1]	9" maximum	0.45
P	4500 at 28 days	4 – 8	+/- 2" of Form 1373 Slump	w/cm on Form 1373
S35	5000 at 28 days	5 – 8	+/- 2" of Form 1373 Slump	w/cm on Form 1373
S40	5800 at 28 days	5 – 8	+/- 2" of Form 1373 Slump	w/cm on Form 1373
S50	7250 at 28 days	5 – 8	+/- 2" of Form 1373 Slump	w/cm on Form 1373
Shotcrete	4500 at 28 days	7-10[3]	N/A	0.45

REVISION OF SECTION 601
STRUCTURAL CONCRETE

[1] 5 - 8% when specified
[2] Slump shall be a maximum of 9.0 inches for all classes of concrete. Concrete may have a slump above 9.0 inches when designed as Self Consolidating Concrete (SCC). The requirements for slump flow, blocking assessment, and segregation shall apply.
[3] Prior to pumping for wet process.

Class B concrete is an air entrained concrete for general use. Class D or P concrete may be substituted for Class B concrete. Additional requirements are:

(1) The coarse aggregate shall have a nominal maximum size of 1½ inches or smaller.

(2) Class B Concrete for Slope and Ditch Paving shall be macro-fiber reinforced.

Class BZ concrete is concrete for drilled shafts. Additional requirements are:

(1) Entrained air is not required unless specified in the Contract. When entrained air is specified in the Contract, the air content shall be 5 to 8 percent.

(2) Slump shall be a minimum of 6 inches and a maximum of 9 inches. A minimum slump of 6 inches shall be maintained during the anticipated pour period. The use of retarders and hydration stabilizers are allowed to extend the slump life of the concrete. When the Contractor elects to use SCC, the slump requirement for Class BZ Concrete does not apply.

(3) The coarse aggregate size shall be AASHTO M43 size #8 unless otherwise approved by the Engineer.

(4) The mix shall either have a permeability not exceeding 2,500 coulombs at an age of not more than 56 days when tested in accordance with ASTM C1202, or have a surface resistivity of at least 12 kΩ-cm at 28 days using AASHTO T358.

(5) The unrestrained shrinkage shall not exceed 0.050 percent at 28 days when tested by CP-L 4103.

Class D concrete is a denser general use concrete. Additional requirements are:

(1) The mix shall either have a permeability not exceeding 2,500 coulombs at an age of not more than 56 days when tested in accordance with ASTM C1202, or have a surface resistivity of at least 12 kΩ-cm at 28 days using AASHTO T358.

(2) The unrestrained shrinkage shall not exceed 0.050 percent at 28 days when tested by CP-L 4103.

(3) The mix may use an optimized gradation (OG) with a nominal maximum aggregate size of at least ¾ inch.

(4) The mix shall have a nominal maximum aggregate size of at least ¾ inch if an OG is not used.

(5) When used in slip forming, an edge slump less than 6 mm (0.25 in.) and less than 30 percent surface voids (ranking of 2 or less) is required. The box test is described in CP 63.

(6) Class D Concrete for sidewalks on bridge decks and bridge rail shall be macro-fiber reinforced.

Class DT concrete is used for bridge deck resurfacing. Additional requirements are:

(1) The concrete mix shall consist of a minimum 50 percent AASHTO M 43 size No. 7 or No. 8 coarse aggregate by weight of total aggregate.

(2) The mix shall either have a permeability not exceeding 2,500 coulombs at an age of not more than 56 days when tested in accordance with ASTM C1202, or have a surface resistivity of at least 12 kΩ-cm at 28 days using AASHTO T358.

(3) The unrestrained shrinkage shall not exceed 0.050 percent at 28 days when tested by CP-L 4103.

Class P concrete is used in pavements. Additional requirements are:

(1) The Required Field Flexural Strength shall be 650 psi.

(2) The concrete mix shall consist of a minimum 55 percent AASHTO M 43 sizes No. 57, No. 6, No. 67, No. 357, or No. 467 coarse aggregate by weight of total aggregate.

(3) The mix may use an OG with a nominal maximum aggregate size of at least ¾ inch.

(4) ASTM C150 Type III and ASTM C1157 Type HE cements may be used for early opening.

(5) The mix shall either have a permeability not exceeding 2,500 coulombs at an age of not more than 56 days when tested in accordance with ASTM C1202, or have a surface resistivity of at least 12 kΩ-cm at 28 days using AASHTO T358.

(6) The unrestrained shrinkage shall not exceed 0.050 percent at 28 days when tested by CP-L 4103.

(7) When concrete is to be placed using a paver, an edge slump less than 6 mm (0.25 in.) and less than 30 percent surface voids (ranking of 2 or less) is required. The box test is described in CP 63.

(8) A minimum of 20 percent Class F fly ash or 30 percent Slag cement by weight shall be used to replace any ASTM C150 cement, any ASTM C1157 cement, or ASTM C595 Type IL cement. ASTM C595 Type IT(MS), IT(HS), IP(MS) or IP(HS) cements may be used without cement substitutions. Class C fly ash may be used if the calcium oxychloride is determined to be less than 15 g CaOXY/100 g cementitious paste as determined in accordance with AASHTO T 365 for Class 0 Sulfate Exposure.

Class PS Class PS concrete is used for prestressed concrete members. Requirements for Class PS concrete are specified in subsection 618.11. ASTM C150 Type III and ASTM C1157 Type HE cements may be used.

Class S35, S40, and S50 concretes are dense high strength concretes. Additional requirements are:

(1) The concrete mix shall be made with AASHTO M 43 sizes No. 57, No. 6, No. 67, No. 7 or No. 8 course aggregate.

(2) When placed in a bridge deck, the mix shall have a nominal maximum aggregate size of at least 3/4 inch.

(3) The mixes may use an OG with a nominal maximum aggregate size of at least 3/4 inch.

(4) For S35 and S40 concretes, the unrestrained shrinkage shall not exceed 0.050 percent at 28 days when tested by CP-L 4103.

(5) For S50 concretes, the unrestrained shrinkage shall not exceed 0.040 percent at 28 days when tested by CP-L 4103.

(6) For S35 and S40 concretes, the mix shall either have a permeability not exceeding 2,000 coulombs at an age of not more than 56 days when tested in accordance with ASTM C1202, or have a surface resistivity of at least 14 kΩ-cm at 28 days using AASHTO T358.

(7) For S50 concrete, the mix shall either have a permeability not exceeding 1,500 coulombs at an age of not more than 56 days when tested in accordance with ASTM C1202, or have a surface resistivity of at least 18 kΩ-cm at 28 days using AASHTO T358.

REVISION OF SECTION 601
STRUCTURAL CONCRETE

Class Shotcrete concrete is used for shotcrete applications. Additional requirements are:

(1) The required air content prior to the pump for wet process applications shall be 7–10 percent.

(2) Additional requirements are listed in subsection 641.02.

The Contractor may design Class B, Class BZ, Class D, Class PS, Class S35, Class S40, and Class S50 concrete to be Self Consolidating Concrete (SCC) with the following requirements:

(1) SCC shall have a slump flow of 20 to 26 inches when tested in accordance with ASTM C1611 using an inverted slump cone.

(2) SCC shall have a maximum blocking assessment of 2.0 inches when tested in accordance with ASTM C1621.

(3) SCC shall have a maximum static segregation of 10 percent when tested in accordance with ASTM C1610.

REVISION OF SECTION 601
SULFATE MITIGATION

Revise Section 601 of the Standard Specifications as follows:

Revise Section 601.04, delete the Class 2 and Class 3 requirements and replace them as follows:

Class 2 requires that the concrete have a maximum Water/Cementitious Material Ratio of 0.45 and one of the following:

(1) ASTM C150 Type V with a minimum of a 20 percent substitution of Class F fly ash or slag cement by weight

(2) ASTM C150 Type II or III or ASTM C595 Type IL with a minimum of a 20 percent substitution of Class F fly ash, High-Reactivity Pozzolan, or slag cement by weight. The Type II,III, or IL cement shall have no more than 0.040 percent expansion at 14 days when tested according to ASTM C452.

(3) A blend of portland cement meeting ASTM C150 Type II or III with a minimum of 20 percent Class F fly ash, High- Reactivity Pozzolan, or slag cement by weight, where the blend has less than 0.05 percent expansion at 6 months or 0.10 percent expansion at 12 months when tested according to ASTM C1012

(4) ASTM C595 Type IP(HS), IL(HS), or IT(HS). Class F fly ash, slag cement, or High-Reactivity Pozzolan may be substituted for Type IL(HS) cement.

(5) ASTM C595 Type IL(MS) or IT(MS) plus Class F fly ash, slag cement, or High-Reactivity Pozzolan where the blend has less than 0.05 percent expansion at 6 months or 0.10 percent expansion at 12 months when tested according to ASTM C1012

Class 3 requires that the concrete have a maximum Water/Cementitious Material Ratio of 0.40 and one of the following:

(1) A blend of portland cement meeting ASTM C150 Type II, III, or V or ASTM C595 Type IL(MS) with a minimum of a 20 percent substitution of Class F fly ash, High-Reactivity Pozzolan, or slag cement by weight, where the blend has less than 0.10 percent expansion at 18 months when tested according to ASTM C1012

(2) ASTM C595 IT(MS) plus High-Reactivity Pozzolan where the blend has less than 0.10 percent expansion at 18 months when tested according to ASTM C1012

(3) ASTM C595 Type IP(HS), IL(HS), or IT(HS) having less than 0.10 percent expansion at 18 months when tested according to ASTM C1012. Class F fly ash, slag cement, or High-Reactivity Pozzolan may be substituted for Type IL(HS) cement.

(4) ASTM C150 Type I, II, III, or V or ASTM C595 Type IL(MS) plus a minimum of 20 percent Class F fly ash when the R factor of the fly ash is less than 0.75. R factor is determined using the following from the chemical composition of the fly ash:

$$R = \frac{CaO - 5}{Fe_2O_3}$$

AFFIRMATIVE ACTION REQUIREMENTS
EQUAL EMPLOYMENT OPPORTUNITY

A. AFFIRMATIVE ACTION REQUIREMENTS

Notice of Requirement for Affirmative Action to Ensure Equal Employment Opportunity (Executive Order 11246)

1. The Bidder's attention is called to the "Equal Opportunity Clause" and the "Standard Federal Equal Employment Opportunity Construction Contract Specifications" set forth herein.

2. The goals and timetables for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work in the covered area are as follows:

Goals and Timetable for Minority Utilization

Timetable - Until Further Notice			
Economic Area	**Standard Metropolitan Statistical Area (SMSA)**	**Counties Involved**	**Goal**
157 (Denver)	2080 Denver-Boulder	Adams, Arapahoe, Boulder, Denver, Douglas, Gilpin, Jefferson.....	13.8%
	2670 Fort Collins	Larimer.....	6.9%
	3060 Greeley	Weld.....	13.1%
	Non SMSA Counties	Cheyenne, Clear Creek, Elbert, Grand, Kit Carson, Logan, Morgan, Park, Phillips, Sedgwick, Summit, Washington & Yuma.....	12.8%
158 (Colo. Spgs. - Pueblo)	1720 Colorado Springs	El Paso, Teller.....	10.9%
	6560 Pueblo	Pueblo.....	27.5%
	Non SMSA Counties	Alamosa, Baca, Bent, Chaffee, Conejos, Costilla, Crowley, Custer, Fremont, Huerfano, Kiowa, Lake, Las Animas, Lincoln, Mineral, Otero, Prowers, Rio Grande, Saguache.....	19.0%
159 (Grand Junction)	Non SMSA	Archuleta, Delta, Dolores, Eagle, Garfield, Gunnison, Hinsdale, La Plata, Mesa, Moffat, Montezuma, Montrose, Ouray, Pitkin, Rio Blanco, Routt, San Juan, San Miguel	10.2%
156 (Cheyenne - Casper WY)	Non SMSA	Jackson County, Colorado.....	7.5%
GOALS AND TIMETABLES FOR FEMALE UTILIZATION Until Further Notice.....6.9% -- Statewide			

These goals are applicable to all the Contractor's construction work (whether or not it is Federal or federally assisted) performed in the covered area. If the Contractor performs construction work in a geographical area located outside of the covered area, it shall apply the goals established for such geographical area where the work is actually performed. With regard to this second area, the Contractor also is subject to the goals for both its federally involved and non-federally involved construction.

The Contractor's compliance with the Executive Order and the regulations in 41 CFR Part 60-4 shall be based on its implementation of the Equal Opportunity Clause specific affirmative action obligations required by the specifications set forth in 41 CFR 60-4.3(a), and its efforts meet the goals established for the geographical area where the contract resulting form this solicitation is to be performed. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade, and the Contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor or from project to project for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, the Executive Order and the regulations in 41 CFR Par 60-4. Compliance with the goals will be measured against the total work hours performed.

3. The Contractor shall provide written notification to the Director of the Office of Federal Contract Compliance Programs within 10 working days of award of any construction subcontract in excess of $10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the name, address and telephone number of the subcontractor; employer identification number; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the contract is to be performed.

4. As used in this specification, and in the contract resulting from this solicitation, the "covered area" is the county or counties shown on the Invitation for Bids and on the plans. In cases where the work is in two or more counties covered by differing percentage goals, the highest percentage will govern.

B. STANDARD FEDERAL EQUAL EMPLOYMENT OPPORTUNITY CONSTRUCTION CONTRACT SPECIFICATIONS

Standard Federal Equal Employment Opportunity Construction Contract Specifications (Executive Order 11246)

1. As used in these Specifications:

   a. "Covered area" means the geographical area described in the solicitation from which this contract resulted;

   b. "Director" means Director, Office of Federal Contract Compliance Programs, United States Department of Labor, or any person to whom the Director delegates authority;

   c. "Employer identification number" means the Federal Social Security number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941.

   d. "Minority" includes;

      (i) Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);
      (ii) Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish Culture or origin, regardless of race);
      (iii) Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); and
      (iv) American Indian or Alaskan Native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).

2. Whenever the Contractor, or any Subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract in excess of $10,000 the provisions of these specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitations from which this contract resulted.

3. If the Contractor is participating (pursuant to 41 CFR 60-4.5) in a Hometown Plan approved by the U.S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) shall be in accordance with that Plan for those trades which have unions participating in the Plan. Contractors must be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each Contractor or Subcontractor participating in an approved Plan is individually required to comply with its obligations under the EEO clause, and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other Contractors or Subcontractor toward a goal in an approved Plan does not excuse any covered Contractor's or Subcontractor's failure to take good faith efforts to achieve the Plan goals and timetables.

4. The Contractor shall implement the specific affirmative action standards provided in paragraphs 7a through p of these specifications. The goals set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. Covered Construction contractors performing construction work in geographical areas where they do not have a Federal or federally assisted construction contract shall apply the minority and female goals established for the geographical area where the work is being performed. Goals are published periodically in the Federal Register in notice form, and such notices may be obtained from any office of Federal Contract Compliance Programs Office or from Federal procurement contracting officers. The Contractor is expected to make substantially uniform progress in meeting its goals in each craft during the period specified.

5. Neither the provisions of any collective bargaining agreement, nor the failure by a union with whom the Contractor has a collective bargaining agreement, to refer either minorities or women shall excuse the Contractor's obligations under these specifications, Executive Order 11246, or the regulations promulgated pursuant thereto.

6. In order for the nonworking training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees must be employed by the Contractor during the training period, and the Contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U.S. Department of Labor.

7. The Contractor shall take specific affirmative actions to ensure equal employment opportunity. The evaluation of the Contractor's compliance with these specifications shall be based upon its effort to achieve maximum results from its actions. The Contractor shall document these efforts fully, and shall implement affirmative action steps at least as extensive as the following;

   a. Ensure and maintain a working environment free of harassment, intimidation , and coercion at all sites, and in all facilities at which the Contractor's employees are assigned to work. The Contractor, where possible, will assign two or more women to each construction project. The Contractor shall specifically ensure that all foremen, superintendents, and other on-site supervisory personnel are aware of and carry out the Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.

   b. Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the Contractor or its union have employment opportunities available, and maintain a record of the organization's responses.

   c. Maintain a current file of the names, addresses and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source of community organization and of what action was taken with respect to each individual. If such individual was sent to the union hiring hall for referral and was not referred back to the Contractor by the union or, if referred, not employed by the Contractor, this shall be documented in the file with the reason therefor, along with whatever additional actions the Contractor may have taken.

   d. Provide immediate written notification to the Director when the union with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or woman sent by the Contractor, or when he Contractor has other information that the union referral process has impeded the Contractor's efforts to meet its obligations.

   e. Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the Contractor's employment needs, especially those programs funded or approved by the Department of Labor. The Contractor shall provide notice of these programs to the sources compiled under 7b above.

   f. Disseminate the Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the Contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc., by specific review of the policy with all management personnel and with all minority and female employees at least once a year, and by posting the Contractor's EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.

g. Review, at least annually, the Contractor's EEO policy and affirmative action obligations under these specifications with all employees having any responsibility for hiring, assignment, layoff, termination or other employment decisions including specific review of these items with onsite supervisory personnel such as Superintendents, General Foreman, etc., prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.

h. Disseminate the Contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the Contractors and Subcontractors with whom the Contractor does or anticipates doing business.

i. Direct its recruitment efforts, both oral and written, to minority, female and community organizations, to schools with minority and female students and to minority and female recruitment and training organizations serving the Contractor's recruitment area and employment needs. Not later than one month prior to the date for the acceptance of applications for apprenticeship or other training by any recruitment source, the Contractor shall send written notification to organizations such as the above, describing the openings, screening procedures, and tests to be used in the selection process.

j. Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer and vacation employment to minority and female youth both on the site and in other areas of a Contractor's workforce.

k. Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR Part 60-3.

l. Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc. such opportunities.

m. Ensure that seniority practices, job classifications, work assignments and other personnel practices, do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that the EEO policy and the Contractor's obligations under these specifications are being carried out.

n. Ensure that all facilities and Contractor's activities are nonsegregated except that separate or single-user toilet and necessary changing facilities shall be provided to assure privacy between the sexes.

o. Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.

p. Conduct a review, at least annually, of all supervisor's adherence to and performance under the Contractor's EEO policies and affirmative action obligation.

8. Contractors are encouraged to participate in voluntary associations which assist in fulfilling one or more of their affirmative action obligations (7a through p). The efforts of a contractor association, joint contractor-union contractor-community, or other similar group of which the Contractor is a member and participant, may be asserted as fulfilling any one or more of its obligations under 7a through p of these specifications provided that the Contractor actively participates in the group, makes every effort to assure that the group has a positive impact on the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in the Contractor's minority and female workforce participation, makes a good faith effort to meet its individual goal and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation to comply, however, is the Contractor's and failure of such a group to fulfill an obligation shall not be a defense for the Contractor's noncompliance.

9. A single goal for minorities and a separate single goal for women have been established. The Contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, the Contractor may be in violation of the Executive Order if a particular group is employed in a substantially disparate manner (for example, even thought the Contractor has achieved its goals for women generally, the Contractor may be in violation of the Executive Order if a specific minority group of women is underutilized).

10. The Contractor shall not use the goals and timetables or affirmative action standards to discriminate against any person because of race, color, religion, sex, or national origin.

11. The Contractor shall not enter into any Subcontract with any person or firm debarred from Government contracts pursuant to Executive Order 11246.

12. The Contractor shall carry out such sanctions and penalties for violation of these specifications and of the Equal Opportunity Clause, including suspension, termination and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any Contractor who fails to carry out such sanctions and penalties shall be in violation of these specifications and Executive Order 11246, as amended.

13 The Contractor in fulfilling its obligations under these specifications, shall implement specific affirmative action steps, at least as extensive as those standards prescribed in paragraph 7 of these specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of the Executive Order, the implementing regulations, or these specifications, the Director shall proceed in accordance with 41 CFR 60-4.8.

14. The Contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out, to submit reports relating to the provisions hereof as may be required by the Government and to keep records. Records shall at least include for each employee the name, address, telephone numbers, construction trade, union affiliation if any, employee identification number when assigned, social security number, race, sex, status (e.g., mechanic, apprentice, trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in an easily understandable and retrievable form, however, to the degree that existing records satisfy this requirement, contractors shall not be required to maintain separate records.

15. Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon application of requirements for the hiring of local or other area residents (e.g., those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

C. SPECIFIC EQUAL EMPLOYMENT OPPORTUNITY RESPONSIBILITIES.

1. *General.*

   a. Equal employment opportunity requirements not to discriminate and to take affirmative action to assure equal employment opportunity as required by Executive Order 11246 and Executive Order 11375 are set forth in Required Contract. Provisions (Form FHWA 1273 or 1316, as appropriate) and these Special Provisions which are imposed pursuant to Section 140 of Title 23, U.S.C., as established by Section 22 of the Federal-Aid highway Act of 1968. The requirements set forth in these Special Provisions shall constitute the specific affirmative action requirements for project activities under this contract and supplement the equal employment opportunity requirements set forth in the Required Contract provisions.

   b. The Contractor will work with the State highway agencies and the Federal Government in carrying out equal employment opportunity obligations and in their review of his/her activities under the contract.

   c. The Contractor and all his/her subcontractors holding subcontracts not including material suppliers, of $10,000 or more, will comply with the following minimum specific requirement activities of equal employment opportunity: (The equal employment opportunity requirements of Executive Order 11246, as set forth in Volume 6, Chapter 4, Section 1, Subsection 1 of the Federal-Aid Highway Program Manual, are applicable to material suppliers as well as contractors and subcontractors.) The Contractor will include these requirements in every subcontract of $10,000 or more with such modification of language as is necessary to make them binding on the subcontractor.

2. *Equal Employment Opportunity Policy*. The Contractor will accept as his operating policy the following statement which is designed to further the provision of equal employment opportunity to all persons without regard to their race, color, religion, sex, or national origin, and to promote the full realization of equal employment opportunity through a positive continuing program;

   It is the policy of this Company to assure that applicants are employed, and that employees are treated during employment, without regard to their race, religion, sex, color, or national origin. Such action shall include; employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship, preapprenticeship, and/or on-the-job training.

3. *Equal Employment Opportunity Officer*. The Contractor will designate and make known to the State highway agency contracting officers and equal employment opportunity officer (herein after referred to as the EEO Officer) who will have the responsibility for an must be capable of effectively administering and promoting an active contractor program of equal employment opportunity and who must be assigned adequate authority and responsibility to do so.

4. *Dissemination of Policy*.

   a. All members of the Contractor's staff who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action, or who are substantially involved in such action, will be made fully cognizant of, and will implement, the Contractor's equal employment opportunity policy and contractual responsibilities to provide equal employment opportunity in each grade and classification of employment. To ensure that the above agreement will be met, the following actions will be taken as a minimum;

      (1) Periodic meetings of supervisory and personnel office employees will be conducted before the start of work and then not less often than once every six months, at which time the Contractor's equal employment opportunity policy and its implementation will be reviewed and explained. The meetings will be conducted by the EEO Officer or other knowledgeable company official.

(2) All new supervisory or personnel office employees will be given a thorough indoctrination by the EEO Officer or other knowledgeable company official, covering all major aspects of the Contractor's equal employment opportunity obligations within thirty days following their reporting for duty with the Contractor.

(3) All personnel who are engaged in direct recruitment for the project will be instructed by the EEO Officer or appropriate company official in the Contractor's procedures for locating and hiring minority group employees.

b. In order to make the Contractor's equal employment opportunity policy known to all employees, prospective employees and potential sources of employees, i.e., schools, employment agencies, labor unions (where appropriate), college placement officers, etc., the Contractor will take the following actions:

(1) Notices and posters setting forth the Contractor's equal employment opportunity policy will be placed in areas readily accessible to employees, applicants for employment and potential employees.

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(2) The Contractor's equal employment opportunity policy and the procedures to implement such policy will be brought to the attention of employees by means of meetings, employee handbooks, or other appropriate means.

5. *Recruitment*.

a. When advertising for employees, the Contractor will include in all advertisements for employees the notation; "An Equal Opportunity Employer." All such advertisements will be published in newspapers or other publications having a large circulation among minority groups in the area from which the project work force would normally be derived.

b. The Contractor will, unless precluded by a valid bargaining agreement, conduct systematic and direct recruitment through public and private employee referral sources likely to yield qualified minority group applicants, including, but not limited to, State employment agencies, schools, colleges and minority group organizations. To meet this requirement, the Contractor will, through his EEO Officer, identify sources of potential minority group employees, and establish with such identified sources procedures whereby minority group applicants may be referred to the Contractor for employment consideration.

In the event the Contractor has a valid bargaining agreement providing for exclusive hiring hall referrals, he is expected to observe the provisions of that agreement to the extent that the system permits the Contractor's compliance with equal employment opportunity contract provisions. (The U.S. Department of Labor has held that where implementation of such agreements have the effect of discriminating against minorities or women, or obligates the Contractor to do the same, such implementation violates Executive Order 11246, as amended.)

c. The Contractor will encourage his present employees to refer minority group applicants for employment by posting appropriate notices or bulletins in areas accessible to all such employees. In addition, information and procedures with regard to referring minority group applicants will be discussed with employees.

`6. *Personnel Actions*. Wages, working conditions, and employee benefits shall be established and administered, and personnel actions of every type, including hiring, upgrading, promotion, transfer, demotion, layoff, and termination, shall be taken without regard to race, color, religion, sex, or national origin. The following procedures shall be followed;

a. The Contractor will conduct periodic inspections of project sites to insure that working conditions and employee facilities do not indicate discriminatory treatment of project site personnel.

b. The Contractor will periodically evaluate the spread of wages paid within each classification to determine any evidence of discriminatory wage practices.

c. The Contractor will periodically review selected personnel actions in depth to determine whether there is evidence of discrimination. Where evidence is found, the Contractor will promptly take corrective action. If the review indicates that the discrimination may extend beyond the actions reviewed, such corrective action shall include all affected persons.

d. The Contract will promptly investigate all complaints of alleged discrimination made to the Contractor in connection with his obligations under this contract, will attempt to resolve such complaints, and will take appropriate corrective action within a reasonable time. If the investigation indicates that the discrimination may affect persons other than the complainant, such corrective action shall include such other persons. Upon completion of each investigation, the Contractor will inform every complainant of all of his avenues of appeal.

7. *Training and Promotion*.

a. The Contractor will assist in locating, qualifying, and increasing the skills of minority group and women employees, and applicants for employment.

b. Consistent with the Contractor's work force requirements and as permissible under Federal and State regulations, the Contractor shall make full use of training programs, i.e., apprenticeship, and on-the-job training programs for the geographical area of contract performance. Where feasible, 25 percent of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training.

c. The Contractor will advise employees and applicants for employment of available training programs and entrance requirements for each.

d. The Contractor will periodically review the training and promotion potential of minority group and women employees and will encourage eligible employees to apply for such training and promotion.

8. *Unions*. If the Contractor relies in whole or in part upon unions as a source of employees, the Contractor will use his/her best efforts to obtain the cooperation of such unions to increase opportunities for minority groups and women with the unions, and to effect referrals by such unions of minority and female employees. Actions by the Contractor either directly or thorough a contractor's association acting as agent will include the procedures set forth below:

a. The Contractor will use best efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minority group members and women for membership in the unions and increasing the skills of minority group employees and women so that they may qualify for higher paying employment.

b. The Contractor will use best efforts to incorporate an equal employment opportunity clause into each union agreement to the end that such union will be contractually bound to refer applicants without regard to their race, color, religion, sex, or national origin.

c. The Contractor is to obtain information as to the referral practices and policies of the labor union except that to the extent such information is within the exclusive possession of the labor union and such labor union refuses to furnish such information to the Contractor, the Contractor shall so certify to the State highway department and shall set forth what efforts have been made to obtain such information.

d. In the event the union is unable to provide the Contractor with a reasonable flow of minority and women referrals within he time limit set forth in the collective bargaining agreement, the Contractor will, through independent recruitment efforts, fill the employment vacancies without regard to race, color, religion , sex or national origin; making full efforts to obtain qualified and/or qualifiable minority group persons and women. (The U.S. Department of Labor has held that it shall be no excuse that the union with which the Contractor has a collective bargaining agreement providing for exclusive referral failed to refer minority employees.) In the event the union referral practice prevents the Contractor from meeting the obligations pursuant to Executive Order 11246, as amended, and these special provisions, such Contractor shall immediately notify the State highway agency.

9. *Subcontracting*.

a. The Contractor will use his best efforts to solicit bids from and to utilize minority group subcontractors or subcontractors with meaningful minority group and female representation among their employees. Contractors shall obtain lists of minority-owned construction firms from State highway agency personnel.

b. The Contractor will use his best efforts to ensure subcontractor compliance with their equal employment opportunity obligations.

10. *Records and Reports.*

a. The Contractor will keep such records as are necessary to determine compliance with the Contractor's equal employment opportunity obligations. The records kept by the Contractor will be designed to indicate:

(1) The number of minority and nonminority group members and women employed in each work classification on the project.

(2) The Progress and efforts being made in cooperation with unions to increase employment opportunities for minorities and women (applicable only to contractors who rely in whole or in part on unions as a source of their work force).

(3) The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minority and female employees, and

(4) The progress and efforts being made in securing the services of minority group subcontractors or subcontractors with meaningful minority and female representation among their employees.

b. All such records must be retained for a period of three years following completion of the contract work and shall be available at reasonable times and places for inspection by authorized representatives of the State highway agency and the Federal Highway Administration.

c. The Contractors will submit an annual report to the State highway agency each July for the duration of the project, indicating the number of minority, women, and non-minority group employees currently engaged in each work classification required by the contract work. This information is to be reported on Form PR 1391.

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REVISION OF DISADVANTAGED BUSINESS ENTERPRISE (DBE) REQUIREMENTS

1. Definitions.

Terms not defined in this special provision shall have the meaning provided in the *CDOT Standard Specifications for Road and Bridge Construction*.

A. *CDOT Form 1414 Anticipated DBE Participation Plan.* Document that lists all of the bidder's DBE Commitments and submitted with the bid.

B. *CDOT Form 1415 Commitment Confirmation.* Document confirming the bidder's Commitments and submitted post-bid.

C. *CDOT Form 1416 Good Faith Effort Report.* Document that details the actions taken to meet the Contract Goal.

D. *CDOT Form 1417 Approved DBE Participation Plan.* Document that lists the bidder's approved Commitments at the time of Contract award.

E. *CDOT Form 1432 Commercially Useful Function Questionnaire.* Document that records and verifies each DBE's CUF for Eligible Participation.

F. *Commitment.* A portion of the Contract, identified by dollar amount and work area, designated by the bidder or Contractor for participation by a particular DBE. Commitments are initially submitted to CDOT via Form 1414 and/or Form 1415.

G. *Commercially Useful Function (CUF).* Responsibility for the execution of the work and carrying out such responsibilities by actually performing, managing and supervising the work per Section 8 of this special provision.

H. *Contract Goal.* The percentage of the Contract designated by CDOT for DBE participation as specified by the Project Special Provision *Disadvantaged Business Enterprise (DBE) Contract Goal.* For determining whether the Contract Goal was met before award, the Contract Goal will be based upon the proposal amount excluding force account items. In the event a Contract Modification Order increases the amount of the Contract, as described in Section 6 of this special provision, the Contract Goal shall be based on the Total Earnings Amount.

I. *DBE Program Manual.* The manual maintained by the Civil Rights & Business Resource Center (CRBRC) detailing CDOT's policies and procedures for administering the DBE program.

J. *Disadvantaged Business Enterprise (DBE).* A Colorado-certified Disadvantaged Business Enterprise listed on the Colorado Unified Certification Program (UCP) DBE Directory.

K. *Eligible Participation.* Work by a DBE which counts as valid DBE participation on the Contract and may be used towards fulfillment of a Commitment.

L. *Good Faith Efforts.* All necessary and reasonable steps to meet the Contract Goal which, by their scope, intensity, and appropriateness to the objective, could reasonably be expected to obtain sufficient DBE participation, even if not fully successful. Good Faith Efforts are evaluated before award and throughout performance of the Contract. For guidance on Good Faith Efforts, see Section 4 of this special provision below.

M. *Joint Check.* A check issued by the Contractor or one of the Contractor's subcontractors to a DBE firm and a material supplier or other third party for materials or services to be incorporated into the work.

N. *Race-Neutral.* DBE Participation on the Contract obtained through customary competitive procedures.

O. *Reduction.* Lessening the Commitment amount to a DBE. A Reduction constitutes a partial termination and includes, but is not limited to, instances in which a Contractor seeks to perform work originally designated for a DBE with the Contractor's own forces or to have that work performed by a business entity other than the committed DBE.

P. *Subcontractor.* An individual, firm, corporation or other legal entity to whom the Contractor sublets part of the Contract, as per Section 101 in the *Standard Specifications for Road and Bridge Construction*. For purposes of this special provision, the term Subcontractor includes suppliers.

Q. *Substitution.* When a Contractor seeks to find another DBE to perform work on the Contract as a result of a Reduction or Termination.

R. *Termination.* When a Contractor no longer intends to use a DBE for fulfillment of a Commitment.

S. *Total Earnings Amount:* Amount of the Contract earned by the Contractor, including approved Contract Modification Orders and approved force account work performed, but not including deductions for liquidated damages, price reduced material, work time violations, overweight loads or liens. The amount of the Contract earned does not include plan force account items (i.e. OJT, pavement incentives, etc).

T. *Work Code.* A code to identify the work that a DBE is certified to perform as a DBE. A work code includes a six digit North American Industry Classification System (NAICS) number plus a descriptor. Work Codes are listed on a firm's profile on the UCP DBE Directory. The Contractor may contact the CRBRC to receive guidance on whether a work code covers the work to be performed.

2. **Overview.** The Disadvantaged Business Enterprise (DBE) Program is a federally-mandated program that seeks to ensure non-discrimination in the award of U.S. Department of Transportation (DOT)-assisted contracts and to create a level playing field on which DBEs can compete fairly for DOT-assisted contracts. When a Contract Goal for DBE participation is set pursuant to the U.S. Department of Transportation's DBE Program, the apparent low responsible bidder must show that they have committed to DBE participation sufficient to meet the Contract Goal or has otherwise made Good Faith Efforts to do so in order to be awarded the Contract.

The Contractor's progress towards the Contract Goal will be monitored throughout the Contract to ensure the fulfillment of the Contractor's DBE Commitments. Modifications to the Commitments must receive prior approval. If the amount of the Contract increases during the performance of the Contract, the Contractor must make Good Faith Efforts to obtain additional DBE participation to meet the Contract Goal. Final payment to the Contractor may be reduced if the Contractor has failed to fulfill Commitments and/or make Good Faith Efforts to meet the Contract Goal following an increase in the amount of the Contract. The Contractor may be subject to the withholding of payment and/or other contractual remedies if the Contractor does not comply with the requirements of this special provision.

For general assistance regarding the DBE program and compliance, contact CDOT's CRBRC or the CDOT Region Civil Rights Office overseeing the project. For project specific issues, contact the Engineer or CDOT Regional Civil Rights Office.

All forms referenced by this special provision can be found on the CDOT website in the CDOT Forms Catalog: http://www.codot.gov/library/forms.

3. **Contract Assurance.** By submitting a proposal for this Contract, the bidder agrees to the following assurance and shall include the following paragraph verbatim in all subcontracts including those with non-DBE firms:

REVISION OF DISADVANTAGED BUSINESS ENTERPRISE (DBE) REQUIREMENTS

The Contractor, subrecipients of DOT-assistance through CDOT, or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The contractor shall carry out applicable requirements of 49 CFR part 26 in the award and administration of DOT-assisted contracts. Failure by the contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as CDOT deems appropriate, which may include, but is not limited to: (1) Withholding monthly progress payments; (2) Assessing sanctions; (3) Liquidated damages; and/or (4) Disqualifying the contractor from future bidding as non-responsible.

4. **Good Faith Efforts.** Good Faith Efforts may be required before award and/or during Contract performance. Good Faith Efforts should include, but are not limited to, reaching out to DBEs that could perform subcontracting opportunities on the Contract, breaking out contract work items into economically feasible units (e.g., smaller tasks or quantities) to facilitate DBE participation even when the bidder/Contractor might otherwise self-perform these items, negotiating in good faith with DBEs and not refusing to utilize a DBE for price alone, and other efforts to obtain DBE participation on the Contract. For additional guidance on making Good Faith Efforts see 49 CFR Part 26 Appendix A.

(a) *Bidding Requirements***.** When a Contract Goal is established, the Contract may not be awarded until the apparent low responsible bidder has demonstrated Good Faith Efforts to meet the Contract Goal by either

- Documenting sufficient Commitments to meet the Contract Goal, or
- Documenting adequate Good Faith Efforts to meet the Contract Goal even though they did not obtain enough Commitments to do so.

A Commitment may be made to a firm at any tier. The apparent low responsible bidder must have received a quote from a DBE in order to claim a Commitment to a DBE.

(1) *Anticipated Participation Plan.* All bidders shall submit Form 1414 listing Commitments obtained from DBEs, with their proposal, even if such Commitments do not meet the Contract Goal. If the apparent low responsible bidder has not obtained any Commitments or if the Contract Goal is 0% and the apparent low responsible bidder is electing not to make voluntary Commitments, they shall still submit Form 1414 documenting zero anticipated participation. Failure to submit a signed Form 1414 shall result in rejection of the proposal and the apparent low responsible bidder deemed non-responsive. The apparent low responsible bidder shall ensure that Commitments, and the resulting estimated Eligible Participation, have been properly calculated before submitting their proposal. If the apparent low responsible bidder is a DBE seeking Eligible Participation credit for self-performance, the apparent low responsible bidder shall include themselves in Form 1414, list the work to be self-performed, and the amount that the bidder intends to count as Eligible Participation.

(2) *Utilization Plan.*

a. *CDOT Advertised Projects*. These projects will require the submission of a DBE Utilization Plan (UP) via B2GNow. The apparent low responsible bidder shall submit the UP within five days of bid opening. In order to complete the UP, the apparent low responsible bidder shall obtain and upload in B2GNow a completed Form 1415 for each DBE listed on Form 1414. If the total Eligible Participation submitted on the Form 1414 and/or confirmed on Form 1415 did not meet the Contract Goal, the apparent low responsible bidder shall also submit Form 1416 with the UP in B2GNow. The Form 1416 should include any supporting documentation which the apparent low responsible bidder would like to be considered as evidence of their Good Faith Efforts. If a non-DBE was selected in lieu of a DBE, the apparent low responsible bidder shall include all quotes from the non-DBE and DBE firms.

The apparent low responsible bidder shall complete Section 1 of the Form 1415 and the DBE shall complete Section 2 of Form 1415. The Commitment in Form 1415 shall be consistent with the Commitment listed on Form 1414. If a Commitment is made to second tier or lower DBE subcontractor, the apparent low responsible bidder maintains responsibility for the fulfillment of the Commitment and shall sign the Form 1415. The apparent low responsible bidder shall not Terminate, Reduce, or Substitute a Commitment listed on Form 1414 without following the procedures outlined in Section 5 below. Increases in the Commitment amount do not require CDOT approval per the procedures in Section 5 below.

b. *Projects Not Advertised by CDOT*. The apparent low responsible bidder shall submit to the project owner a completed Form 1415 for each DBE listed on the Form 1414 by 4:30 pm on the fifth day after bid opening. If the total Eligible Participation submitted on the Form 1414 and/or Form 1415 does not meet the Contract Goal, the apparent low responsible bidder shall also submit Form 1416 along with any supporting documentation of the apparent low responsible bidder's Good Faith Efforts. If a non-DBE was selected in lieu of a DBE, the apparent low responsible bidder shall include all quotes from the non-DBE and DBE firms.

The apparent low responsible bidder shall complete Section 1 of the Form 1415 and the DBE shall complete Section 2 of Form 1415. The Commitment in Form 1415 shall be consistent with the Commitment listed on Form 1414. If a Commitment is made to second tier or lower DBE subcontractor, the apparent low responsible bidder maintains responsibility for the fulfillment of the Commitment and shall sign the Form 1415. The apparent low responsible bidder shall not Terminate, Reduce, or Substitute a Commitment listed on Form 1414 without following the procedures outlined in Section 5 below. Increases in the Commitment amount do not require approval per the procedures in Section 5 below.

(3) *Good Faith Effort Review Before Award.* The Forms 1414, 1415, and UP (for CDOT advertised projects) will be evaluated to ensure that each Commitment is valid and all Eligible Participation has been properly calculated. The apparent low responsible bidder may be required to provide additional information in order to confirm the accuracy of a Commitment.

If the apparent low responsible bidder's Forms 1414, 1415, and UP (for CDOT advertised projects) claimed that the Contract Goal was met but the total estimated Eligible Participation of the Commitments does not meet the Contract Goal, the apparent low responsible bidder will be given two working days to amend their Commitments by submitting amended Form(s) 1415 and UP (for CDOT advertised projects). If the total Eligible Participation on the amended Commitments do not meet the Contract Goal, the apparent low responsible bidder shall submit Form 1416 and provide documentation of their Good Faith Efforts.

When the total estimated Eligible Participation of the Commitments does not meet the Contract Goal, the Form 1416 and all supporting documentation will be evaluated per Appendix A of 49 CFR Part 26. The apparent low responsible bidder will be deemed to not have made Good Faith Efforts if a Commitment lists a DBE for a work area for which the DBE is not certified and the apparent low responsible bidder cannot establish a

reasonable basis for the error. Commitments made after submission of the bid will only be considered for acceptance if the bidder demonstrates that (1) Good Faith Efforts were made before submission of the bid, and (2) there is reasonable justification for not obtaining sufficient Commitments before submission of the bid.

The apparent low responsible bidder will be notified in writing if CRBRC determines that Good Faith Efforts to meet the Contract Goal were not demonstrated. The apparent low responsible bidder may request administrative reconsideration as outlined in subsection 4(a)(4) of this special provision. CDOT will include instructions on how to request administrative reconsideration in the written Good Faith Effort determination.

(4) *Administrative Reconsideration*. The apparent low responsible bidder will be provided an opportunity to request administrative reconsideration if the CRBRC determines that the apparent low responsible bidder did not demonstrate Good Faith Efforts to meet the Contract Goal. The independent Administrative Reconsideration Official is the CDOT Chief Engineer or designee, provided that such designee did not participate in the original determination. The CRBRC will provide the Administrative Reconsideration Official with a copy of the Good Faith Effort notice issued to the apparent low responsible bidder. The apparent low responsible bidder shall have five working days from the date of the Good Faith Effort determination notice to submit a written request for administrative reconsideration. The written request shall include the apparent low responsible bidder's basis for reconsideration, including any supporting documentation which they would like to be considered. The written request shall also include a statement as to whether the apparent low responsible bidder would like an in-person or telephonic hearing before the Administrative Reconsideration Official. If the apparent low responsible bidder does not specify a hearing request, the right to a hearing will be waived and administrative reconsideration will be based on the available record, as well as any written documentation provided by the apparent low responsible bidder. If the apparent low responsible bidder requests a hearing, the Administrative Reconsideration Official will establish a date and time for the hearing and send written notice at least two working days in advance of the hearing. The Administrative Reconsideration Official may waive the two-day requirement if holding the hearing sooner is determined to be in the public interest. The Administrative Reconsideration Official may request additional documentation. A copy of all requests and responses shall be provided to all parties. The Administrative Reconsideration Official will issue the final determination as to whether the apparent low responsible bidder demonstrated Good Faith Efforts to meet the Contract Goal. The determination of the Administrative Reconsideration Official is final.

(5) *Approval*. Upon a determination that the apparent low responsible bidder has demonstrated Good Faith Efforts to meet the Contract Goal, the apparent low responsible bidder will be issued Form 1417 or an approved UP in B2GNow (for CDOT advertised projects), documenting the approved Commitments on the Contract.

5. **Commitment Modifications.** The Contractor shall fulfill Commitments unless the Contractor obtains approval for Termination, Reduction, or Substitution. Unless approved, the Contractor will not be entitled to payment for the work or materials pertaining to an unapproved Termination, Reduction, or Substitution. During the performance of the Contract, the Contractor shall use Form 1420, *DBE Participation Plan Modification Request* to communicate all requests for Termination, Reduction, and/or Substitution. One Form 1420 may include multiple Commitment modification requests and must be submitted to CDOT at the time of the occurrence or, if that is not possible, within a reasonable time of the occurrence requiring Termination, Reduction, and/or Substitution. Failure by the Contractor to carry out the requirements of

this section is a material breach of the Contract and may result in the termination of the Contract or other established remedies.

(a) *Good Cause Requirement.* Termination, Reduction, and/or Substitution will not be approved unless the Contractor has Good Cause to modify the Commitment. Good Cause includes, but is not limited to

i. The DBE fails or refuses to execute a written contract;
ii. The DBE fails or refuses to perform the work of their subcontract consistent with normal industry standards, provided that such failure is not the result of bad faith or discriminatory actions of the Contractor or one of their subcontractors;
iii. The DBE fails to meet reasonable, nondiscriminatory bond requirements;
iv. The DBE becomes bankrupt, insolvent, or exhibits credit unworthiness;
v. The DBE is ineligible to work because of suspension or debarment proceedings or other state law;
vi. The DBE is not a responsible contractor;
vii. The DBE voluntarily withdraws from the project and provides written notice;
viii. The DBE is ineligible to receive DBE credit for the work required;
ix. The DBE owner dies or becomes disabled and is unable to complete the work;
x. The DBE ceases business operations or otherwise dissolves; or
xi. Other documented Good Cause that compels termination.

Good Cause does not exist if the Contractor seeks Termination so that the Contractor can self-perform the work for which the DBE was engaged or solely so that the Contractor can Substitute another DBE or non-DBE contractor after Contract award. When work Committed to a DBE is eliminated or reduced and such change is not due to and/or initiated by the Contractor, the change shall be Good Cause for Termination or Reduction. Upon approval of a Termination and/or Reduction, the Contractor will be subject to the Substitution requirements of subsection 5(d) of this special provision.

(b) *Notice to the DBE*. The Contractor shall notify the DBE in writing of the Contractor's intent to Terminate, Reduce, or Substitute, and the underlying reason(s) before submitting the Form 1420 requesting the proposed Commitment modification. In the notice of intent, the Contractor shall provide the DBE at least five days to respond to the notice and inform the Contractor of the reasons, if any, why the DBE objects to the proposed Commitment modification. The Contractor is not required to provide the five days written notice in cases where the DBE in question has provided written notice they are withdrawing from their subcontract or purchase order. The notice period may be reduced if determined to be in the public interest by the project owner.
Following the notice period, the Contractor shall submit a Form 1420 to request approval of the proposed Commitment modification, along with written documentation of the notice given to the DBE.

(c) *Determination*. The Contractor will be notified in writing of the Good Cause determination and whether the modification request is approved or denied.

(d) *Substitution Requirement.* When a Commitment is Terminated or Reduced (including when a DBE withdraws), the Contractor shall make Good Faith Efforts to find another DBE to Substitute for the original DBE. These Good Faith Efforts shall be directed at finding another DBE to perform at least the same amount, but not necessarily the same type, of work under the Contract as the participation that was Terminated or Reduced up to the Contract Goal. To make a Substitution, the Contractor may:

i. Make a new Commitment to any unperformed work on the Contract by providing a completed Form 1415*, Commitment Confirmation* for each new DBE Commitment;
ii. Increase the amount of an existing Commitment for any unperformed work on the Contract by submitting a revised Form 1415 for that Commitment; or
iii. Utilize any Race-Neutral Eligible Participation on the Contract performed before the Form 1420 submission as part of their Good Faith Efforts pursuant to this subsection by submitting a completed Form 1420.

If the Contractor has not obtained sufficient Substitutions up to the Contract Goal, the Contractor shall submit evidence of Good Faith Efforts to Substitute via the Form 1416 *Good Faith Effort Report*. The Contractor shall have seven days from the submission date of the Commitment modification request (Form 1420) to submit documentation of Substitutions and/or Form 1416 evidencing Good Faith Efforts to obtain sufficient Substitutions despite failing to do so. This period may be extended at the discretion of CDOT.

6. **Contract Modification Orders***.* When one or more Contract Modification Orders, as defined in CDOT's *Standard Specifications for Road and Bridge Construction*, adds new work items or increases the total dollar amount of the Contract, the Contractor is required to make Good Faith Efforts to obtain additional Eligible Participation sufficient to meet the Contract Goal on the Total Earnings Amount. Under this section, the Contractor may obtain additional Eligible Participation by:

i. Making a new Commitment to any unperformed work on the Contract by providing a completed Form 1415*, Commitment Confirmation* for each new DBE Commitment;
ii. Increasing the amount of an existing Commitment for any unperformed work on the Contract by submitting a revised Form 1415 for that Commitment;
iii. Utilizing other Eligible Participation on the Contract as part of Good Faith Efforts pursuant to this Section by submitting a completed Form 1420*.*

When the Contractor elects to obtain additional Eligible Participation under subpart (iii), such Eligible Participation does not need to be included as part of an approved Commitment. However, the Contractor is responsible to provide a completed Form 1420 documenting all additional Eligible Participation obtained under subpart (iii) before, or at the time of, Contract finalization.

If the Contractor determines they will be unable to obtain additional Eligible Participation sufficient to meet the Contract Goal on the Total Earnings Amount following a Contract Modification Order(s), the Contractor shall provide documentation of Good Faith Efforts to obtain additional DBE participation by submitting a completed Form 1416, along with any supporting documentation which they would like considered as evidence of Good Faith Efforts. The Form 1416 must be submitted within a reasonable time of the Contractor's initial determination that they will be unable to obtain additional Eligible Participation sufficient to meet the Contract Goal on the Total Earnings Amount. The Contractor may be required to provide additional documentation. The Contractor's Good Faith Efforts to obtain additional Eligible Participation, or lack thereof, will be considered when assessing any potential payment reductions to the Contractor per Section 9 of this special provision.

When one or more Contract Modification Orders, as defined under subsection 101.18 of CDOT's *Standard Specifications for Road and Bridge Construction*, reduces work items or decreases the total dollar amount of the Contract, any approved Commitments on the Contract continue to be binding on the Contractor unless Good Cause is established to Substitute, Terminate, and/or Reduce the Commitment per Section 5 of this special provision.

7. **Counting.** In order for work performed by a DBE to count as Eligible Participation, the following criteria must be met:

(a) *DBE Certified to Perform the Work.* The DBE must be certified by the Colorado UCP in the work to be performed. DBEs are certified in particular areas of work which are designated by a Work Code. Each DBE's Work Codes can be found on their profile on the Colorado UCP DBE Directory. The DBE must be certified to perform the work, and not under suspension, upon submission of the Commitment and upon execution of the DBE's subcontract. When a Commitment has been made, but upon review of the Form 205, *Sublet Permit Application*, or Form 1425, *Supplier Application Approval Request*, the DBE is no longer certified in the Work Code which covers the work to be performed, the Contractor may not use the DBE's participation as Eligible Participation. The Contractor shall Terminate the DBE Commitment and seek Substitution(s) per subsection 5(d) of this special provision. However, a DBE's work will continue to count as Eligible Participation if the DBE was certified upon approval of the Form 205 or Form 1425 but the certification status changes during the performance of the work. Suppliers must be certified upon execution of the purchase order.

(b) *Work Included in Commitment and/or Verified via Form 205 or Form 1425.* The work performed by the DBE must be reasonably construed to be included in the work area and Work Code identified by the Contractor in an approved Commitment or verified via Form 205 or Form 1425. The work identified on a Form 1425 shall not count against the Contractor's 30 percent as required under CDOT's *Standard Specifications for Road and Bridge Construction.*

If the Contractor intends to use a DBE for work in order to fulfill an existing Commitment to that DBE but the work was not listed in the original Commitment (Form 1415), the Contractor shall submit a request for modification per Section 5 of this special provision to include the new area of work to be performed. Unapproved work may count as Eligible Participation on the Contract but may not be used towards the fulfillment of the original Commitment to the DBE. A DBE Commitment cannot be modified to include work for which the DBE was not certified at the time of the approval of the original Commitment unless such work is in addition to the original Commitment.

Form 205 will be reviewed to determine whether the work being sublet is consistent with the Contractor's Commitments. Approval of the sublet request may be withheld if the Contractor has Reduced, Terminated, or otherwise modified the type or amount of work to be performed by a DBE without seeking advanced approval.

(c) *Work Performed by DBE.* The work must be actually performed by the DBE with their own forces. For purposes of this specification, work performed by the DBE with their own forces includes work by temporary employees, provided such employees are under the control of the DBE; the cost of supplies and materials obtained by the DBE for their work on the Contract, provided that such supplies are not purchased or leased from the Contractor or a subcontractor that is subletting to the DBE; the cost of any equipment leased by the DBE, provided that such equipment is not leased from the Contractor or a subcontractor that is subletting to the DBE.
When a DBE subcontracts part of the work, the value of the subcontracted work shall be counted as Eligible Participation only if the subcontractor is a DBE and meets the criteria of this special provision. Performance of subcontracted work by non-DBE subcontractors, including non-DBE trucking firms and owner-operators, is not Eligible Participation and may not be used towards the fulfillment of a Commitment, the Substitution requirements under Section 5(d) of this special provision, and/or additional Eligible Participation under Section 6 of this special provision.

(d) *Payment Received for Work*. The DBE must receive payment, including the release of their retainage, in order for the work to count as Eligible Participation.

(e) *Special Calculations for Suppliers.* When a DBE supplies goods or materials for a project, the DBE may be classified as a manufacturer, dealer or broker. The DBE's status as a manufacturer, dealer or broker is determined on a contract-by-contract basis, based upon the actual work performed, per 49 CFR Part 26.55(e). When a DBE is deemed to be acting as a manufacturer, 100 percent of the cost of the materials and/or supplies will count as Eligible Participation. When a DBE is deemed to be acting as a regular dealer (non-manufacturer supplier), only 60 percent of the cost of the materials and/or supplies will count as Eligible Participation. When a DBE is deemed to be acting as a broker, only the reasonable brokerage fee will count as Eligible Participation.

(f) *Service Fees.* For a DBE firm providing a bona fide service, such as professional, technical, consultant, or managerial services, or for providing bonds or insurance specifically required for the performance of a DOT-assisted contract, the fees and commissions charged by the DBE shall count as Eligible Participation, provided the fees are not excessive as compared with fees customarily allowed for similar services. In the case of DBE temporary employment placement agencies, only the placement fee for a temporary employee that will be specifically and exclusively used for work on the contract shall count as Eligible Participation; the hourly fee does not count as Eligible Participation unless the firm is also certified in the work to be performed.

(g) *Joint Venture Calculation.* When a DBE is a participant in a joint venture, the DBE must submit Form 893, *Information for Determining DBE Participation when a Joint Venture Includes a DBE*, to determine how much of the work performed by the joint venture may be considered Eligible Participation. To ensure sufficient time for review, Form 893 shall be submitted to CDOT no less than ten days before the submission of the bid or, if requested during the Contract, the point at which the DBE will begin work.

(h) *Commercially Useful Function.* Upon a determination that a DBE has not performed a Commercially Useful Function (CUF) on the project, no participation by such DBE is Eligible Participation. DBE performance on the Contract will be monitored to ensure each DBE is performing a CUF. The DBE, Contractor, and any other involved third parties may also be subject to additional enforcement actions as described in Section 9 of this special provision.
The amount of work subcontracted, industry practices, the amount the firm is to be paid compared to the work performed and eligible participation claimed, and any other relevant factors will be considered in evaluating whether a DBE is performing a CUF. With respect to material and supplies used on the Contract, the DBE must be responsible for negotiating price, determining quality and quantity, ordering the material, installing the material, if applicable, and paying for the material itself in order to perform a CUF.

With respect to trucking, the DBE trucking firm must own and operate at least one fully licensed, insured, and operational truck used on the Contract in order to perform a CUF. Additionally, the DBE trucking firm must be responsible for the management and supervision of their entire trucking operation on the Contract. Work by a DBE trucking firm will count as Eligible Participation only if the work was performed (i) with trucks owned and insured by the DBE trucking firm and those trucks were operated by drivers employed by the DBE trucking firm or (ii) with trucks leased by the DBE trucking firm from another DBE firm including owner operators who are certified DBEs. The DBE who leases trucks from another DBE receives credit for the transportation services the lessee DBE provides on the contract.

A DBE does not perform a CUF when their role is limited to that of an extra participant in a transaction, contract or project through which funds are passed in order to obtain the appearance of DBE participation. Similar transactions involving non-DBEs will be evaluated in order to determine whether a DBE is an extra participant. If a DBE does not perform or exercise responsibility for at least 30 percent of the total cost of their contract or subcontract with their own work force, or the DBE subcontracts a greater portion of the work than would be expected on the basis of normal industry

practice for the type of work involved, CDOT will presume the DBE is not performing a CUF. The DBE may present evidence to rebut this presumption.

CUF will be evaluated using Form 1432 per Section 8(a) below.

(i) *Joint Checks.* All Joint Checks must be approved before they are used in payment to a DBE. Joint Checks used in payments to DBEs will be monitored closely to ensure the DBE is performing a CUF and the Joint Checks are not being used in a discriminatory manner. The Contractor shall request approval for the use of a Joint Check in a written letter signed by the DBE and the Contractor, stating the reason for the Joint Checks and the approximate number of checks that will be needed. Failure to receive approval of a Joint Check may result in not counting such payment as Eligible Participation.

8. **Contract Finalization**

(a) *Form 1432.* In order to have work performed and/or supplies provided by a DBE on the Contract count as Eligible Participation, the Contractor must submit a Form 1432 for that DBE. The Form 1432 must be signed by the DBE, Contractor and Project Engineer. Work performed and/or supplies provided on the Contract by a DBE Commitment will not count as Eligible Participation without a corresponding Form 1432 and the Contractor may be subject to a payment reduction as described in subsection 8(b) of this special provision.

(b) *Payment Reduction.* The Contractor's retainage will not be released until a determination is made as to whether the Contractor will be subject to a payment reduction. The Contractor will be subject to a payment reduction for any unapproved Termination, Reduction, and/or Substitution. Additionally, the Contractor will be subject to a payment reduction for any portion of a Commitment that was not fulfilled. The Contractor will not be subject to duplicate payment reductions for the same offense. The amount of the payment reduction may be adjusted if the Contractor demonstrates that a failure to fulfill a Commitment or otherwise meet their obligations under this special provision was due to circumstances outside of their control.

9. **Other Enforcement**. As necessary, participants may be reviewed or investigated. All participants, including, but not limited to, DBE firms and applicants for DBE certification, complainants, and contractors using DBE firms to meet contract goals, are required to cooperate fully and promptly with compliance reviews, certification reviews, investigations, and other requests for information.
Participants shall not intimidate, threaten, coerce, or discriminate against any individual or firm for the purpose of interfering with any right or privilege secured by the DBE program or because the individual or firm has made a complaint, testified, assisted, or participated in any manner in an investigation, proceeding, or hearing under the DBE program. Failure to comply with this paragraph shall be a ground for appropriate action against the party involved (with respect to recipients, a finding of noncompliance; with respect to DBE firms, denial of certification or removal of eligibility, and/or suspension and debarment; with respect to a complainant or appellant, dismissal of the complaint or appeal; with respect to a contractor which uses DBE firms to meet goals, findings of non-responsibility for future contracts and/or suspension and debarment).

Upon a determination that a Contractor or subcontractor was a knowing and willing participant in any intended or actual subcontracting arrangement contrived to artificially inflate DBE participation or any other impermissible business arrangement, or if the Contractor engages in repeated violations, falsification or misrepresentation, any fraudulent or misrepresented DBE participation shall not count as Eligible Participation, progress payments may be withheld from the Contractor commensurate with the violation, the Contractor's prequalification status may be suspended, the matter may be referred to the Office of Inspector General of the U.S. Department of Transportation for investigation and/or any other available contractual remedy may be sought.

Decision Nos. CO20230008 dated January 6, 2023 supersedes **Decision Nos. CO20220008** dated January 7, 2022.	**Modifications**	**ID**
When work within a project is located in two or more counties and the minimum wages and fringe benefits are different for one or more job classifications, the higher minimum wages and fringe benefits shall apply throughout the project.	**MOD Number / Date / Page Number(s)** **1 / 2/24/23 / 1** **2 / 6/2/23 / 1** **3 (no changes) / 7/14/23 / -** **4 / 8/4/23 / 1**	**1** **2** **-** **4**
General Decision No. CO20230008 applies to the following counties: El Paso, Pueblo, and Teller counties.		

General Decision No. CO20230008

The wage and fringe benefits listed below reflect collectively bargained rates.

Code	Classification	Basic Hourly Rate	Fringe Benefits	Last Mod
	ELECTRICIAN:			
1199	El Paso, Teller	35.70	17.52	**2**
1200	Pueblo	30.40	14.41	**4**
	POWER EQUIPMENT OPERATOR:			
	Drill Rig Caisson			
1201	Smaller than Watson 2500 and similar	33.30	14.20	**4**
1202	Watson 2500 similar or larger	34.41	14.20	**4**
	Crane			
1203	50 tons and under	33.83	14.20	**4**
1204	51 - 90 tons	34.41	14.20	**4**
1205	91 - 140 tons	35.28	14.20	**4**

General Decision No. CO20230008

The wage and fringe benefits listed below do not reflect collectively bargained rates.

	CARPENTER:			
1206	Excludes Form Work	24.15	6.25	
	Form Work Only			
1207	El Paso, Teller	19.06	5.84	
1208	Pueblo	19.00	5.88	
	CEMENT MASON/CONCRETE FINISHER:			
1209	El Paso, Teller	17.36	3.00	
1210	Pueblo	17.74	3.00	

General Decision No. CO20230008

The wage and fringe benefits listed below do not reflect collectively bargained rates.

Code	Classification	Basic Hourly Rate	Fringe Benefits	Last Mod
1199	**FENCE ERECTOR**	13.02	3.20	
1200	**GUARDRAIL INSTALLER**	12.89	3.20	
	HIGHWAY/PARKING LOT STRIPING:			
1201	Painter	12.62	3.21	
	IRONWORKER:			
	Reinforcing (Excludes Guardrail Installation)			
1202	El Paso, Teller	20.49	1.65	
1203	Pueblo	16.69	5.45	
1204	**Structural** (Excludes Guardrail Installation)	18.22	6.01	
	LABORER:			
1205	Asphalt Raker	17.54	3.16	
1206	Asphalt Shoveler	21.21	4.25	
1207	Asphalt Spreader	18.58	4.65	
	Common or General			
1208	El Paso	17.05	3.69	
1209	Pueblo	16.29	4.25	
1210	Teller	16.88	3.61	
1211	Concrete Saw (Hand Held)	16.29	6.14	
1212	Landscape and Irrigation	12.26	3.16	
1213	Mason Tender - Cement/Concrete	16.29	4.25	
1214	Pipelayer	18.72	3.24	
1215	Traffic Control (Flagger)	9.55	3.05	
1216	Traffic Control (Sets Up/Moves Barrels, Cones, Installs signs, Arrow Boards and Place Stationary Flags), (Excludes Flaggers)	12.43	3.22	
1217	**PAINTER (Spray Only)**	16.99	2.87	

General Decision No. CO20230008

The wage and fringe benefits listed below do not reflect collectively bargained rates.

Code	Classification	Basic Hourly Rate	Fringe Benefits	Last Mod
	POWER EQUIPMENT OPERATOR:			
1211	Asphalt Laydown	22.67	8.72	
1212	Asphalt Paver	21.50	3.50	
	Asphalt Roller			
1213	El Paso	24.42	6.96	
1214	Pueblo	23.67	9.22	
1813	Teller	24.42	6.96	
1234	Asphalt Spreader	22.67	8.72	
	Backhoe/Trackhoe			
1235	El Paso	23.31	5.61	
1236	Pueblo	21.82	8.22	
1237	Teller	23.32	5.50	
1238	Bobcat/Skid Loader	15.37	4.28	
1239	Boom	22.67	8.72	
	Broom/Sweeper			
1240	El Paso, Teller	23.43	8.04	
1241	Pueblo	23.47	9.22	
	Bulldozer			
1242	El Paso	26.56	7.40	
1243	Pueblo, Teller	26.11	6.92	
1244	Drill	17.59	3.45	
1245	Forklift	15.91	4.68	
	Grader/Blade			
1246	El Paso	22.83	8.72	
1247	Pueblo	23.25	6.98	
1248	Teller	23.22	8.72	
1249	Guardrail/Post Driver	16.07	4.41	

General Decision No. CO20230008

The wage and fringe benefits listed below do not reflect collectively bargained rates.

Code	Classification	Basic Hourly Rate	Fringe Benefits	Last Mod
	POWER EQUIPMENT OPERATOR (con't.):			
	Loader (Front End)			
1234	El Paso	23.61	7.79	
1235	Pueblo	21.67	8.22	
1236	Teller	23.50	7.64	
	Mechanic			
1237	El Paso	22.35	6.36	
1238	Pueblo	24.02	8.43	
1239	Teller	22.16	6.17	
	Oiler			
1240	El Paso	23.29	7.48	
1241	Pueblo	23.13	7.01	
1242	Teller	22.68	7.11	
	Roller/Compactor (Dirt and Grade Compaction)			
1243	El Paso	16.70	3.30	
1244	Pueblo, Teller	18.43	4.62	
1245	Rotomill	16.22	4.41	
1246	Scraper	24.28	4.83	
	Screed			
1247	El Paso, Teller	25.22	5.74	
1248	Pueblo	23.67	9.22	
1249	Tractor	13.13	2.95	

General Decision No. CO20230008

The wage and fringe benefits listed below do not reflect collectively bargained rates.

Code	Classification	Basic Hourly Rate	Fringe Benefits	Last Mod
	TRUCK DRIVER:			
	Distributor			
1234	El Paso, Teller	17.98	3.97	
1235	Pueblo	18.35	3.85	
	Dump Truck			
1236	El Paso, Teller	16.85	4.83	
1237	Pueblo	16.87	4.79	
1238	Lowboy Truck	17.25	5.27	
1239	Mechanic	26.69	3.50	
1240	Multi-Purpose Specialty & Hoisting Truck	17.27	3.71	
1241	Pickup and Pilot Car	13.93	3.68	
1242	Semi/Trailer Truck	16.00	2.60	
1243	Truck Mounted Attenuator	12.43	3.22	
	Water Truck			
1244	El Paso	17.24	4.15	
1245	Pueblo	20.93	4.98	
1246	Teller	17.31	4.07	

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29 CFR 5.5(a)(1)(ii)).

In the listing above, the "SU" designation means that rates listed under the identifier do not reflect collectively bargained wage and fringe benefit rates. Other designations indicate unions whose rates have been determined to be prevailing.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program.
If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7).
Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

END OF GENERAL DECISION NO. CO20230008

ON THE JOB TRAINING

This On-the-Job Training (OJT) special provision is an implementation of 23 U.S.C, 140(a), a federal requirement to provide equal opportunity and training on federal-aid construction projects. The Contractor shall meet the requirements of the FHWA 1273 for all apprentices and trainees. For additional guidance, please look at the OJT Contractor Manual.

1. Goal Setting

CDOT will set OJT goals for every federally-assisted project. Goals for the projects will be set based on the criteria that is outlined in the 23 CFR Part 230, Appendix B to Subpart (A):

A. Availability of minorities, women, and disadvantaged persons for training;

B. The potential for effective training;

C. Duration of the contract;

D. Dollar value of the contract;

E. Total normal workforce that the average bidder could be expected to use;

F. Geographic location;

G. Type of work;

H. The need for journey-level workers in the area;

I. Recognition of the state's goal;

J. A satisfactory ratio of trainees to journeymen expected to be on the workforce.

The number of required training hours will be identified in the Contract. The following chart provides guidelines based on contract value, but the required number of hours will be determined by CDOT after consideration of the aforementioned variables.

Contract dollar value	Training hours to be provided on the project
Up to 1 million	0
>1 - 2 million	320
>2 - 4 million	640
>4 - 6 million	1280
>6 - 8 million	1600
>8 - 12 million	1920
>12 - 16 million	2240
>16 - 20 million	2560
For each increment of $5 million, over $20 million	1280

2. Training Plan Options

CDOT accepts the following training programs:

A. CDOT's pre-approved classifications utilization program (PAC-UP);

B. A registered U.S. Department of Labor training program or apprenticeship program;

C. Approved programs through workforce centers and through specific groups like Colorado Contractors Association (CCA) and Western Colorado Contractors Association (WCCA);

D. A Contractor specific plan approved by CDOT and the Federal Highway Administration (FHWA).

The minimum length and type of training for each skilled craft shall be as established in the training program selected by the Contractor.

When one or more approved plans are chosen, the Contractor shall submit the OJT Contractor Commitment to Meet OJT Requirements, CDOT Form 1337 to the Engineer. Additional pre-approved training programs and/or additional apprentices/trainees may be utilized at any point throughout the project. The plan option(s) that the Contractor chooses will be effective for the duration of the project.

3. Journey-Level Worker to Apprentice/Trainee Ratio

The OJT goal requirement shall be met through approved trainee(s)/apprentice(s) working on the CDOT project under the supervision of a journey-level worker. For the CDOT Pre-Approved Classification Training Programs (PAC-UP), the apprentice/trainee ratio to journey-level worker shall not exceed a one to one ratio for all classifications, and the Contractor shall not exceed 25 percent of the workforce as trainees/apprentices at any time. Furthermore, it is at CDOT's discretion that a stricter ratio guideline may be imposed as outlined in the specific training classification. For all other approved programs, the apprentice/trainee ratio shall be as outlined in the specific program. When apprentices/trainees are on the job without proper supervision as outlined above, they shall be paid full Davis-Bacon wages.

4. Trainee Selection

Two components must be considered when choosing a trainee:

A. The intent of this program is for Contractors to recruit and train entry-level individuals or individuals who will be working within new classifications and guide them toward journey-level status in that specific classification. A trainee will not be approved in any classification for which they have already obtained journey-level status.

B. Another intent of the OJT program is the primary consideration for the Contractor to use minorities, women, and disadvantaged persons to fulfill the trainee roles, and as such, the Contractor shall make every effort to enroll such individuals in the program by using "systematic and direct recruitment through public and private sources."

The consideration to include women and minorities is based on the regulation; however, it will not be used to systematically deny any one person or group from the opportunity to be a part of the OJT program. CDOT may reject non-minority male trainees for entry into the program if it is determined that a Contractor failed to make sufficient good faith efforts (GFE) to hire minorities or female trainees and/or the Contractor failed to document or submit evidence of its GFE to do so. CDOT will consider a Contractor's documentation of all GFE on a case-by-case basis and will take into account the items listed in the goal setting section of this specification. For more information, please see Section 11 of this specification.

5. OJT Apprentice/Trainee Approval

As a condition of the OJT program, the Contractor will:

A. Notify all employees at the start of employment and at a minimum of at least once per year regarding the available training programs, positions, and eligibility requirements. The Contractor shall document that this information was conveyed to and received by employees.

B. Provide each trainee with a copy of his or her enrollment form (if applicable) and the training program within a month of starting the chosen plan.

The OJT submittals (CDOT Form 1337, Contractor Commitment to Meet OJT Requirements; CDOT Form 832, Trainee Status and Evaluation; CDOT Form 838, OJT apprentice/trainee Record) shall be filled out completely and approved or rejected by CDOT. If the apprentice/trainee is working within the proposed classification before approval is granted, full Davis-Bacon prevailing wages shall be paid to the individual.

The Regional Civil Rights Office must approve the CDOT Form 838 prior to any of the hours counting toward the OJT goal. If there is a CDOT delay that is completely outside of the Contractor's responsibility

for approval of the apprentices/trainees, and if approval is ultimately granted, the date that will be utilized will be ten business days after the date that the CDOT Form 838 was submitted.

The Contractor shall retain full responsibility for meeting the training requirements imposed by this special provision.

6. Eligible Work Activities that Count Toward the Training Goal

The work hours that are completed on the site of work and per the training documents for approved apprentices/trainees in approved classifications and programs will apply toward the project goal. Hours for work performed outside the individual's approved training classification will not count toward the project OJT goal and the individual shall be paid full applicable prevailing wage.

Job shadowing can apply toward the project goal if it is written into the specific training plan. If the Contractor is using CDOT's PAC-UP training program, job shadowing can apply toward the project goal when the approved employee is performing within the "Observation" component of the plan (hours vary by classification). Non-CDOT project hours will not be accepted toward the project goal.

Although US DOL apprenticeship programs can use the reduced wages for any CDOT job (with or without an OJT goal) with approval, none of these "additional" hours may be banked or included for use as part of the required special provisions on any project other than that for which it was approved.

The Contractor may count OJT hours accomplished by a subcontractor with an approved plan. The subcontractor's trainee or apprentice, who is enrolled in any of the approved OJT programs and is contributing toward meeting a project's OJT goal hours, can count toward the project's OJT goal to satisfy the requirement of this specification. A subcontractor who chooses to participate in meeting the OJT goal shall follow the same process as the Contractor in terms of approving apprentices/trainees, submitting forms, etc. The Contractor retains the full responsibility for meeting the training requirements imposed by this special provision.

7. Contractor Training and Trainee Monitoring

The Contractor's representative (supervisor, manager, or other designee) will evaluate progress for the apprentice/trainee monthly and will provide a copy to the apprentice/trainee of the submitted CDOT Form 832 within 30 calendar days. This evaluation will include documentation of the apprentice/trainee's performance including what was done well and what needs to be improved. The Contractor training and monitoring will be evaluated through CDOT's use of the CDOT Form 200 Interview.

8. Wages

The Contractor may pay apprentice/trainee wages at a reduced rate for those that are in an approved program according to the following guidelines:

US DOL Apprenticeship Programs

Rates (at minimum) will be paid according to the scaled adjustments for a registered US DOL Apprentice. Fringe benefits (either in cash and/or bona fide benefits in lieu of cash) will be paid in full and as outlined by the bargained agreement. If fringe benefits are not mentioned as part of a bargained agreement or if there is no collectively bargained agreement, full fringe benefits will be paid as outlined through the US DOL wage decision. Approved US DOL apprenticeship programs can use the reduced wages for any CDOT project.

If the project does not have a training goal and the Contractor is seeking to pay apprenticeship rates as part of a registered US DOL Apprenticeship Program, the following documentation is required to ensure wages are being paid correctly: apprenticeship program registration, OA (formerly BAT) certificates, and collective bargaining agreement including the wage sheet.

Other Approved Programs

For all other OJT wage reductions, reduced percentages are allowed for the project if there is a goal greater than zero as outlined in the 23 CFR Appendix B to Subpart A of Part 230 (as described in this section), in the collectively bargained agreement, or as outlined in the specific plans. If the Contractor chooses to pay the trainee rates, the reduced percentage shall be based only on the base rate of pay. Fringe benefits shall be paid at 100 percent of the journey-level wage. If the apprentice/trainee is working within the proposed classification before approval is granted, full Davis-Bacon prevailing wages shall be paid to the apprentice/trainee.

The minimum trainee wage (base and fringe) shall be no less than $13.00 per hour. Trainees shall be paid at minimum:

First half of the training period -- at least 60 percent of the appropriate minimum journey-level rate

Third quarter of the training period – at least 75 percent of the appropriate minimum journey-level rate

Last quarter of the training period -- at least 90 percent of the appropriate minimum journey-level rate

9. Contractor Reporting

The Contractor shall keep all data associated with the trainees and the project for a period of at least three years from the closing date of the Contract.

10. Reimbursement to Contractors

For the purposes of reimbursement, the Contractor will have satisfied its responsibilities under this specification if CDOT has determined that it has fulfilled the acceptable number of training hours. Contractors will be reimbursed at a rate of $10.00 per hour per (approved) trainee for all OJT hours worked in approved classifications up to the project goal.

The Contractor will be reimbursed for no more than the amount outlined in the OJT Force Account budget.

11. OJT Good Faith Efforts (GFE)

CDOT recognizes two explanations of good faith efforts: (1) The Contractor will be required to prove an effort has been made to achieve a diversified workforce, but it has not yet been accomplished, or (2) The attempt has been made to meet the number of required OJT hours by using approved trainees or apprentices in approved classification(s) utilizing approved plans, but the Contractor cannot meet the required number of hours. In either case, a GFE will be required, and the Region Civil Rights Office will make the determination.

A. If the Contractor does not meet its OJT project goal with the inclusion of some female and/or minority trainees, the Contractor may be requested to produce documentation of adequate good faith efforts taken to fill that position with a minority or female applicant. Good faith efforts are designed to achieve equal opportunity through positive, assertive, and continuous result-oriented measures. Good faith efforts should be taken as hiring opportunities arise.

B. If the Contractor does not meet its OJT project goal, the Contractor may submit a CDOT Form 1336, Waiver Request for Contract's OJT Hours. On the form, the Contractor shall outline and submit all good faith efforts made when it is believed that the required number of training hours will not be met. If GFE is not demonstrated and approved, The Contractor will be subject to payment reductions outlined in the Disincentive Section.

If a good faith effort has been denied by CDOT, the Contractor may ask for reconsideration by the Region Civil Rights Manager and the Resident Engineer for the region where work is being performed. Additionally, if requested by the Contractor, the Region Civil Rights Office and the Project Engineer will meet with the Contractor to discuss the Contractor's initial Good Faith Effort determination.

12. Disincentive

A failure to provide the required training without the demonstration and approval of GFE to meet the project OJT goal may result in the Region Civil Rights Office assigning the following disincentive: A sum representing the total number of hours not met in the contract shall be multiplied by the journey worker hourly wages plus fringe benefits [(hours not met) x (dollar per hour + fringe benefits) = disincentive amount].

In order to obtain the disincentive amount, the journey worker wages will be figured using the prevailing wages for the classifications outlined on the CDOT Form 1337. If a single classification is noted on the submitted CDOT Form 1337, then that one wage will be used to figure the monetary amount owed. If multiple classifications are used, then the journey worker wages of all classifications will be used to determine an average wage rate. If the Contractor does not submit any documentation toward the OJT goal, the disincentive rate will be calculated at $30.00 per hour. CDOT will provide the Contractor a written notice at the final acceptance stage of the project informing them of the noncompliance with this specification which will include a calculation of the disincentive(s) to be assessed.

SCHEDULE G – CLAUSES FOR CONTRACTS SUBJECT TO FEDERAL REQUIREMENTS

1. EQUAL EMPLOYMENT OPPORTUNITY

To view the City of Colorado Springs EEOP (Equal Employment Opportunity Plan) Utilization Report, the link is www.coloradosprings.gov/eeop.

During the performance of this Contract, the Contractor agrees as follows:

A. The Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion, sex, or national origin. such action shall include, but not be limited to the following: Employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.

B. The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive considerations for employment without regard to race, color, religion, sex, or national origin.

C. The Contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the said labor union or workers' representatives of the contractor's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

D. The Contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.

E. The Contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the administering agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

F. In the event of the Contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this contract may be canceled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further Government contracts or federally assisted construction contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

G. The Contractor will include the portion of the sentence immediately preceding paragraph (1) and the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding

upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: *Provided, however,* that in the event the Contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the administering agency the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

H. Subcontracts. Each nonexempt prime contractor or subcontractor shall include the equal opportunity clause in each of its nonexempt subcontracts.

I. Incorporation by reference. The equal opportunity clause may be incorporated by reference in all Government contracts and subcontracts, including Government bills of lading, transportation requests, contracts for deposit of Government funds, and contracts for issuing and paying U.S. savings bonds and notes, and such other contracts and subcontracts as the Deputy Assistant Secretary may designate.

J. Incorporation by operation of the order. By operation of the order, the equal opportunity clause shall be considered to be a part of every contract and subcontract required by the order and the regulations in this part to include such a clause whether or not it is physically incorporated in such contracts and whether or not the contract between the agency and the contractor is written.

K. Adaptation of language. Such necessary changes in language may be made in the equal opportunity clause as shall be appropriate to identify properly the parties and their undertakings. [43 FR 49240, Oct. 20, 1978, as amended at 62 FR 66971, Dec. 22, 1997]

2. EQUAL EMPLOYMENT OPPORTUNTY REPORTS AND OTHER REQUIRED INFORMATION

A. *Requirements for prime contractors and subcontractors.*

1. Each prime contractor and subcontractor shall file annually, on or before the September 30, complete and accurate reports on Standard Form 100 (EEO-1) promulgated jointly by the Office of Federal Contract Compliance Programs, the Equal Employment Opportunity Commission and Plans for Progress or such form as may hereafter be promulgated in its place if such prime contractor or subcontractor (i) is not exempt from the provisions of these regulations in accordance with § 60-1.5; (ii) has 50 or more employees; (iii) is a prime contractor or first tier subcontractor; and (iv) has a contract, subcontract or purchase order amounting to $50,000 or more or serves as a depository of Government funds in any amount, or is a financial institution which is an issuing and paying agent for U.S. savings bonds and savings notes: *Provided,* That any subcontractor below the first tier which performs construction work at the site of construction shall be required to file such a report if it meets requirements of paragraphs (a)(1) (i), (ii), and (iv) of this section.

2. Each person required by § 60-1.7(a)(1) to submit reports shall file such a report with the contracting or administering agency within 30 days after the award to him of a contract or subcontract, unless such person has submitted such a report within 12 months preceding the date of the award. Subsequent reports shall be submitted annually in accordance with § 60-1.7(a)(1), or at such other intervals as the Deputy Assistant

Secretary may require. The Deputy Assistant Secretary may extend the time for filing any report.
3. The Deputy Assistant Secretary or the applicant, on their own motions, may require a contractor to keep employment or other records and to furnish, in the form requested, within reasonable limits, such information as the Deputy Assistant Secretary or the applicant deems necessary for the administration of the order.

4. Failure to file timely, complete and accurate reports as required constitutes noncompliance with the prime contractor's or subcontractor's obligations under the equal opportunity clause and is ground for the imposition by the Deputy Assistant Secretary, an applicant, prime contractor or subcontractor, of any sanctions as authorized by the order and the regulations in this part.

B. *Requirements for bidders or prospective contractors—*

1. Certification of compliance with Part 60-2: Affirmative Action Programs. Each agency shall require each bidder or prospective prime contractor and proposed subcontractor, where appropriate, to state in the bid or in writing at the outset of negotiations for the contract: (i) Whether it has developed and has on file at each establishment affirmative action programs pursuant to Part 60-2 of this chapter; (ii) whether it has participated in any previous contract or subcontract subject to the equal opportunity clause; (iii) whether it has filed with the Joint Reporting Committee, the Deputy Assistant Secretary or the Equal Employment Opportunity Commission all reports due under the applicable filing requirements.

2. Additional information. A bidder or prospective prime contractor or proposed subcontractor shall be required to submit such information as the Deputy Assistant Secretary requests prior to the award of the contract or subcontract. When a determination has been made to award the contract or subcontract to a specific contractor, such contractor shall be required, prior to award, or after the award, or both, to furnish such other information as the applicant or the Deputy Assistant Secretary requests.

C. *Use of reports.* Reports filed pursuant to this section shall be used only in connection with the administration of the order, the Civil Rights Act of 1964, or in furtherance of the purposes of the order and said Act.[43 FR 49240, Oct. 20, 1978, as amended at 62 FR 66971, Dec. 22, 1997]

3. CONSTRUCTION WAGE RATE REQUIREMENTS (DAVIS BACON) (From FAR 52.222-6)

The term “Contracting Officer” herein shall refer to the City of Colorado Springs Contracting Specialist assigned to this contract.

A. Definition.-“Site of the work”-

1. Means-

a. *The primary site of the work*. The physical place or places where the construction called for in the contract will remain when work on it is completed.
b. The secondary site of the work, if any. Any other site where a significant portion of the building or work is constructed, provided that such site is-

1. Located in the United States; and
2. Established specifically for the performance of the contract or project;

2. Except as provided in paragraph (3) of this definition, includes any fabrication plants, mobile factories, batch plants, borrow pits, job headquarters, tool yards, etc., provided-

a. They are dedicated exclusively, or nearly so, to performance of the contract or project; and
b. They are adjacent or virtually adjacent to the “primary site of the work” as defined in paragraph (a)(1)(i), or the “secondary site of the work” as defined in paragraph (a)(1)(ii) of this definition;

3. Does not include permanent home offices, branch plant establishments, fabrication plants, or tool yards of a Contractor or subcontractor whose locations and continuance in operation are determined wholly without regard to a particular Federal contract or project. In addition, fabrication plants, batch plants, borrow pits, job headquarters, yards, etc., of a commercial or material supplier which are established by a supplier of materials for the project before opening of bids and not on the Project site, are not included in the “site of the work.” Such permanent, previously established facilities are not a part of the “site of the work” even if the operations for a period of time may be dedicated exclusively or nearly so, to the performance of a contract.

B. All laborers and mechanics employed or working upon the site of the work will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, or as may be incorporated for a secondary site of the work, regardless of any contractual relationship which may be alleged to exist between the Contractor and such laborers and mechanics. Any wage determination incorporated for a secondary site of the work shall be effective from the first day on which work under the contract was performed at that site and shall be incorporated without any adjustment in contract price or estimated cost. Laborers employed by the construction Contractor or construction subcontractor that are transporting portions of the building or work between the secondary site of the work and the primary site of the work shall be paid in accordance with the wage determination applicable to the primary site of the work.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Construction Wage Rate Requirements statute on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (e) of this clause; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such period.

Such laborers and mechanics shall be paid not less than the appropriate wage rate and fringe benefits in the wage determination for the classification of work actually performed, without regard to skill, except as provided in the clause entitled Apprentices and Trainees. Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein; provided that the

employer's payroll records accurately set forth the time spent in each classification in which work is performed.

The wage determination (including any additional classifications and wage rates conformed under paragraph (c) of this clause) and the Construction Wage Rate Requirements (Davis-Bacon Act) poster (WH-1321) shall be posted at all times by the Contractor and its subcontractors at the primary site of the work and the secondary site of the work, if any, in a prominent and accessible place where it can be easily seen by the workers.

C. The Contracting Officer shall require that any class of laborers or mechanics which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The Contracting Officer shall approve an additional classification and wage rate and fringe benefits therefor only when all the following criteria have been met:

1. The work to be performed by the classification requested is not performed by a classification in the wage determination.
2. The classification is utilized in the area by the construction industry.
3. The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

If the Contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the Contracting Officer agree on the classification and wage rate (including the amount designated for fringe benefits, where appropriate), a report of the action taken shall be sent by the Contracting Officer to the Administrator of the:

Wage and Hour Division
Employment Standards Administration
U.S. Department of Labor
Washington, DC 20210

The Administrator or an authorized representative will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the Contracting Officer or will notify the Contracting Officer within the 30-day period that additional time is necessary.

In the event the Contractor, the laborers or mechanics to be employed in the classification, or their representatives, and the Contracting Officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the Contracting Officer shall refer the questions, including the views of all interested parties and the recommendation of the Contracting Officer, to the Administrator of the Wage and Hour Division for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the Contracting Officer or will notify the Contracting Officer within the 30-day period that additional time is necessary.

The wage rate (including fringe benefits, where appropriate) determined pursuant to paragraphs (c)(2) and (c)(3) of this clause shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

D. Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the Contractor

shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

E. If the Contractor does not make payments to a trustee or other third person, the Contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program; provided, That the Secretary of Labor has found, upon the written request of the Contractor, that the applicable standards of the Construction Wage Rate Requirements statute have been met. The Secretary of Labor may require the Contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

4. CONTRACT WORK HOURS AND SAFETY STANDARDS (from FAR 52.222-4)

The term “Contracting Officer” herein shall refer to the City of Colorado Springs Contracting Specialist assigned to this contract.

The term “Government” herein shall refer to the City of Colorado Springs and any interested federal or state entity.

A. *Overtime requirements*. No Contractor or subcontractor employing laborers or mechanics (see Federal Acquisition Regulation 22.300) shall require or permit them to work over 40 hours in any workweek unless they are paid at least 1 and 1/2 times the basic rate of pay for each hour worked over 40 hours.

B. *Violation; liability for unpaid wages; liquidated damages*. The responsible Contractor and subcontractor are liable for unpaid wages if they violate the terms in paragraph (a) of this clause. In addition, the Contractor and subcontractor are liable for liquidated damages payable to the Government. The Contracting Officer will assess liquidated damages at the rate of $10 per affected employee for each calendar day on which the employer required or permitted the employee to work in excess of the standard workweek of 40 hours without paying overtime wages required by the Contract Work Hours and Safety Standards statute (found at 40 U.S.C. chapter 37).

C. *Withholding for unpaid wages and liquidated damages*. The Contracting Officer will withhold from payments due under the contract sufficient funds required to satisfy any Contractor or subcontractor liabilities for unpaid wages and liquidated damages. If amounts withheld under the contract are insufficient to satisfy Contractor or subcontractor liabilities, the Contracting Officer will withhold payments from other Federal or federally assisted contracts held by the same Contractor that are subject to the Contract Work Hours and Safety Standards statute

D. Payrolls and basic records.

1. The Contractor and its subcontractors shall maintain payrolls and basic payroll records for all laborers and mechanics working on the contract during the contract and shall make them available to the Government until 3 years after contract completion. The records shall contain the name and address of each employee, social security number, labor classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. The records need not duplicate those required for construction work by Department of Labor regulations at 29 CFR 5.5(a)(3) implementing the Construction Wage Rate Requirements statute.

2. The Contractor and its subcontractors shall allow authorized representatives of the Contracting Officer or the Department of Labor to inspect, copy, or transcribe records maintained under paragraph (d)(1) of this clause. The Contractor or subcontractor also shall allow authorized representatives of the Contracting Officer or Department of Labor to interview employees in the workplace during working hours.

E. *Subcontracts*. The Contractor shall insert the provisions set forth in paragraphs (a) through (d) of this clause in subcontracts that may require or involve the employment of laborers and mechanics and require subcontractors to include these provisions in any such lower tier subcontracts. The Contractor shall be responsible for compliance by any subcontractor or lower-tier subcontractor with the provisions set forth in paragraphs (a) through (d) of this clause.

5. CLEAN AIR ACT

By signing this Contract, the Contractor agrees to comply with all applicable standards, orders, or regulations issued pursuant to the Clean Air Act (42 U.S.C. 7401-7671q) and the Federal Water Pollution Control Act as amended (33 U.S.C. 1251-1387). Violations must be reported to the Federal awarding agency and the Regional Office of the Environmental Protection Agency (EPA). Further, the Contractor agrees to include this clause in all subcontracts in excess of $150,000.

6. DEBARMENT AND SUSPENSION

By signing this Contract, the Contractor certifies to the best of its knowledge and belief that it and its principals:

A. Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

B. Have not within a three year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, falsification or destruction of records, making false statements, or receiving stolen property;

C. Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State, or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

D. Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or local) terminated for cause or default.

7. BYRD ANTI-LOBBYING AMENDMENT

By signing this Contract, the Contractor certifies that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, officer or employee of Congress, or an employee of a member of Congress in connection with obtaining any Federal contract, grant or any other award covered by 31 U.S.C. 1352. Further, the Contractor certifies that it has not engaged in lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. The Contractor must require the same certification from all subcontractors

with subcontracts valued in excess of $100,000 under this Contract.

8. SMALL BUSINESS REQUIREMENTS

The Contractor must take all necessary affirmative steps to assure that minority businesses, women's business enterprises, and labor surplus area firms are used when possible.

Affirmative steps must include:

A. Placing qualified small and minority businesses and women's business enterprises on subcontract solicitation lists.

B. Assuring that small and minority businesses, and women's business enterprises are solicited whenever they are potential sources for subcontracting.

C. Dividing total requirements, when economically feasible, into smaller tasks or quantities to permit maximum participation by small and minority businesses, and women's business enterprises.

D. Establishing delivery schedules, where the requirement permits, which encourage participation by small and minority businesses, and women's business enterprises.

E. Using the services and assistance, as appropriate, of such organizations as the Small Business Administration and the Minority Business Development Agency of the Department of Commerce.

9. PROCUREMENT OF RECOVED MATERIALS

The Contractor must comply with section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act. The requirements of Section 6002 include procuring only items designated in guidelines of the Environmental Protection Agency (EPA) at 40 CFR part 247 that contain the highest percentage of recovered materials practicable, consistent with maintaining a satisfactory level of competition, where the purchase price of the item exceeds $10,000 or the value of the quantity acquired by the preceding fiscal year exceeded $10,000; procuring solid waste management services in a manner that maximizes energy and resource recovery; and establishing an affirmative procurement program for procurement of recovered materials identified in the EPA guidelines.

10. ANTI-KICKBACK PROCEDURES

A. Definitions.

1. “Kickback,” as used in this clause, means any money, fee, commission, credit, gift, gratuity, thing of value, or compensation of any kind which is provided to any prime Contractor, prime Contractor employee, subcontractor, or subcontractor employee for the purpose of improperly obtaining or rewarding favorable treatment in connection with a prime contract or in connection with a subcontract relating to a prime contract.

2. “Person,” as used in this clause, means a corporation, partnership, business association of any kind, trust, joint-stock company, or individual.

3. “Prime contract,” as used in this clause, means a contract or contractual action entered into by the United States for the purpose of obtaining supplies, materials, equipment, or services of any kind.

4. “Prime Contractor” as used in this clause, means a person who has entered into a prime contract with the United States.

5. “Prime Contractor employee,” as used in this clause, means any officer, partner, employee, or agent of a prime Contractor.

6. “Subcontract,” as used in this clause, means a contract or contractual action entered into by a prime Contractor or subcontractor for the purpose of obtaining supplies, materials, equipment, or services of any kind under a prime contract.

7. “Subcontractor,” as used in this clause,

a. Means any person, other than the prime Contractor, who offers to furnish or furnishes any supplies, materials, equipment, or services of any kind under a prime contract or a subcontract entered into in connection with such prime contract, and

b. Includes any person who offers to furnish or furnishes general supplies to the prime Contractor or a higher tier subcontractor.

8. “Subcontractor employee,” as used in this clause, means any officer, partner, employee, or agent of a subcontractor.

B. The 41 U.S.C. chapter 87, Kickbacks, prohibits any person from --

1. Providing or attempting to provide or offering to provide any kickback;

2. Soliciting, accepting, or attempting to accept any kickback; or

3. Including, directly or indirectly, the amount of any kickback in the contract price charged by a prime Contractor to the United States or in the contract price charged by a subcontractor to a prime Contractor or higher tier subcontractor.

C. The Contractor shall have in place and follow reasonable procedures designed to prevent and detect possible violations described in paragraph (b) of this clause in its own operations and direct business relationships.

When the Contractor has reasonable grounds to believe that a violation described in paragraph (b) of this clause may have occurred, the Contractor shall promptly report in writing the possible violation. Such reports shall be made to the inspector general of the contracting agency, the head of the contracting agency if the agency does not have an inspector general, or the Attorney General.

The Contractor shall cooperate fully with any Federal agency investigating a possible violation described in paragraph (b) of this clause.

The Contracting Officer may

1. offset the amount of the kickback against any monies owed by the United States under the prime contract and/or

2. direct that the Prime Contractor withhold from sums owed a subcontractor under the prime contract the amount of the kickback. The Contracting Officer may order that monies withheld under subdivision (c)(4)(ii) of this clause be paid over to the Government unless the Government has already offset those monies under subdivision (c)(4)(i) of this clause. In either case, the Prime Contractor shall notify the Contracting Officer when the monies are withheld.

The Contractor agrees to incorporate the substance of this clause, including subparagraph (c)(5) but excepting subparagraph (c)(1), in all subcontracts under this contract which exceed $150,000.

11. ENERGY EFFICIENCY IN ENERGY CONSUMING PRODUCTS

A. Definition. As used in this clause--

1. “Energy-efficient product”—

a. Means a product that—

i. Meets Department of Energy and Environmental Protection Agency criteria for use of the Energy Star trademark label; or

ii. Is in the upper 25 percent of efficiency for all similar products as designated by the Department of Energy’s Federal Energy Management Program.

2. The term “product” does not include any energy-consuming product or system designed or procured for combat or combat-related missions (42 U.S.C. 8259b).

B. The Contractor shall ensure that energy-consuming products are energy efficient products (i.e., ENERGY STAR® products or FEMP-designated products) at the time of contract award, for products that are—

1. Delivered.

2. Acquired by the Contractor for use in performing services at a Federally controlled facility.

3. Furnished by the Contractor for use by the Government.

4. Specified in the design of a building or work, or incorporated during its construction, renovation, or maintenance.

C. The requirements of paragraph (b) apply to the Contractor (including any subcontractor) unless:

1. The energy-consuming product is not listed in the ENERGY STAR® Program or FEMP; or

2. Otherwise approved in writing by the Contracting Officer.

D. Information about these products is available for—

1. ENERGY STAR® at http://www.energystar.gov/products; and

2. FEMP at http://www1.eere.energy.gov/femp/procurement/eep_requirements.html.

12. BUY AMERICAN—CONSTRUCTION MATERIALS

A. Definitions. As used in this clause—

1. "Commercially available off-the-shelf (COTS) item"—
   a. Means any item of supply (including construction material) that is—
      i. A commercial item (as defined in paragraph (1) of the definition at FAR 2.101);
      ii. Sold in substantial quantities in the commercial marketplace; and
      iii. Offered to the Government, under a contract or subcontract at any tier, without modification, in the same form in which it is sold in the commercial marketplace; and
   b. Does not include bulk cargo, as defined in 46 U.S.C. 40102(4), such as agricultural products and petroleum products.

2. "Component" means an article, material, or supply incorporated directly into a construction material.

3. "Construction material" means an article, material, or supply brought to the construction site by the Contractor or a subcontractor for incorporation into the building or work. The term also includes an item brought to the site preassembled from articles, materials, or supplies. However, emergency life safety systems, such as emergency lighting, fire alarm, and audio evacuation systems, that are discrete systems incorporated into a public building or work and that are produced as complete systems, are evaluated as a single and distinct construction material regardless of when or how the individual parts or components of those systems are delivered to the construction site. Materials purchased directly by the Government are supplies, not construction material.

4. "Cost of components" means—
   a. For components purchased by the Contractor, the acquisition cost, including transportation costs to the place of incorporation into the construction material (whether or not such costs are paid to a domestic firm), and any applicable duty (whether or not a duty-free entry certificate is issued); or
   b. For components manufactured by the Contractor, all costs associated with the manufacture of the component, including transportation costs as described in paragraph (1) of this definition, plus allocable overhead costs, but excluding

profit. Cost of components does not include any costs associated with the manufacture of the construction material.

5. “Domestic construction material” means—

a. An unmanufactured construction material mined or produced in the United States;

b. A construction material manufactured in the United States, if—

i. The cost of its components mined, produced, or manufactured in the United States exceeds 50 percent of the cost of all its components. Components of foreign origin of the same class or kind for which nonavailability determinations have been made are treated as domestic.

b. The construction material is a COTS item.

6. “Foreign construction material” means a construction material other than a domestic construction material.

7. “United States” means the 50 States, the District of Columbia, and outlying areas.

a. Domestic preference.

i. This clause implements 41 U.S.C. chapter 83, Buy American, by providing a preference for domestic construction material. In accordance with 41 U.S.C. 1907, the component test of the Buy American statute is waived for construction material that is a COTS item. (See FAR 12.505(a)(2)). The Contractor shall use only domestic construction material in performing this contract, except as provided in paragraphs (b)(2) and (b)(3) of this clause.

ii. This requirement does not apply to information technology that is a commercial item or to the construction materials or components listed by the Government as follows:

b. The Contracting Officer may add other foreign construction material to the list in paragraph (b)(2) of this clause if the Government determines that—

i. The cost of domestic construction material would be unreasonable. The cost of a particular domestic construction material subject to the requirements of the Buy American statute is unreasonable when the cost of such material exceeds the cost of foreign material by more than 6 percent;

ii. The application of the restriction of the Buy American statute to a particular construction material would be impracticable or inconsistent with the public interest; or

iii.The construction material is not mined, produced, or manufactured in the United States in sufficient and reasonably available commercial quantities of a satisfactory quality.

8. Request for determination of inapplicability of the Buy American statute.

a. Any Contractor request to use foreign construction material in accordance with paragraph (b)(3) of this clause shall include adequate information for Government evaluation of the request, including—

i. A description of the foreign and domestic construction materials
ii. Unit of measure
iii. Quantity
iv. Price
v. Time of delivery or availability
vi. Location of the construction project
vii. Name and address of the proposed supplier
viii. A detailed justification of the reason for use of foreign construction materials cited in accordance with paragraph (b)(3) of this clause.

b. A request based on unreasonable cost shall include a reasonable survey of the market and a completed price comparison table in the format in paragraph (d) of this clause.

(iii) The price of construction material shall include all delivery costs to the construction site and any applicable duty (whether or not a duty-free certificate may be issued).

(iv) Any Contractor request for a determination submitted after contract award shall explain why the Contractor could not reasonably foresee the need for such determination and could not have requested the determination before contract award. If the Contractor does not submit a satisfactory explanation, the Contracting Officer need not make a determination.

(2) If the Government determines after contract award that an exception to the Buy American statute applies and the Contracting Officer and the Contractor negotiate adequate consideration, the Contracting Officer will modify the contract to allow use of the foreign construction material. However, when the basis for the exception is the unreasonable price of a domestic construction material, adequate consideration is not less than the differential established in paragraph (b)(3)(i) of this clause.

(3) Unless the Government determines that an exception to the Buy American statute applies, use of foreign construction material is noncompliant with the Buy American statute.

(d) Data. To permit evaluation of requests under paragraph (c) of this clause based on unreasonable cost, the Contractor shall include the following information and any applicable supporting data based on the survey of suppliers:

FOREIGN AND DOMESTIC CONSTRUCTION MATERIALS PRICE COMPARISON

Construction Material Description	Unit of Measure	Quantity	Price (Dollars)*
Item 1:			
Foreign construction material	_____	_____	_____
Domestic construction material	_____	_____	_____

Item 2:	_____	_____	_____
Foreign construction material	_____	_____	_____
Domestic construction material			

[List name, address, telephone number, and contact for suppliers surveyed. Attach copy of response; if oral, attach summary.]
[Include other applicable supporting information.]
[* Include all delivery costs to the construction site and any applicable duty (whether or not a duty-free entry certificate is issued).]

13. INFRASTRUCTURE INVESTMENT AND JOBS ACT, BUILD AMERICA, BUY AMERICA

THIS SECTION ONLY APPLIES TO PROJECTS THAT HAVE A TOTAL COST OF $250,000 OR MORE AND THAT INCLUDE THE USE OF IRON OR STEEL.

Recipients of an award of Federal financial assistance from a program for infrastructure are hereby notified that none of the funds provided under this Agreement may be used for a project for infrastructure unless:

A. All iron and steel used in the PROJECT are produced in the United States--this means all manufacturing processes, from the initial melting stage through the application of coatings, occurred in the United States.

B. All manufactured products used in the PROJECT are produced in the United States—this means the manufactured product was manufactured in the United States; and the cost of the components of the manufactured product that are mined, produced, or manufactured in the United States is greater than 55 percent of the total cost of all components of the manufactured product, unless another standard for determining the minimum amount of domestic content of the manufactured product has been established under applicable law or regulation.

C. All construction materials (excludes cement and cementitious materials, aggregates such as stone, sand, or gravel, or aggregate binding agents or additives) are manufactured in the United States—this means that all manufacturing processes for the construction material occurred in the United States.

D. The Buy America preference only applies to articles, materials, and supplies that are consumed in, incorporated into, or affixed to an infrastructure project. As such, it does not apply to tools, equipment, and supplies, such as temporary scaffolding, brought to the construction site and removed at or before the completion of the infrastructure project. Nor does a Buy America preference apply to equipment and furnishings, such as movable chairs, desks, and portable computer equipment, that are used at or within the finished infrastructure project but are not an integral part of the structure or permanently affixed to the infrastructure project.

E. Definitions:

“Construction materials” includes an article, material, or supply—other than an item of primarily iron or steel; a manufactured product; cement and cementitious materials; aggregates such as stone, sand, or gravel; or aggregate binding agents or additives 46—that is or consists primarily of:

1. Non-ferrous metals
2. Plastic and polymer-based products (including polyvinyl/chloride, composite building materials, and polymers used in fiber optic cables
3. Glass (including optic glass)
4. Lumber; or drywall

F. Subrecipient Agreements

Contractors and their subcontractors who apply or bid for an award for an infrastructure project subject to the domestic preference requirement in the Build America, Buy America Act (BABAA) shall file the required certification to the City with each bid or offer for an infrastructure project, unless a domestic preference requirement is waived by the federal awarding agency. Contractors and subcontractors certify that no federal financial assistance funding for infrastructure projects will be provided unless all the iron, steel, manufactured projects, and construction materials used in the project are produced in the United States. BABAA, Pub. L. No. 117-58, §§ 70901-52. Contractors and subcontractors shall also disclose any use of federal financial assistance for infrastructure projects that do not ensure compliance with BABAA domestic preference requirement. Such disclosures shall be forwarded to City who in turn will forward the disclosures to the federal awarding agency; subrecipients will forward disclosures to the City, who will in turn forward the disclosures to the federal awarding agency.

SCHEDULE H – CONSTRUCTION PLAN SET

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SCHEDULE I – 404 PERMIT

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DEPARTMENT OF THE ARMY
ALBUQUERQUE DISTRICT, CORPS OF ENGINEERS
SOUTHERN COLORADO REGULATORY BRANCH
201 WEST 8TH STREET, SUITE 350
PUEBLO, COLORADO 81003

November 9, 2022

Regulatory Division

SUBJECT: Nationwide Permit Verification – Fairfax Pond (SPA-2019-00278)

City of Colorado Springs, Water Resources Engineering Division
Adam Cooper
30 S. Nevada Ave., Suite 401
Colorado Springs, CO 80901

Dear Mr. Cooper:

The U.S. Army Corps of Engineers (Corps), Albuquerque District, is responding to your preconstruction notification (PCN) submitted to us for verification of authorization under Nationwide Permit (NWP) 43 for the Fairfax Pond Project, Colorado Springs, Colorado project. The project site is located at approximately latitude 38.96220, longitude -104.72844, El Paso County, Colorado.

Based on the information provided, we have determined that the Fairfax Pond Project, Colorado Springs, Colorado project involves the discharge of dredged or fill material into waters of the United States, subject to Section 404 of the Clean Water Act. The specific activity that requires Corps authorization is the construction of a principal spillway and emergency spillway adjacent to Fairfax Creek, a tributary to Cottonwood Creek. The project will permanently impact approximately 0.036 acre of wetlands and temporarily impact 0.058 acre of wetlands and will be conducted as described in the referenced PCN.

The Corps has determined that activities associated with the project are authorized by 2021 NWP 43. A summary of this NWP and the 2021 Colorado Regional Conditions are available on our website at www.spa.usace.army.mil/reg/nwp. Failure to comply with all terms and conditions of this NWP may result in the suspension or revocation of this authorization. As required by General Condition 30, you shall sign the enclosed Compliance Certification (Enclosure 1) and return it to this office within 30 days after completion of the authorized work. For specific information regarding compliance with water quality certification (WQC) requirements, please refer to our website at www.spa.usace.army.mil/reg/wqc.

Our review of this project also addressed its effects on threatened and endangered species and historic properties in accordance with General Conditions 18 and 20. Based on the information provided, we have determined that this project will have no effect on federally listed species or their critical habitat. Additionally, the project has no potential to cause effects on historic properties. However, these determinations may be

invalidated if the project is not completed as authorized or you did not provide accurate information in your PCN.

This permit verification is valid until March 14, 2026, unless the NWP is modified, suspended, reissued, or revoked prior to that date. Continued confirmation that an activity complies with the terms and conditions, and any changes to the NWP, is the responsibility of the permittee. Activities that have commenced, or are under contract to commence, in reliance on an NWP will remain authorized provided the activity is completed within 12 months of the date of the NWP's expiration, modification, or revocation.

This letter does not constitute approval of the project design features, nor does it imply that the construction is adequate for its intended purpose. This permit does not authorize any injury to property or invasion of rights or any infringement of federal, state, local, or tribal laws or regulations. The permittee and/or any contractors acting on behalf of the permittee must possess the authority and any other approvals required by law, including property rights, to undertake the proposed work.

The landowner must allow Corps representatives to inspect the authorized activity at any time deemed necessary to ensure that it is being, or has been, accomplished in accordance with the terms and conditions of the permit.

We would appreciate your feedback on this permit action including your interaction with our staff or suggestions for improving our program. For more information about our program or to complete our Regulatory Program national customer service survey, visit our website at https://www.spa.usace.army.mil/Missions/Regulatory-Program-and-Permits/.

Please refer to identification number SPA-2019-00278 in any correspondence concerning this project. If you have any questions, please contact Kraig Jashinsky by email at Kraig.A.Jashinsky@usace.army.mil, or telephone at (719) 439-7281.

Sincerely,

Kara A. Hellige
Chief, Southern Colorado Regulatory Branch

cc: Tamara Keefe, Felsburg Holt & Ullevig, tamara.keefe@fhueng.com

COMPLIANCE CERTIFICATION

Action Number: SPA-2019-00278

Name of Permittee: City of Colorado Springs, Water Resources Engineering Division, Adam Cooper

Permit: Nationwide Permit 43

Upon completion of the activity authorized by this permit and any mitigation required by the permit, sign this certification and return it to the following address:

U.S. Army Corps of Engineers, Albuquerque District
Southern Colorado Regulatory Branch
201 West 8th Street, Suite 350
Pueblo, Colorado 81003
Chief, Southern Colorado Regulatory Branch

Please note that your permitted activity is subject to a compliance inspection by a U.S. Army Corps of Engineers representative. If you fail to comply with this permit, you are subject to permit suspension, modification, or revocation.

Please enclose photographs showing the completed project (if available).

I hereby certify that the work authorized by the above-referenced permit has been completed in accordance with the terms and conditions of the said permit, and required mitigation was completed in accordance with the permit conditions.

Date Work Started _____

Date Work Completed _____

_____ _____
Signature of Permittee Date

Encl 1

SCHEDULE J – GEOTECHNICAL REPORT

Starts on Next Page

Kumar & Associates, Inc.®
Geotechnical and Materials Engineers
and Environmental Scientists

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Colorado Springs, CO 80918
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An Employee Owned Company

Office Locations: Denver (HQ), Parker, Colorado Springs, Fort Collins, Glenwood Springs, and Summit County, Colorado

FINAL GEOTECHNICAL ENGINEERING STUDY
PROPOSED INTERCHANGE AT
RESEARCH PARKWAY AND POWERS BOULEVARD
COLORADO SPRINGS, COLORADO

Prepared By:
Duane P. Craft, P.E.

Reviewed By:
Jim A. Noll, P.E.

COLORADO REGISTERED
DUANE P. CRAFT
37553
6/9/20
PROFESSIONAL ENGINEER

Prepared For:

Steve Murray, P.E.
Felsburg Holt, & Ullevig
3 South Tejon Street, Suite 300
Colorado Springs, Colorado, 80903

Project No: 17-2-183.A

June 9, 2020

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SUMMARY

1. The overburden soils varied across the project area, and included man-placed fill, silty sand, poorly graded sand with silt, silty to clayey sand, clayey sand, and sandy lean clay. Overall, the overburden soils encountered were predominately the granular soil types. Claystone and sandstone bedrock were encountered at depths ranging from directly below the topsoil to about 27 feet in 51 of the 81 borings.

2. Groundwater was encountered within 34 of the borings at depths ranging from approximately 2.4 feet to 32 feet. It is anticipated that groundwater levels will fluctuate with time. Depending on the depths of excavations planned, groundwater may impact areas of proposed construction, in particular, work in and around the north tributary of Cottonwood Creek where the groundwater level should be anticipated in the vicinity of the base of excavations within the channel.

3. The majority of the soils encountered had nil to low swell potential, but expansive clay or claystone materials were encountered within a few of the borings at or near the anticipated roadway elevations. Where clay or claystone bedrock is encountered, we recommend the overexcavation and replacement with suitable material to a depth of at least 2 feet. The same over-excavation requirement is recommended for retaining walls and other shallow foundation supported structures.

4. Based on the traffic information provided, the following pavement sections were developed.

Roadway	HMA over ABC	JPCP over ABC
Powers Blvd – N. of Research Pkwy	7.5 over 10	9 over 6
Powers Blvd – S. of Research Pkwy	7.5 over 10	10.5 over 6
SB Off Ramp	5.5 over 10	7.5 over 6
SB On Ramp	6.5 over 10	8 over 6
NB On Ramp	5.5 over 10	7.5 over 6
NB Off Ramp	5.5 over 10	7.5 over 6
Research Pkwy – W. of Powers Blvd.	10.25 over 12	12.25 over 4
Research Pkwy – E. of Powers Blvd.	10 over 12	12 over 4

5. Both driven H-pile and drilled caisson foundation recommendations have been provided for the bridge and wall structures. The steel H-piles used for support of the abutments should be driven through the existing overburden soils and terminate in the underlying bedrock. The H-piles should be driven to refusal in competent bedrock. As discussed in Section 502.05 of the CDOT *Standard Specifications*, refusal criteria should be established by the Engineer after PDA monitoring has been performed on a minimum of one pile per abutment.

In general, the highest stress a driven pile will experience is during installation. In order to avoid damaging the pile, the allowable driving stress is limited to a maximum of $0.9F_y$ (45 ksi for a 50 ksi pile). Some consultants and design professionals prefer to further reduce the maximum allowable driving to $0.8F_y$ (40 ksi for a 50 ksi pile) to account for uncertainties during driving and to provide a maximum driving resistance (refusal) criteria that provides more efficient (quicker) installation of the piles and an additional factor of safety against overstressing the pile.

For sites where the piles are to be driven to practical "refusal", the PDA method is used to establish the maximum driving resistance criteria, and a design "geotechnical" resistance factor of 0.65 can be applied to the nominal "geotechnical" capacity of the pile to calculate the allowable "geotechnical" resistance of the pile. If the factored load used in design includes all possible permutations, including drag load, the effects of scour, etc., we recommend using a nominal "geotechnical" capacity of 45 ksi; however, the designer may consider using a lower nominal "geotechnical" capacity of 40 ksi if there is some uncertainty regarding the factored load or a desire to include an additional safety factor with regard to driving conditions.

6. For drilled caisson foundations, the design approach used in determination of the nominal bedrock resistance and the associated resistance factors were based upon a Category I material (soil-like claystone) and the procedures outlined Appendix B of FHWA GEC 010. Design nominal values are presented in the report. Caissons should penetrate at least three diameters or 8 feet into bedrock, whichever is greater, and should also have a minimum length of 20 feet.

7. Shallow footings can be used for lightly loaded structures placed on suitable fill. A nominal bearing resistance of 6.3 ksf can be used with a resistance factor of 0.45 as described in Table 10.5.5.2.2-1 of the AASHTO LRFD Bridge Design Specifications. Additional criteria for MSE wall design are presented in the report.

PURPOSE AND SCOPE OF STUDY

This report presents the results of a geotechnical engineering study for the proposed interchange of Powers Boulevard and Research Parkway in Colorado Springs, Colorado. The overall project site is shown on Fig. 1. The study was conducted in general accordance with the scope of work in our Proposal No. C18-265R, dated November 8, 2018, to develop final recommendations for foundations, pavements and earthwork as part of our scope for Task Order #3.

We previously prepared a preliminary geotechnical engineering report, Task Order #1, Project No. 17-2-183, dated November 30, 2017. We also previously performed supplemental drilling and associated laboratory testing in the Fall of 2018 associated with Task Order #2 as an effort toward the final study for the overall project. This previously collected information has been incorporated into this report.

This report has been prepared to summarize the data obtained during this study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to the proposed design are included in the report.

PROPOSED CONSTRUCTION

We understand a grade-separated interchange will be constructed at the intersection of Powers Boulevard and Research Parkway to carry Powers Boulevard over Research Parkway. The bridge construction will consist of a single-span of bulb tee girders supported on integral abutments supported with driven H-piles. The overall span will be about 126 feet between abutments.

The bridge abutment walls (referred to as Walls 1 and 2) will consist of mechanically stabilized earth (MSE) construction. Additional MSE walls will be constructed north of the interchange adjacent to the outside lane of northbound Powers (Wall 3), and adjacent to exit ramp in the northwest quadrant of the intersection (Walls 4 and 5). Our study has also addressed potential sound wall structures at three locations within the project limits (east side of Powers, north and south of the interchange, and south side of Research, west of the interchange). If constructed, we understand they would likely consist of post and panel type construction, supported with drilled caissons. At the time this report was prepared, it was our understanding these walls have been deleted from the project. A summary of our understanding of the proposed retaining and sound walls for this project is presented in the table below.

Table 1: Details of Proposed Walls

Wall Type & Designation		Location	Station	Length	Max. Height (Approx.)
MSE	1	South Abutment	Sta. 10+00 to 12+70	270’	23’
	2	North Abutment	Sta. 20+00 to 22+92	292’	24’
	3	E. side of NB Powers, N. of interchange	Sta. 30+00 to 32+30	230’	10’
	4	W. side of SB exit ramp	Sta. 40+00 to 41+10	110’	13’
	5	W. side of SB exit ramp	Sta. 50+00 to 51+13	113’	10’
Sound Wall	n/a	E. side of NB Powers, S. of interchange	n/a	2,210’	n/a
	n/a	E. side of NB Powers, N. of interchange	n/a	1,380’	n/a
	n/a	S. side of EB Research, W. of interchange	n/a	834’	n/a

At the Powers Boulevard crossing of the north tributary to Cottonwood Creek, we understand the existing culvert will be extended at each end of the crossing. In addition, there is a potential that drop structures or other energy reducing structures may be installed within the channel, in the vicinity of Borings D1 and D2.

The project pavements will also include reconstruction of about 6,800 lineal feet of Powers Boulevard and 1,900 lineal feet of Research Parkway; each of which will have 3 lanes per direction. Exit or entrance ramps will be constructed within each quadrant of the interchange as shown on Fig. 1B. Pavement materials being considered include a composite asphalt and aggregate base course section, as well as concrete over base course.

Site grading is anticipated to consist of maximum embankment fill depths on the order of 20 to 25 feet for the raised portion of Powers Boulevard, and maximum cuts and fills of 5 to 10 feet or less elsewhere within the project. We understand Research Parkway will generally maintain the existing alignment and grades. At the northwest quadrant of the intersection, the existing fill pile will be removed, and a stormwater pond will be constructed. Grading details associated with the pond were not available at the time of this study.

SITE CONDITIONS

The region generally slopes down to the south-southwest, toward Cottonwood Creek located about 3,500 feet south of Research Parkway crossing beneath Powers Boulevard. The north tributary of Cottonwood Creek flows southwest crossing under Powers Boulevard approximately 1,000 feet north of Research Parkway and crossing under Research Parkway approximately 800 feet west of Powers Boulevard.

Existing interchanges on Powers Boulevard are located to the south and north of the site at Woodman Road and Briargate Parkway respectively. Channel Drive and Cross Creek Drive intersect with Research Parkway within the project limits.

Existing sections of Powers Boulevard and Research Parkway each consist of divided 6-lane asphalt paved roadways. At the current at-grade intersection, auxiliary turn lanes and or merge lanes are present.

Marshland vegetation was observed around and within the Cottonwood Creek and North Tributary drainages at their crossings of Powers Boulevard and Research Parkway. Along the Powers Boulevard and Research Parkway right of ways the existing vegetation generally consisted of weeds and natural grasses with some deciduous trees along Research Parkway.

FIELD EXPLORATION PROGRAM

The field exploration for the project was conducted between September 19 and October 13, 2017 and between September 19 and October 15, 2018. Eighty-one (81) exploratory borings were drilled at the approximate locations shown on Figs. 1A thru 1C to explore the subsurface conditions.

Table 2: Summary of Boring Locations

Location	Number of Borings	Borings
Main Interchange Bridge Structure and Associated Abutment Walls	6	S1, S2, S1A, S2A, W1 and W2
North Powers Drainage Crossing	4	S3, S4, W3 and W4
SE Powers Sound Wall	7	SW1 through SW7
NE Powers Sound Wall	11	SW8 through SW18
Research Sound Wall	6	SW19 through SW24
Drainage NW Quadrant	2	D1 and D2
Fill Pile, NW Quadrant	3	F1 through F3
Mainline Powers Boulevard and Research Boulevard Pavements	26	B1 through B26
Ramp Pavements	16	R1 through R16

Locations of the exploratory borings were determined by taping from existing site features. Upon completion of drilling, the locations and elevations (excluding the sound wall borings) were surveyed by 105 West, Inc. The approximate boring locations are shown on Figs. 1A thru 1C, and the boring elevations are shown on the boring logs, Figs. 2 thru 8.

The borings were advanced through the overburden soils and into the underlying bedrock, where present, with 4 and 6-inch diameter continuous flight augers. The borings were logged by a representative of Kumar & Associates, Inc. Samples of the soils and bedrock were obtained with either a 2-inch I.D. California liner sampler or a 1 3/8-inch I.D. spoon sampler. The samplers were driven into the various strata with blows from a 140-pound hammer falling 30 inches. The spoon sampler test is the standard penetration test described by ASTM Method D 1586. Penetration resistance values, when properly evaluated, indicate the relative density or consistency of the soils. Depths at which the samples were obtained, and the penetration resistance values are shown on the Logs of Exploratory Borings, Figs. 2 through 8.

Measurements of the water level were made in the borings by lowering an electronic water level indicator into the open hole shortly after completion of drilling. Follow-up measurements were made, between 5 and 13 days after drilling. The depths of the water levels measured are shown on the Logs of Exploratory Borings.

SUBSURFACE CONDITIONS

A brief discussion of the major soil and bedrock types encountered follows, along with generalized summary for each specific target area. Detailed depictions of material types and depths can be found on Figs. 2 through 8, with the associated explanatory legend and notes are provided on Fig. 9.

Pavement Materials: The asphalt pavement thickness ranged from approximately 7 to 12 inches with an average of 9.0 inches within Powers Boulevard, and 5 to 13.25 inches with an average of 9.1 inches within Research Parkway. Aggregate Base Course (ABC) was not encountered in the exploratory borings. The pavement thickness at each boring location is shown adjacent to the Boring Logs (Figs. 2 through 8) and is also summarized on Table II.

Fill: Man-placed fill consisting of silty to clayey sand, and less frequently occurring sandy lean clay was found extending to various depths as show on the attached boring logs. The granular fill was relatively moist, and varied from brown, dark brown, gray and dark gray in color. The cohesive fill was also noted as moist and brown to gray in color. Our study did not define the exact lateral or vertical extent of the fill.

Granular Overburden Soils: Silty sand (SM), silty-clayey sand (SC-SM), and clayey sand (SC) soils were found in the majority of the borings at various depths as shown on the attached boring logs. The silty sand contained occasional zones of poorly-graded sand with silt, was generally fine to coarse grained, was moist to wet, and varied from tan, brown, reddish-brown and gray in color. The silty-clayey sand and clayey sand was fine to medium grained, moist, and brown and gray in color. Based on the penetration resistance blow counts, the soil types mentioned above are loose to dense.

Cohesive Overburden Soils: Sandy lean clay (CL) with occasional clayey sand was found in four of the borings at the depths shown in the attached figures. The clay was fine to coarse grained, moist to wet, and brown to gray in color. Based on the penetration resistance blow counts, the sandy lean clay was stiff to very stiff.

Bedrock: Claystone and sandstone bedrock was encountered in 51 of the borings at depths ranging from directly below the topsoil to about 27 feet. The claystone was occasionally sandy and contained occasional clayey sandstone layers. The sandstone was occasionally clayey and contained occasional sandy claystone layers. Both bedrock types were fine to coarse grained,

moist to wet, gray to brown in color. Based on the penetration resistance blow counts the claystone was firm to very hard and the sandstone was medium hard to very hard.

Groundwater: Groundwater was encountered within 34 of the borings at the time of drilling and/or when checked 5 to 13 days after drilling. The measured groundwater depths ranged from approximately 2.4 feet to 32 feet and are shown on the Logs of Exploratory Borings. It is anticipated that groundwater levels will fluctuate with time.

Bridge / Abutment Walls: Man placed fill consisting of silty to clayey sand was encountered in two of the borings and extended to approximately 3 feet below the existing grade. Beneath the topsoil/fill materials the overburden soils generally consisted of silty sand extending to approximately 7 to 14 feet below the existing grade. Beneath the overburden soils and extending to the maximum depths explored of 20 to 40 feet below grade, sandstone and claystone bedrock were encountered.

N. Powers Drainage Crossing: Man placed fill was encountered in each of the borings, extending to approximately 5 to 17 feet below the existing grade. The fill material generally consisted of silty to clayey sand. The man placed fill was underlain by 2 to 6 feet of silty sand in two of the borings, and sandstone and claystone bedrock in the remaining boring. The bedrock extended to the maximum depths explored in this area of 20 to 40 feet below grade.

SE Powers Sound Wall: Man placed fill consisting of clayey sand to lean clay was encountered within two boring locations and extended to approximately 3 to 5 feet. Granular overburden soils were encountered beneath the fill in five of the borings and extended to approximately 7 to 11 feet below grade. The overburden soils were underlain by sandstone and claystone bedrock extending to the maximum depth explored of 20 feet below the existing grade.

NE Powers Sound Wall: Man placed fill consisting of silty to clayey sand was encountered in five of the 11 borings and extended to approximately 3 to 12 feet below grade. Beneath the man placed fill and the topsoil in the remainder of the borings, silty to clayey sand was encountered 8 of the borings extending to approximately 1 to 17 feet below the existing grade. The overburden soils were then underlain by sandstone and claystone bedrock extending to the maximum depth explored of 20 to 40 feet below the existing grade. The bedrock was typically shallower at the northern and southern ends of the wall alignment.

Research Sound Wall: Man placed fill consisting of lean to fat clay and silty to clayey sand was encountered in each of the borings. The man placed fill extended to approximately 3 to 9 feet below the existing grade. The man placed fill soils were underlain by silty to clayey sand overburden soils which extended to approximately 3 to 25 feet below the existing grade in 5 of the 6 borings. The overburden soils were then underlain by claystone and sandstone bedrock which extended to the maximum depths explored of 20 to 35 feet below grade.

Drainage NW Quadrant: Beneath a thin layer of topsoil, silty sand was encountered extending to approximately 9 to 12 feet below the existing grade. The overburden soils were underlain by sandstone and claystone bedrock which extended to the maximum depths explored of 20 feet.

Fill Pile NW Quadrant: Beneath a thin layer of topsoil, man placed fill consisting of silty to clayey sand was encountered in each of the borings and extended to approximately 10 to 22 feet below the existing grade. The fill was underlain by silty sand in one of the borings which extended to approximately 27 feet below grade. The overburden soils were underlain by claystone and sandstone which extended to the maximum depths explored of 15 to 40 feet below grade.

Mainline Powers Pavements: Beneath approximately 7 to 12 inches of asphalt pavement, man placed fill generally consisting of silty to clayey sand and lean clay was encountered extending to approximately 1 to 8 feet in seven of the borings and the maximum depths explored of 5 to 10 feet in two of the borings. In fourteen of the borings, overburden soils consisting of silty to clayey sand and lean clay were encountered beneath the asphalt pavement and man placed fill materials, extending to depths of 3 and 9 feet in two of the borings and the maximum depths explored of 5 to 10 feet in 12 of the borings. Beneath the overburden soils in four of the borings, sandstone was encountered extending to the maximum depths explored of 5 to 10 feet.

Mainline Research Pavements: The asphalt pavement thickness ranged from approximately 5 to 13.25 inches. Man placed fill consisting of silty to clayey sand and lean clay was encountered in five of the borings and extended to approximately 1 to 8 feet in three of the borings and the maximum depths explored of 5 to 10 feet in two of the borings. Beneath the fill in two borings and the asphalt pavement in three borings, native overburden soils generally consisting of silty to clayey sand were encountered extending to a depth of approximately 2.5 and 7 feet below grade in two borings and the maximum depth explored of 5 to 10 feet in three borings. Claystone bedrock was encountered within three borings, beginning at depths of 2.5 to 7 feet below grade and extending to the maximum depths explored of 5 to 10 feet.

Ramp Pavements: Seven of the 16 borings encountered man placed fill which generally consisted of silty to clayey sand or lean clay and extended to approximately 2 to 8 feet below grade in five of the borings and the maximum depth explored of 5 feet in two borings. Native overburden soils generally consisting of silty to clayey sand were encountered in 10 of the borings. The native overburden soils extended to approximately 1.5 feet in one of the borings and the maximum depth explored of 5 to 10 feet in nine of the borings. Sandstone and claystone bedrock were encountered in five of the borings and extended to the maximum depths explored of 5 to 10 feet.

LABORATORY TESTING

Laboratory testing performed on selected sampled obtained from the borings included the natural moisture content and dry density, gradation analysis, liquid and plastic limits, swell-consolidation tests, water soluble sulfate concentrations, electrical resistivity, chloride content, pH, unconfined compressive strength, Hveem's Resistance values (R-value), and soil moisture-density relationships (Proctors). The laboratory test results are shown adjacent to the boring logs on Figs. 2 through 8, plotted graphically on Figs. 10 thru 77, and summarized in Table I and IA.

Swell-consolidation tests were performed on selected samples of the silty clayey sand, clayey sand, sandy lean clay fill (both clay and clayey sand), fat clay fill, sandy lean clay, clayey sandstone, sandy claystone and claystone. The expansion was measured after wetting under a constant surcharge load of 200 psf in pavement boring locations and 1,000 psf in structure boring samples. Generally, the more granular materials, such as the silty clayey sand, clayey sand, clayey sandstone and fill materials exhibited nil to low swell potential, while the cohesive materials including the sandy lean clay and claystone exhibited low to moderate swell potential. Detailed results of the swell-consolidation tests are presented on the attached Figs. 10 through 24.

Testing of unconfined compressive strength was performed on eight samples of bedrock. The unconfined compressive strength of the six tested samples of claystone was ranged from 9,631 psf to 26,704 psf, with an average of 16,508 psf. The tested samples of sandstone were approximately 1,548 psf and 6,887 psf, with an average of 4,218 psf.

Hveem's Resistance Values (R-values) were run on samples of the silty-clayey sand, clayey sand, sandstone, claystone and clayey sandstone, which are thought to represent the predominant material types that will be encountered at the proposed roadway grades. The tested R-values ranged from 4 to 40 and averaged about 15. Test results are included are Figs. 59 thru 68.

Soil moisture-density relationship (standard Proctor) testing was performed on samples of sandy lean clay, silty-clayey sand, clayey sand, claystone and clayey sandstone. The tested sample of silty-clayey sand had a maximum dry density of 119.0 pcf and an optimum moisture content of 10.6%. Testing performed on four different samples of clayey sand indicate a maximum dry density in the range of 106.8 pcf to 122.0 pcf, and an optimum moisture content in the range of 11.0% to 16.0%. The tested sample of sandy lean clay had a maximum dry density of 102.2 pcf and an optimum moisture content of 15.7%. The tested sample of clayey sandstone had a maximum dry density of 107.9 pcf and an optimum moisture content of 15.3%. The tested sample of claystone had a maximum dry density of 107.1 pcf and an optimum moisture content of 14.0%. These test results are included on Figs. 69 thru 77.

BRIDGE FOUNDATIONS (DRIVEN H-PILES)

A single-span bridge structure is proposed along SH21 at the Research Parkway Interchange. We anticipate that steel pile foundations will be utilized at the abutments and have provided recommendations for this foundation type herein. Design criteria are based on the Load and Resistance Factor Design (LRFD) method for Highway Bridge Substructures as presented by the Federal Highway Administration.

The design and construction details presented below should be observed for a new driven H- pile foundation system. Construction details should be considered when preparing project documents. The settlement of properly constructed driven piles is expected to be less than about ½ inch.

1. The steel H-piles used for support of the abutments should be driven through the existing overburden soils and terminate in the underlying bedrock. The H-piles should be driven to refusal in competent bedrock. As discussed in Section 502.05 of the CDOT *Standard Specifications*, refusal criteria should be established by the Engineer after PDA monitoring has been performed on a minimum of one pile per abutment.

   In general, the highest stress a driven pile will experience is during installation. In order to avoid damaging the pile, the allowable driving stress is limited to a maximum of $0.9F_y$ (45 ksi for a 50 ksi pile). Some consultants and design professionals prefer to further reduce the maximum allowable driving to $0.8F_y$ (40 ksi for a 50 ksi pile) to account for uncertainties during driving and to provide a maximum driving resistance (refusal) criteria that provides more efficient (quicker) installation of the piles and an additional factor of safety against overstressing the pile.

For sites where the piles are to be driven to practical "refusal", the PDA method is used to establish the maximum driving resistance criteria, and a design "geotechnical" resistance factor of 0.65 can be applied to the nominal "geotechnical" capacity of the pile to calculate the allowable "geotechnical" resistance of the pile. If the factored load used in design includes all possible permutations, including drag load, the effects of scour, etc., we recommend using a nominal "geotechnical" capacity of 45 ksi; however, the designer may consider using a lower nominal "geotechnical" capacity of 40 ksi if there is some uncertainty regarding the factored load or a desire to include an additional safety factor with regard to driving conditions.

2. Installation of piling should be in accordance with Section 502 of the most recent version of the Colorado Department of Transportation (CDOT*) Standard Specifications for Road and Bridge Construction*.

3. The piles should consist of a heavy steel H-section and should include a pile tip.

4. The pile driving contractor should provide the results of a driveability analysis using an accepted wave equation analysis program such as GRLWEAP for the pile driving equipment proposed for use, and the type of pile prior to pile driving operations.

5. Piles should be driven to a minimum depth of 10 feet below the bedrock elevation, which is anticipated to range from about 8 to 14 feet below the surface grade. To achieve the required depths, drilling pilot holes through a portion of the bedrock may be necessary, particularly if well cemented sandstone lenses are present. Pre-drilling, if required, should be conducted in accordance to Section 502.06 of CDOT's *Standard Specifications for Road and Bridge Construction*.

6. The range of tip penetration for H-piles driven into the bedrock bearing stratum is estimated to be approximately 5 to 10 feet. This is an estimate based on past experience and does not account for irregularities in hardness of the bedrock. If the piles are driven to a significantly greater bedrock penetration, additional PDA testing should be performed to verify and/or adjust the pile driving refusal criteria.

7. Uplift resistance of the piles will be developed by skin friction between the pile and the overburden soils. The allowable unit shaft resistance at any depth along the pile can be assumed to be 10 percent of the effective overburden stress at that depth, but should not

exceed an ultimate nominal value of 1,500 psf. A resistance factor of 0.35 should be applied to the ultimate nominal value. Overburden stress should account for buoyancy below the groundwater level. Pile and pile cap weights may be included as dead weight resistance to uplift forces.

8. We assume that the LPILE computer program will be used to evaluate lateral load capacity and deflection behavior of driven H-pile and drilled caisson foundations. The overburden soils in the vicinity of the bridge structure include silty sand fill, native silty sand, and some clay, but the native silty sands are the most prevalent soil type. The bedrock encountered included claystone and clayey sandstone. To simplify the analysis, properties for silty sand and cohesive bedrock were presented in the following table showing lateral capacity analysis parameters for use in the LPILE program.

Table 3: LPILE Parameters

Material		c	Ø	Y_T	K_s	K_c	$Є_{50}$	Soil Model Type
Overburden soils	Above Groundwater	0	30	120	90	90	--	Sand (Reese)
	Below Groundwater	0	30	60	60	60	--	Sand (Reese)
Bedrock		8,000	--	130	2,000	800	0.004	Stiff clay w/o water

c - Cohesion intercept (psf)
ø - Angle of internal friction (degrees)
Y_T - Effective unit weight (pcf)
k_s - Initial modulus of horizontal subgrade reaction – Static (pci)
k_c - Initial modulus of horizontal subgrade reaction – Seismic (pci)
$Є_{50}$ - Strain at 50 percent of peak shear strength

9. Pile groups will require appropriate reductions of the axial, uplift and lateral capacities based on the effective envelope of the pile group. These reductions can be avoided by spacing the piles at a distance of at least 5 diameters center-to-center in the direction both parallel and perpendicular to loading, and 3 diameters center-to-center for axial loading. More closely spaced piles should be studied on an individual basis to determine the appropriate reduction in axial and lateral load design parameters.

10. If the recommended minimum center-to-center pile spacings cannot be achieved, we recommend the load-displacement curve (p-y curve) for an isolated pile be modified for

closely-spaced piles using p-multipliers to reduce all the p-values on the curve. With this approach, the computed load carrying capacity of the pile in a group is reduced relative to the isolated pile capacity. The modified p-y curve should then be reentered into the LPILE software to calculate the pile deflection. The reduction in capacity for the leading pile, the pile leading the direction of movement of the group, is less than that for the trailing piles.

For center-to-center spacing of vertical piles in the group in the direction of loading expressed in multiples of the pile diameter, we recommend the following p-multipliers presented in Table 10.7.2.4-1 of the 2017 AASHTO LRFD Bridge Design Specifications (8th Edition):

Table 4: P-Multipliers

Pile Spacing (Center to Center) in the direction of loading	p-Multipliers, p_m		
	Row 1	Row 2	Row 3 and Higher
3B	0.8	0.4	0.3
5B	1.0	0.85	0.7

For loading in a direction perpendicular to the row of piles, the p-multipliers should be 1.0 for pile spacing of 5 diameters or greater, 0.8 for 3 diameters, and 0.5 for a pile spacing of 1 diameter. P-multiplier values for other pile spacing values should be determined by interpolation. It will be necessary to determine the load distribution between the piles that attains deflection compatibility because the leading pile carries a higher proportion of the group load and the pile cap prevents differential movement between the piles.

11. Alternatively, lateral resistance to horizontal forces can be provided by battered piles. It is typically assumed that a battered pile can resist the same axial load as a vertical pile of the same type and size driven to the same elevation. The vertical and horizontal components of the load will depend on the batter inclinations. Batter inclinations should not exceed 1 horizontal to 4 vertical.

12. The selection and approval of pile driving equipment should be in accordance with Sections 502.03 and 502.04 of the CDOT Standard Specifications. An appropriately-sized hammer should be used to achieve the required capacity without overstressing the pile.

13. The pile driving operations should be observed by qualified personnel on a full- time basis. Each pile should be observed and checked for buckling, crimping and alignment in addition to recording penetration resistance and general pile driving operations.

DRILLED CAISSON FOUNDATIONS

We understand that if sound barriers are constructed for this project, they will likely utilize drilled caisson foundations. The design and construction criteria provided below should be followed for this foundation type. The design approach used in determination of the nominal bedrock resistance and the associated resistance factors were based on the procedures outlined in Appendix B of the FHWA Geotechnical Engineering Circular titled "Drilled Shafts: Construction Procedures and LRFD Design Methods" (FHWA GEC 10, May 2010).

Based on the tested properties and penetration resistance blow counts of the bedrock sampled, this material generally falls within Category I (soil-like claystone). A representative blow count value of 40 was used for the calculation of the base and side unit resistance values presented in Item 1 below.

If drilled pier foundations are considered, the following design and construction criteria should be observed.

1. The geotechnical design values for the proposed drilled caisson alternative are as follows:

Table 5: Drilled Caisson Resistance Values

Drilled Caissons – Design Values (LRFD)			
Nominal Base Resistance (ksf)	Base Resistance Factor	Nominal Side Resistance (ksf)	Side Resistance Factor
36.8	0.60	3.00	0.60

2. Caissons should penetrate at least three diameters or 8 feet into bedrock, whichever is greater. Caissons should also have a minimum length of 20 feet.

3. The field exploration encountered areas of weak to non-cemented sandstone below the bedrock surface. These materials may cave during the drilling process and casing in the bedrock may be required to complete the caissons. Zones of caving material should not be included when determining whether the required length of penetration has been met; the pier length should be increased an amount equal to the length of caving material.

4. Difficulty may be encountered in establishing a casing seat in the sandstone to achieve a positive cutoff of groundwater seepage into the hole. In drilled shafts where temporary casing is used, skin friction should be neglected in the cased portion of the hole. Additional

bedrock penetration will be required to compensate for the lost skin friction. The amount of additional penetration should be determined in the field at the time of construction. The contract documents should advise potential drilled shaft contractors of these subsurface conditions. In addition, careful consideration should be given to preparing bid items to avoid high costs for potential overruns.

5. It is recommended that the caissons be spaced at least three pier diameters (center-to-center) apart. If it is necessary to place caissons closer together, the capacity of the caissons should be reduced in accordance Item 11 in the "Driven H-Pile" subsection of the report.

6. Our experience with drilled caissons in similar bedrock indicates that settlement of less than one inch can be expected for individual caissons founded in bedrock.

7. Lateral deflection of the caissons can be calculated based on the LPILE parameters provided in the "Driven H-Pile" subsection of the report.

8. Casing procedures should be evaluated by the geotechnical engineer on caissons that will be subjected to lateral loads. Oversizing the portion of the hole in the overburden to allow casing insertion can reduce the lateral pier capacity if the hole is processed with a dense, viscous mixture of water and soil and that material is not displaced from the hole during concreting. If lateral support from the overburden soil is relied upon in design, the specifications should require intimate contact between the pier and the surrounding soil. If slurry processing is required, this may be accomplished by using slurry with properties that ensure slurry displacement from the hole during concrete placement (such as polymer slurry materials). Other options proposed by the pier contractor may also be considered. Alternatively, the lateral support contribution from the overburden soil may be ignored in design.

9. When water and/or drilling slurry is present outside the casing, care should be taken that concrete of sufficiently high slump is placed to a sufficiently high elevation inside the casing to prevent intrusion of the water and/or slurry into the concrete when the casing is withdrawn.

10. Drilled pier holes should be properly cleaned prior to placement of concrete.

11. Drilled shafts will likely require temporary casing during drilling and concrete placement. In addition, tremie placement of concrete will be required. In no case should concrete be placed in more than 3 inches of water unless the tremie method is used.

12. A high slump (minimum 5 inches) concrete should be used to reduce the possibility of concrete arching in the pier and to reduce the potential for concrete to adhere to the casing when extracted. Concrete in the upper 5 feet of the caissons should be consolidated with a mechanical vibrator.

13. Concrete should be placed in caissons the same day they are drilled. The anticipated presence of water and caving soils will most likely require the concrete to be placed immediately after the drilled pier hole is completed. Failure to place concrete the day of drilling will result in a requirement for additional bedrock penetration.

14. The pier drilling contractor should mobilize equipment of sufficient size and operating condition to achieve the required penetration into bedrock. If well cemented zones are encountered within the bedrock, a pilot hole may be necessary.

15. It is recommended that a minimum pier diameter based on an allowable maximum length to diameter ratio of 30 to 1 be used to facilitate pier construction and inspection.

16. Installation of the drilled caissons should be observed by a representative of our firm on a full-time basis to identify and confirm the bearing conditions and construction procedures.

RETAINING WALLS AND SHALLOW FOUNDATIONS

We understand that the proposed retaining walls will reach a maximum exposed height of up to 25 feet. It is anticipated that mechanically stabilized earth (MSE) walls will be utilized in these areas. Additionally, concrete footings will be utilized for the proposed culvert extension and wingwalls. No formal stability analysis was performed for the proposed retaining walls, and it is our understanding that this will be completed by the wall designer. We are available to conduct such an analysis if this is not the case.

MSE Walls: We understand that MSE retaining walls for the project will be designed and constructed in general accordance with CDOT requirements for MSE walls, which include minimum geometric configurations of the reinforced and retained soil zones and specification of the soil materials to be used within those zones. The designer should check for feasibility at the

proposed location based on these configurations. At a minimum, CDOT requires the retained soil to include Class 1 structure backfill contained within a zone defined by a line extending 1.5 feet horizontally from the heel of the reinforced zone and then upward at a maximum 1H:1V (horizontal:vertical) slope. Excavation for MSE walls must consider the extent of the retained zone as well as the maximum allowable inclination of temporary unsupported excavation slopes, which are expected to increase the horizontal extent of site excavations necessary for construction of MSE walls.

To achieve an adequate factor of safety for overall stability, the reinforced zone of MSE walls should extend back from the wall face a horizontal distance of at least 0.70 times the total height of the MSE wall as measured from the leveling pad, or a minimum of 8 feet, whichever is greater. Soil backfill within the reinforced zone and the minimum retained soil zone defined by CDOT should consist of CDOT Class 1 Structure Backfill. For wall design, an internal angle of friction of 32 degrees and a moist unit weight of 125 pcf may be used for Class 1 structure backfill. Material proposed for use as Class 1 structure backfill should have the internal angle of friction determined by the geotechnical engineer to confirm that the design value is achieved. An internal friction angle of 28 degrees and a moist unit weight of 125 pcf should be used for the foundation soils and retained soils outside of the Class 1 retained fill zone.

Adequate surface and subsurface drainage should be provided for MSE walls.
MSE walls in general, are designed to tolerate moderate movements. Walls constructed as outlined in this report should experience settlements in a tolerable range.

Shallow Foundations: The design and construction criteria presented below should be observed for a spread footing foundation system. These construction details should be considered when preparing project documents.

1. Foundations and leveling pads should be constructed on a minimum of 12 inches of suitable non-expansive fill. Where applicable, additional overexcavation to address existing fill and soft subgrade conditions should be performed per the criteria in the “Site Grading” Section of this report. Fill should extend out at a 1:1 projection from the base of the pad.

2. For walls and structures founded on properly compacted suitable materials, a nominal bearing resistance of 6.3 ksf may be used with a resistance factor of 0.45 as described in Table 10.5.5.2.2-1 of the AASHTO LRFD Bridge Design Specifications. An internal friction

angle of 30, and a unit weight of 125 pcf were used to develop this bearing resistance. A groundwater depth of at least 1.5 times the footing width as measured from the base of the foundation was also assumed. If these values do not reflect the construction conditions, the nominal bearing resistance may be less. We should be contacted to provide revised recommendations if this is the case.

3. Concrete footings should have a minimum width of 16 inches to provide the bearing resistance given in Item 2 above.

4. Walls and wall facing should be constructed a minimum of 30 inches below grade for frost protection. Segmental block walls should also maintain an embedment of at least 1/7 of the exposed wall height.

5. As mentioned in the “Lateral Earth Pressures” section, drainage methods should be utilized behind retaining walls. For MSE walls, a layer of free draining aggregate meeting the specifications listed in the “Fill Material Specifications” subsection of the “Site Grading” section should extend at least 12 inches behind the block facing, and should be separated from the reinforced soil using filter fabric, Mirafi 140N or equivalent. For concrete-faced walls, drainboard products may be used, but should be approved by the geotechnical engineer. An underdrain located at the base of the wall should collect and convey the water to a positive discharge point.

6. To limit the infiltration of surface water behind the wall, the upper 12 inches of retained soil should consist of less permeable clay and should be sloped to prevent ponding and promote runoff. An impermeable concrete or asphalt lining may also be used.

7. Runoff should not be permitted to pass freely over walls. A coping drain system, or a properly designed ditch should be used to carry runoff water along the wall to be properly deposited.

8. Walls should be designed by a qualified engineer and should be installed in accordance to the manufacturer’s specifications.

9. A representative of the geotechnical engineer should observe all footing excavations prior to fill or concrete placement.

LATERAL EARTH PRESSURES

Earth retaining structures should be designed for the lateral pressure generated by the backfill, which is a function of the degree of rigidity of the retaining structure, and the type of backfill material being used.

Retaining structures such as box culverts, integral wing walls, small reinforced concrete tank walls or other retaining walls that are not expected to deflect should be designed for an at-rest earth pressure structure based on the following equivalent fluid pressures:

CDOT Class 1 (<20% passing No. 200 Sieve).....59 pcf
Non-Expansive Fill ..... 66 pcf

Retaining structures that are laterally supported and can be expected to undergo only a moderate amount of deflection should be designed for earth pressures based on the following equivalent fluid pressures.

CDOT Class 1 (<20% passing No. 200 Sieve).....45 pcf
On-site Non-Expansive Fill ..... 55 pcf

Cantilevered retaining structures that can be expected to deflect sufficiently to mobilize the full active earth pressure condition should be designed for the following equivalent fluid pressures:

CDOT Class 1 (<20% passing No. 200 Sieve).....38 pcf
On-site Non-Expansive Fill ..... 45 pcf

The values presented above are based on internal friction angles of 32 degrees for CDOT Class 1 material, and 28 degrees for the onsite non-expansive fill. A total unit weight of 125 pounds per cubic foot was assumed for both material types.

All foundation and retaining structures should be designed for appropriate hydrostatic and surcharge pressures such as adjacent footings, traffic, construction materials, and equipment. The pressures recommended above assume drained conditions behind the walls and a horizontal backfill surface. The buildup of water behind a wall or an upward sloping backfill surface will increase the lateral pressure imposed on a retaining structure. We recommend the use of a drainage system as described in the “Retaining Wall and Foundation Recommendations” section.

PAVEMENT DESIGN

The predominant soil types anticipated to be encountered at the existing roadway elevations are silty-clayey sand, clayey sand and clayey sandstone. These soils are generally considered to be fair to good roadway subgrade materials. Other less desirable materials, such as sandy lean clay and claystone were also encountered in our investigation and may be encountered in limited areas of the proposed roadway alignments. We recommend that these soils be removed and replaced with suitable granular materials to a depth of at least 2 feet below the proposed roadway where encountered. A more detailed discussion can be found in the "Site Grading" section of this report.

For Powers Boulevard, our pavement design was performed following Mechanistic-Empirical (M-E) design methodology presented by the American Association of State Highway Officials (AASHTO) and the CDOT 2020 M-E Design Manual, utilizing AASHTOWare M-E pavement design software. With Research Parkway, the design was based on City of Colorado Springs Pavement Design Criteria Manual procedures using AASHTOWare DARWin 3.01 pavement design software, which is based on 1993 AASHTO pavement design methodology.

Mechanistic-Empirical Design Parameters: The Mechanistic-Empirical (M-E) Design method requires specific information regarding traffic volume and distribution, climate, and pavement layer materials. In general, where more specific data was not available, the calibration factors provided in the CDOT 2020 M-E Design Manual were used. Climate information was supplied from the Colorado Springs Municipal Airport weather station, located at Latitude 38.812N, and Longitude 104.711W at an elevation of 6169.9 feet above median sea level. Details regarding traffic volumes and materials can be found herein. The software output reports are included in Appendix A, and include additional information on the input parameters used.

AASHTO 1993 Design Parameters: The input parameters used for the design of Research Parkway include an initial and terminal serviceability index of 4.5 and 2.5, respectively, a reliability index of 95%, and with the additional traffic and subgrade values presented below. A summary of the input parameters used; along with the software output reports are included in Appendix B.

Subgrade Materials: Based on the American Association of State Highway Transportation Officials (AASHTO) classification system the soils tested near the proposed subgrade elevation were predominantly A-2-4, A-4, and A-6 soils with group indices ranging from 0 to 6. Less frequently occurring soil types included A-1-b, A-2-6, A-7-5 and A-7-6. As discussed in the above "Laboratory Testing" section, the tested R-values ranged from 4 to 40, and averaged about 19.

Because variability of the subsurface soil types is anticipated, and because R-values can vary substantially even within the soil types tested, an R-value of 13 was assumed for the proposed embankment along Powers Boulevard based on our experience with similar soils in the area. Based on the CDOT 2020 M-E Pavement Design Manual, this R-value was correlated to a resilient modulus of 6,967 psi for the design of flexible and rigid pavement. For Research Parkway, an R-value of 4 was assumed, and was correlated to a resilient modulus of 2,928 psi and an effective modulus of subgrade reaction of 50 pci for design of flexible and rigid pavement, respectively.

Design Traffic: Traffic loading information was provided by FHU for our design, and included the following parameters for Powers Boulevard.

Table 6: Powers Boulevard Traffic Data

Powers Blvd.	Current AADTT	Growth Rate	Design Lanes per Travel Direction	Design Speed
N. of Research	2179	2.97%	3	70 mph
S. of Research	2468	1.99%	3	70 mph
SB Off Ramp	101*	2.76%	1	40 mph
SB On Ramp	581*	1.03%	2	40 mph
NB On Ramp	282*	1.34%	2	40 mph
NB Off Ramp	189*	3.21%	2	40 mph

AADTT – Average Annual Daily Truck Traffic

* - Not provided, but assumed 4.4% of total daily volume, same as mainline.

Additional traffic input parameters used, to include vehicle class distribution can be found within the design output reports in Appendix A.

For Research Parkway, the following 18-kip ESAL (equivalent single axle load) values were provided.

Table 7: Research Parkway 18-Kip ESALs

Research Pkwy	Flexible (20 yr.)	Rigid (30 yr.)
W. of Powers	3,861,700	7,882,905
E. of Powers	3,284,270	6,704,685

If it is determined that actual traffic data is different from that provided, we should be contacted to reevaluate the pavement thickness designs presented in this report.

Pavement Sections: The recommended sections were determined using AASHTOware M-E 2.3.1 design software for Powers Boulevard, and AASHTOWare DARWin 3.01 design software for Research Parkway. Based on the subgrade conditions encountered and the traffic information provided, we recommend the following pavement sections:

Table 8: Summary of Pavement Sections

Roadway	HMA over ABC	JPCP over ABC
Powers Blvd – N. of Research Pkwy	7.5 over 10	9 over 6
Powers Blvd – S. of Research Pkwy	7.5 over 10	10.5 over 6
SB Off Ramp	5.5 over 10	7.5 over 6
SB On Ramp	6.5 over 10	8 over 6
NB On Ramp	5.5 over 10	7.5 over 6
NB Off Ramp	5.5 over 10	7.5 over 6
Research Pkwy – W. of Powers Blvd.	10.25 over 12	12.25 over 4
Research Pkwy – E. of Powers Blvd.	10 over 12	12 over 4

It should be noted that because of the differences in the design procedures used for the two roadways, the 1993 AASHTO/City of Colorado Springs procedures used for Research Parkway appears to yield a more conservative section.

Pavement Materials: The asphalt pavement should consist of a bituminous material which meets the requirements of the CDOT Specifications for Road and Bridge Construction. Aggregate base course should meet the requirements of a CDOT Class 6. For the top lift of asphalt on Powers Boulevard, the designs assumed a stone matrix asphalt (SMA) pavement with SX gradation

(Region 2 Level I SMA). For the lower asphalt lifts of Powers Boulevard and for Research Parkway, a superpave mix with a design gyration N value of 75, and a binder performance grade of 64-22 was assumed for the design (Region 2 Level 1 SX(75) PG 64-22).

The aggregate grading, binder type, and recommended gyratory design revolutions for each area are summarized on the following table.

Table 9: Recommended Pavement and Binder Types

Area	Lower Lifts		Top Lift	
	Nominal Grading (N_{des})	Binder	Nominal Grading (N_{des})	Binder
Powers Boulevard	SX (75)	64-22	SMA, SX (100)	76-28
Research Parkway	SX (75)	64-22	SX (75)	64-22

Minimum lift thicknesses of 3 inches for S mixes, and 2 inches for SX and ½-inch SMA mixes are recommended. Lift thickness should not exceed 3 inches unless pneumatic or vibratory rollers are used.

Concrete pavement should meet the requirements of a Class P Mix, per Section 601 of the CDOT Standard Specifications, and should be based on a mix design established by a qualified engineer. Joint spacing and fillers should be established be a qualified engineer, and load transfer devices should be used at the transverse joints. Dowels used at joints should be at least 1.25 inches in diameter. A maximum joint spacing of 15 feet and a minimum slab width of 12 feet is also recommended.

Subgrade Preparation: In general, the soils encountered near the pavement section were found to have a nil to low swell potential, but some samples of clay and claystone were encountered with a moderate swell potential. To mitigate the effects of expansive native soils and bedrock near the roadway elevation, we recommend the replacement of these materials with suitable onsite granular materials to a minimum depth of 2 feet below the base of the pavement section. New fill should be moisture conditioned, and recompacted in accordance with the “Site Grading” section of this report. The lower 12 inches of treatment can be done in-place if no shallow claystone or otherwise unsuitable materials are present. If grading is such that there is a minimum 2 feet of separation between the pavement grade and the clay and claystone materials, overexcavation will not be required.

Based on our boring logs, we anticipate that shallow claystone will be most likely encountered along a portion of the eastern leg of Research Parkway, and a portion of the northbound Powers Boulevard off and on ramps. The potential areas that may require overexcavation are shown on Fig. 78, and have been approximated based on the conditions encountered in the borings and the assumed grading. It is possible for conditions to vary between the borings, and actual limits will need to be determined in the field at the time of construction. We anticipate potholing of the subgrade will be required at the time of grading to facilitate in determining the limits of where overexcavation will be required. We should be consulted to assist in defining the limits of overexcavation at the time of construction.

Immediately prior to paving, we recommend the pavement subgrade throughout be thoroughly scarified and well-mixed to a minimum depth of 12 inches and adjusted to the moisture and compaction criteria presented in the "Site Grading" section of the report.

Proof Roll: Before paving, the subgrade should be proof rolled with a heavily loaded, pneumatic-tired vehicle. The vehicle should have a gross weight of at least 50,000 pounds, with a single loaded axle weight of 18,000 pounds, and a tire pressure of 100 psi. Areas that deform excessively under heavy wheel loads are not stable should be removed and replaced with suitable material to achieve a stable subgrade prior to paving.

Drainage: The collection and diversion of surface drainage away from paved areas is extremely important to the satisfactory performance of the pavement. Drainage design should provide for the removal of water from paved areas and prevent wetting of the subgrade soils. Landscape vegetation which requires irrigation should be avoided adjacent to pavements.

EXCAVATION CONSIDERATIONS

In our opinion, excavation of the overburden soils should be possible with conventional heavy-duty equipment. We recommend temporary excavation slopes in the soils be constructed in accordance with OSHA regulations. In accordance with OSHA criteria, the on-site soils will likely classify as OSHA Type C soils. Temporary unretained excavations should have slopes no steeper than 1½ :1 (H:V) in Type C soils. A properly braced excavation or the use of a trench box should be used where the indicated unretained slopes cannot be accommodated. Flatter slopes will be required where groundwater seepage is encountered. OSHA regulations require that excavations greater than 20 feet in depth be designed by a professional engineer. If soils different from those indicated in this report are encountered, the OSHA soil type may vary and the required cut slopes may need to be adjusted. A contractor's competent person should make decisions

regarding cut slopes. A qualified geotechnical engineer should observe any questionable slopes or conditions.

As discussed, groundwater was encountered in 34 of the 81 borings, at depths ranging from approximately 2.4 feet to 32 feet. Depending on the depths of excavations planned, ground water may impact areas of proposed construction, in particular, work in and around the north tributary to Cottonwood Creek where the groundwater level should be anticipated in the vicinity of the base of excavations within the channel. If groundwater is encountered in excavations, we believe the dewatering can be accomplished by pumping from sumps installed within the excavation. The pits should be constructed well below the base of the excavation to avoid loss of supporting capacity of the soils. The dewatering system should be properly designed, installed and maintained. The bottom and sides of the excavation may become unstable if the groundwater level is not maintained at a sufficient depth below the bottom of the excavation.

Overly moist soils may also contribute to unstable subgrade conditions when preparing roadway embankment. Refer to the "Site Grading – Subgrade Stabilization" for additional discussions.

SITE GRADING

We recommend the following criteria be used when preparing the site grading plans.

Cut and Fill Slopes: Permanent cut and fill slopes constructed at a grade of 3:1 horizontal to vertical or flatter will generally be suitable for this project. No formal stability analyses were performed to evaluate the slopes, but our experience with similar cuts and fills indicate that the slopes should have adequate factors of safety. If seepage is encountered across significant portions of the cut slopes, shallower slopes may be necessary.

Good surface drainage should be provided around all permanent cuts and fills to direct surface runoff away from the slope faces. Fill slopes, cut slopes and other stripped areas should be protected against erosion by revegetation or other methods.

Fill Material Specifications: The following material specifications are presented for fills on the project site.

1. *General Fill Within the Proposed Improvements*: The on-site granular soils, minus any deleterious materials, will be generally be suitable for reuse as a nonexpansive structural fill. Import soils if used, should consist of a nonexpansive soil, consisting of a minus 2-

inch material that has a maximum 50% passing the No. 200 sieve, and a maximum plasticity index of 15. In general, the granular soils encountered onsite will meet these criteria. The native clay soils and claystone bedrock should not be reused under structures, behind walls, or within 2 feet of roadway pavements. New fill should extend down from the edges of foundations at a minimum 1:1 horizontal to vertical projection.

2. *Roadway Embankment:* For Powers Boulevard, the pavement design has assumed the embankment would consist of a granular fill similar to the on-site clayey sand (A-6 or better) soils encountered, with a minimum R-value of 13. For Research Parkway, on-site soils meeting Item #1 above would be suitable for the upper 2 feet.

3. *Import Structural Fill:* Structural fill should consist of granular, non-expansive material meeting CDOT Class 1 grading requirements.

4. *Material Suitability*: All fill material should be free of vegetation, brush, sod and other deleterious substances. Fill should not contain concentrations of organic matter or other deleterious substances. The geotechnical engineer should evaluate the suitability of all proposed fill materials prior to placement.

Removal and Replacement Requirements: As described herein, we recommend an over-excavation depth of 2 feet below the base of pavements areas where clay, claystone or otherwise unsuitable material is encountered. The over-excavation requirements presented for the pavement areas should also be followed for sidewalks and concrete flatwork that is sensitive to movement. The same over-excavation requirement should be followed for shallow foundation supported retaining walls and other structures.

Existing fill, where encountered below shallow foundations should be considered unsuitable and should be removed and replaced with properly compacted nonexpansive structural fill prior to placement of concrete. Reference the “Pavement Design – Subgrade Preparation” and “Retaining Walls and Shallow Foundations” sections for additional discussions specific to these items.

Subgrade Preparation: The ground surface shall be stripped of vegetation/organics, or any other unsuitable materials prior to fill placement. The resulting ground surface should be scarified to a depth of 12 inches; moisture conditioned as necessary, and compacted in a manner specified below for the subsequent layers of fill. Loose or unstable soils shall be removed, where present, in order to provide a stable platform prior to placement of fill.

Compaction Requirements: A representative of the geotechnical engineer should observe fill placement operations on a full-time basis. We recommend the compaction criteria presented in Section 203.07 of the CDOT Standard Specifications be used on the project.

Subgrade Stabilization: Given the conditions encountered, it should be anticipated that some unstable subgrade areas will be encountered during construction. We anticipate portions of the roadway will have soils with moisture contents above the optimum, particularly immediately below the existing pavement, in low-lying areas near drainage ditches, near the bedrock surface, and in areas where the adjacent roadway drainage is poor. Subgrade soils with elevated moisture contents are expected to be unstable and prone to deflections and rutting.

We anticipate stabilization may be achieved by methods such as scarifying/ripping the subgrade and allowing it to dry, or by overexcavation and replacement of the subgrade with suitable, imported, angular, well-graded materials. Other alternatives include the use of Type 2 biaxial geogrid reinforcement in combination with a layer of Class 6 aggregate base course. A layer of crushed gravel placed on geogrid may be required in the areas of the CBC extension. The use of dry cement blended into the subgrade can also be used to stabilize subgrade. Treatment depths typically extend to a depth of 1 foot and can sometimes extend to 2 feet depending on the severity. Specific stabilization requirements should be evaluated at the time of construction, as field conditions may vary and the contractor may have a preference based on time of season and the duration they have to complete the project. Given the amount of subsurface information collected, we cannot accurately predict or quantify areas where unstable subgrade conditions may occur. We recommend this work activity, if required, be included as a line item in the construction bids to avoid cost overruns.

Fill Stockpile At NW Quadrant: Borings F1 thru F3 were drilled within the stockpile to evaluate the suitability of the stockpile for reuse as embankment fill for the project. The fill materials encountered consisted of clayey sand (SC), with AASHTO classifications ranging from A-2-4, A-2-6 and A-6. The R-value test results of the fill material included 14 and 19 for the two tested samples. Based on our boring logs and laboratory test results, it is our opinion the stockpiled fill will be suitable for use as embankment fill for this project.

WATER SOLUBLE SULFATES

The concentration of water soluble sulfates measured in samples obtained from the exploratory borings ranged from approximately less than 0.01% to 0.26%. These concentrations of water soluble sulfates represents a Class 0 to Class 2 severity of exposure to sulfate attack on concrete

exposed to these materials. The degree of attack is based on a range of Class 0 to Class 3 severity of exposure as presented in ACI 201. Based on this information and our experience with similar materials, we recommend concrete exposed to the on-site soils meet the requirements for Class 2 exposure, as defined in Section 601.04 of the CDOT Standard Specifications.

BURIED METAL CORROSION

The potential corrosive environment for metal was evaluated based on data collected during our field exploration and laboratory testing. The data included pH, laboratory resistivity, and the concentrations of water soluble sulfates and chlorides. The laboratory test results are shown on the boring logs, and are summarized in Tables I and IA.

The subsurface profile encountered varied across the project area, and included man-placed fill, silty sand, poorly graded sand with silt, silty to clayey sand, clayey sand, and sandy lean clay. Overall, the overburden soils encountered were predominately the granular soil types. Claystone and sandstone bedrock were encountered in 51 of the 81 borings at depths ranging from directly below the topsoil to about 27 feet. In-situ moisture contents varied considerably within the soil and bedrock types encountered as summarized below.

Table 10: Summary of In-Situ Moisture Contents

Material Type	Min. Moisture Content	Max. Moisture Content	Average Moisture Content
Granular Soils	0.6%	23.5%	10.5%
Clay Soils	12.8%	22.5%	17.6%
Sandstone	3.2%	20.7%	13.3%
Claystone	8.9%	24.5%	18.8%

Drainage for the material types encountered is anticipated to be variable, ranging from good for the granular overburden, to poor for clay soils and underlying bedrock.

The laboratory resistivity test results are shown on Figs. C1 and C2 of Appendix C, and indicate minimum resistivity values ranging from 589 to 4,400 ohm-centimeters for the tested samples of silty sand and clayey sand; 4,400 ohm-centimeters for the tested sample of sandstone; and 424 ohm-centimeters for the claystone when tested at or near saturation. At the in-situ moisture contents, the resistivity of the materials ranged from 1,150 to over 12,000 ohm-centimeters.

The pH of the samples tested ranged from 5.9 to 7.4. These results suggest the on-site materials vary from slightly acidic to neutral.

As discussed in the previous section, the concentration of water soluble sulfates in the samples tested ranged from less than 0.01% to 0.26%. The concentration of water soluble chlorides ranged from 0.01 to 0.02%.

Though the soils and bedrock tested do not appear to have a very high corrosion potential, the subsurface profile could result in a potentially corrosive environment, particularly near the groundwater level. We recommend a qualified corrosion engineer review the information presented above to design an appropriate level of corrosion protection for buried metal and concrete. In particular, Section 10.7.5 of the AASHTO 2012 LRFD Bridge Manual should be consulted when considering the corrosion potential of piles, and Section 206 of the CDOT Standard Specifications should be consulted when considering the corrosion potential of buried pipes.

DESIGN AND SUPPORT SERVICES

Kumar & Associates, Inc. should be retained to review the project plans and specifications for conformance with the recommendations provided in our report. We are also available to assist the design team in preparing specifications for geotechnical aspects of the project, and performing additional studies if necessary, to accommodate possible changes in the proposed construction.

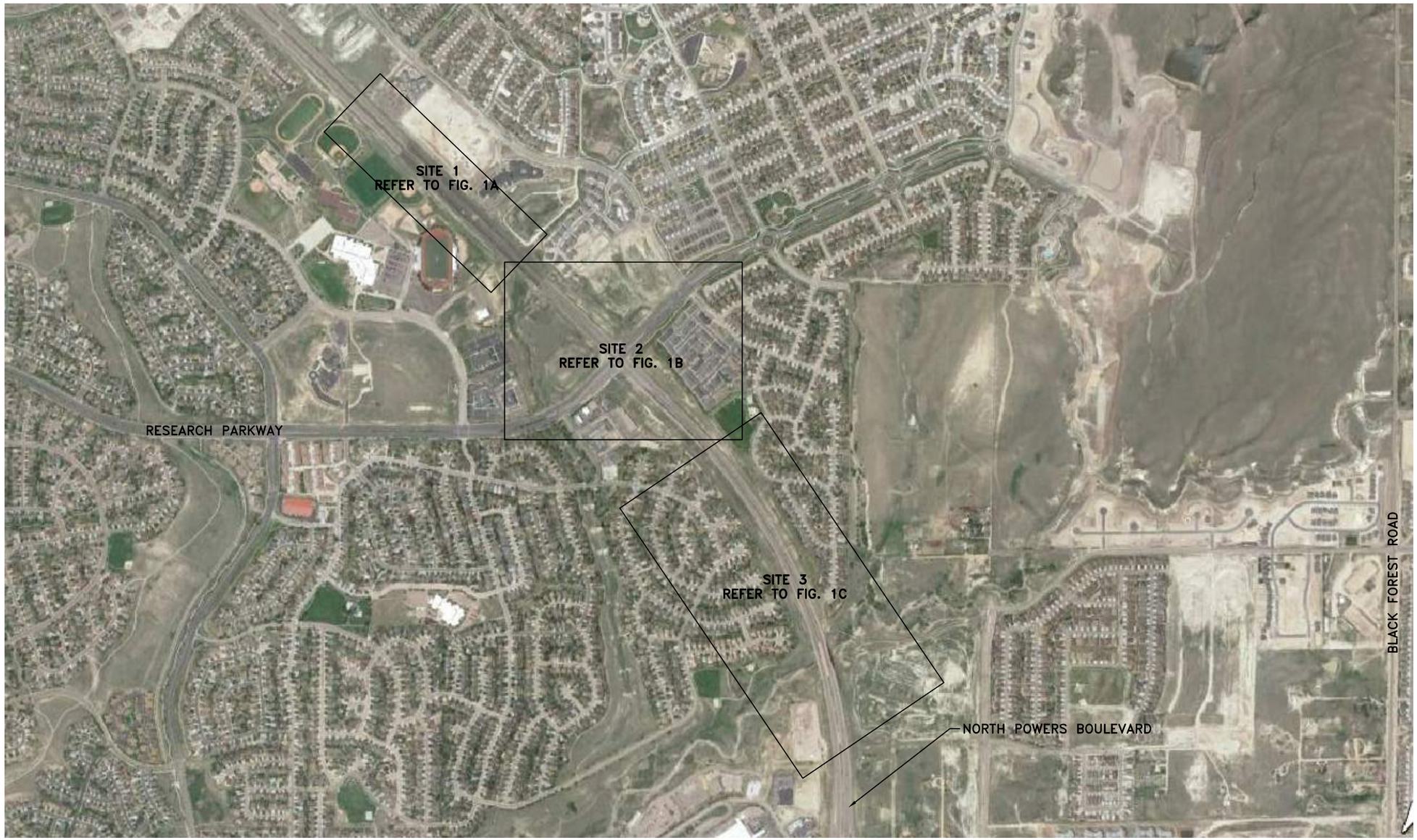
We recommend that Kumar & Associates, Inc. be retained to provide observation and testing services to document that the intent of this report and the requirements of the plans and specifications are being followed during construction, and to identify possible variations in subsurface conditions from those encountered in this study so that we can re-evaluate our recommendations, if needed.

LIMITATIONS

This study has been conducted for exclusive use by the client for geotechnical related design and construction criteria for the project. The conclusions and recommendations submitted in this report are based upon the data obtained from the exploratory borings at the locations indicated on Figs. 1A thru 1C or as described in the report, and the proposed type of construction. This report may not reflect subsurface variations that occur, and the nature and extent of variations across the site may not become evident until site grading and excavations are performed. If during construction, fill, soil, rock or water conditions appear to be different from those described

herein, Kumar & Associates, Inc. should be advised at once so that a re-evaluation of the recommendations presented in this report can be made. Kumar & Associates, Inc. is not responsible for liability associated with interpretation of subsurface data by others.

DPC:bj



NOT TO SCALE

17-2-183A	Kumar & Associates	LOCATION OF SITE PLANS	VICINITY MAP	Fig. 1

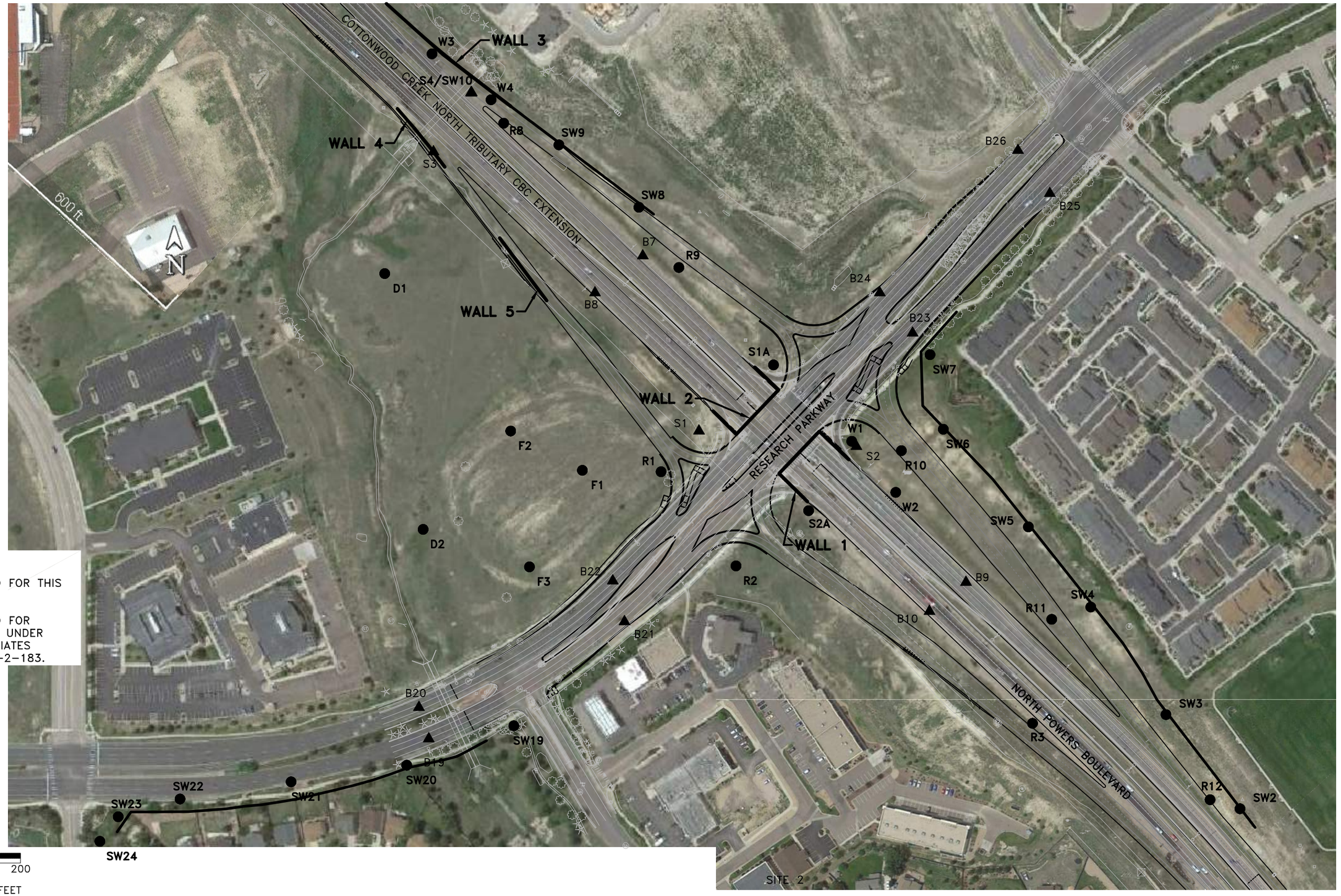
100 0 100 200

APPROXIMATE SCALE–FEET

LEGEND:

- ● BORINGS DRILLED FOR THIS STUDY.
- ▲ BORINGS DRILLED FOR PREVIOUS STUDY UNDER KUMAR & ASSOCIATES PROJECT NO 17–2–183.

17–2–183A	Kumar & Associates		LOCATION OF EXPLORATORY BORINGS	Fig. 1A



LEGEND:

- ● BORINGS DRILLED FOR THIS STUDY.
- ▲ BORINGS DRILLED FOR PREVIOUS STUDY UNDER KUMAR & ASSOCIATES PROJECT NO 17-2-183.

17-2-183A	Kumar & Associates	LOCATION OF EXPLORATORY BORINGS	Fig. 1B

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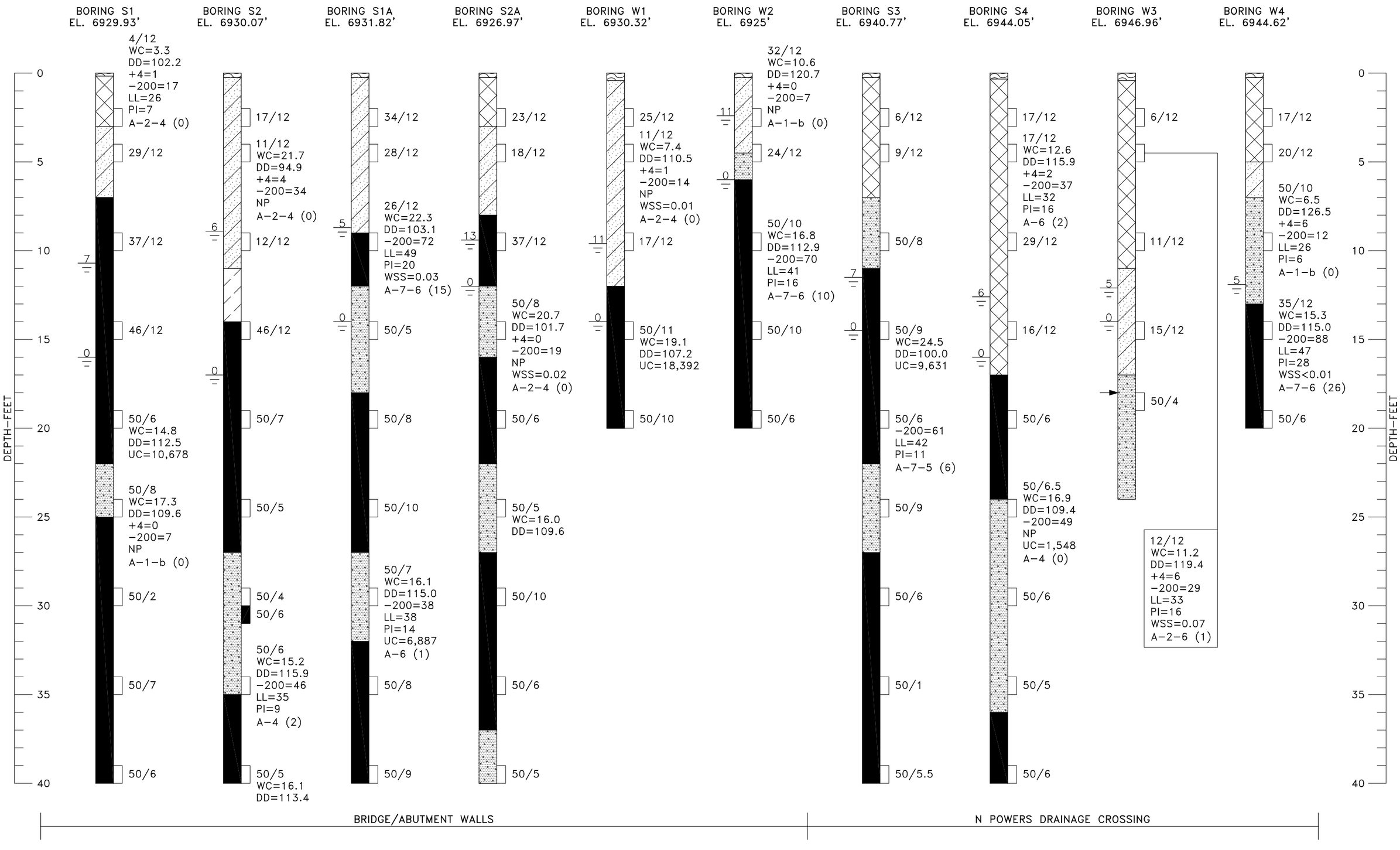
100 0 100 200

APPROXIMATE SCALE–FEET

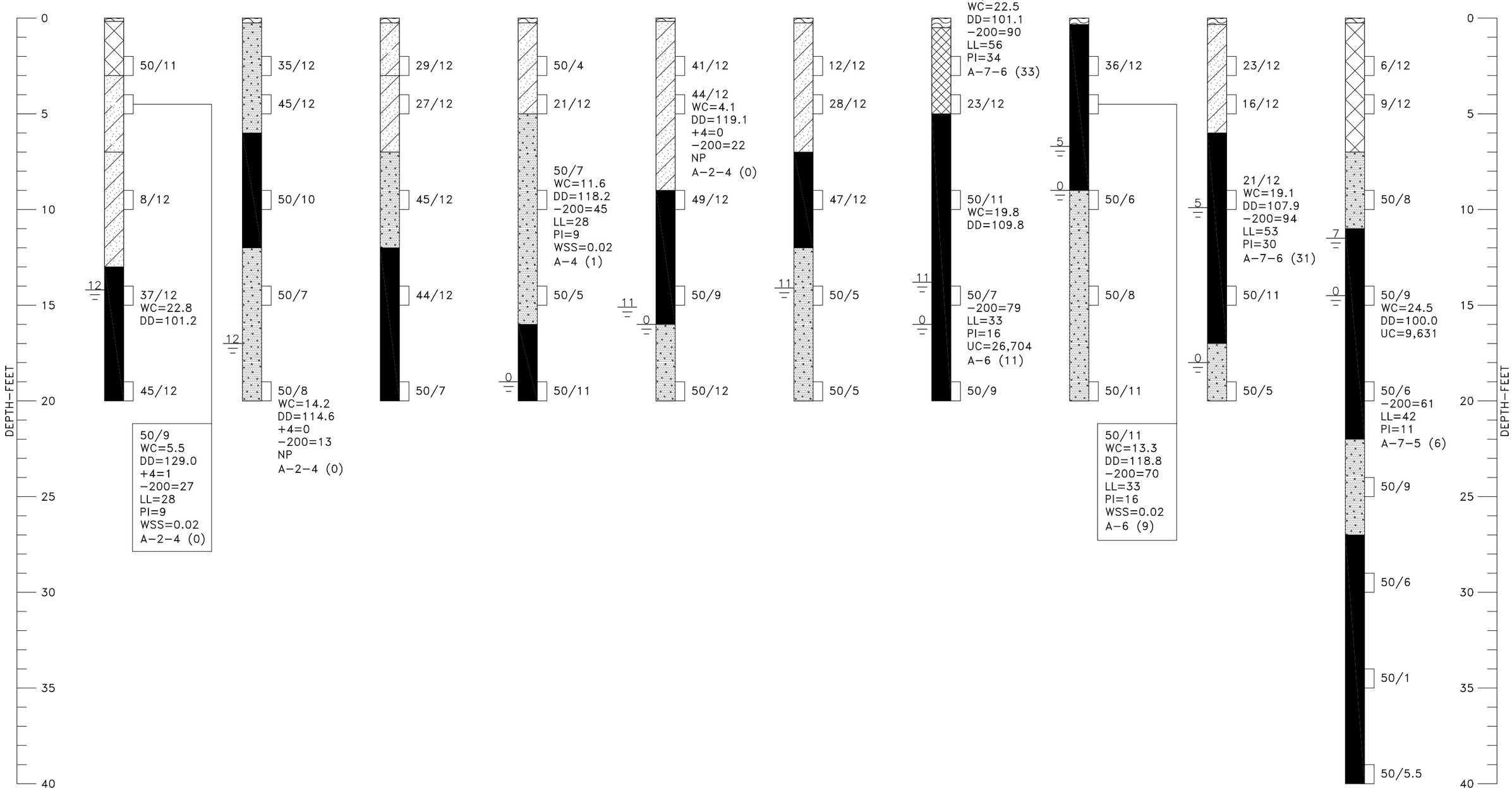
LEGEND:

- ● BORINGS DRILLED FOR THIS STUDY.
- ▲ BORINGS DRILLED FOR PREVIOUS STUDY UNDER KUMAR & ASSOCIATES PROJECT NO 17–2–183.

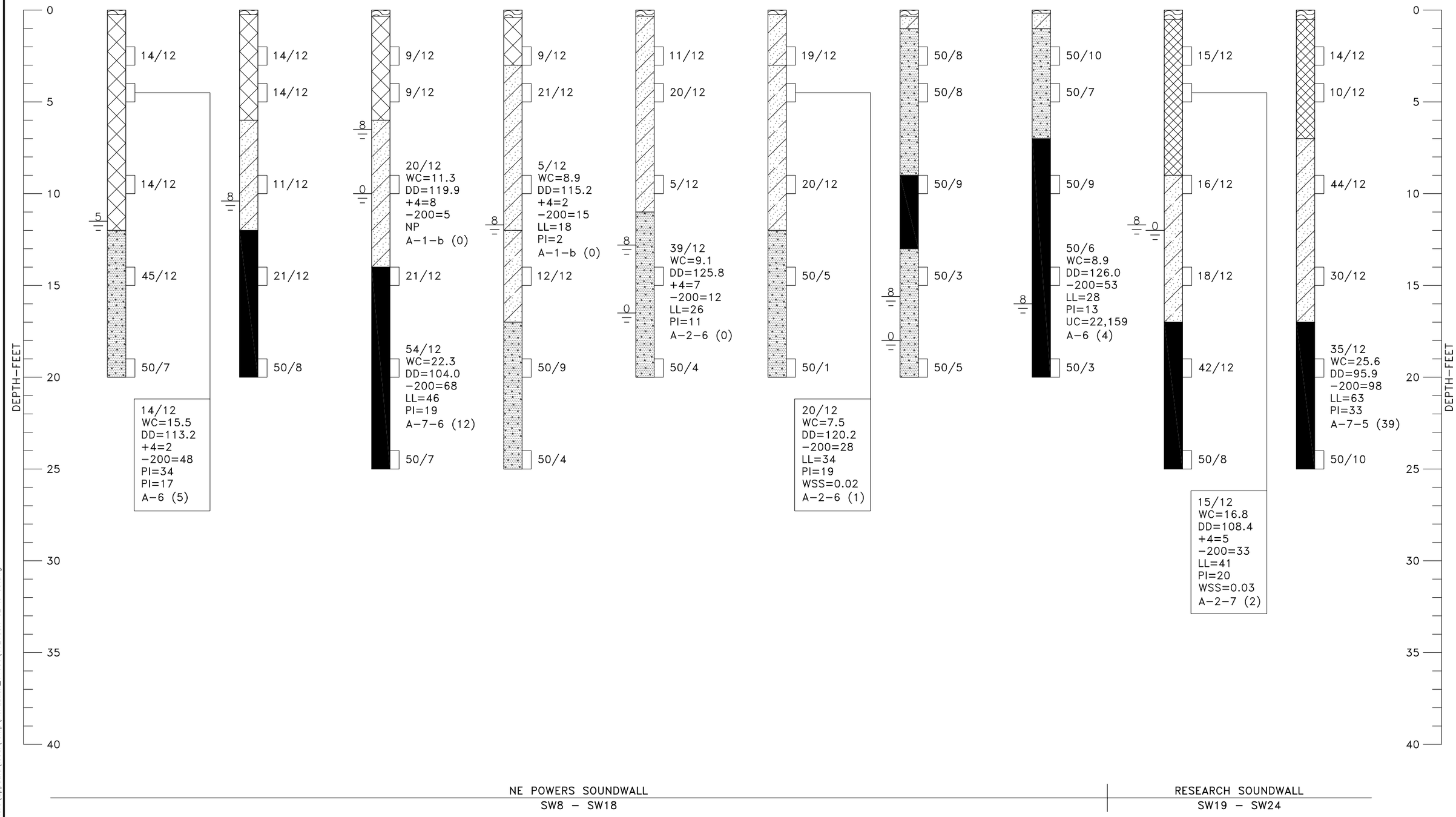
17–2–183A	Kumar & Associates		LOCATION OF EXPLORATORY BORINGS	Fig. 1C



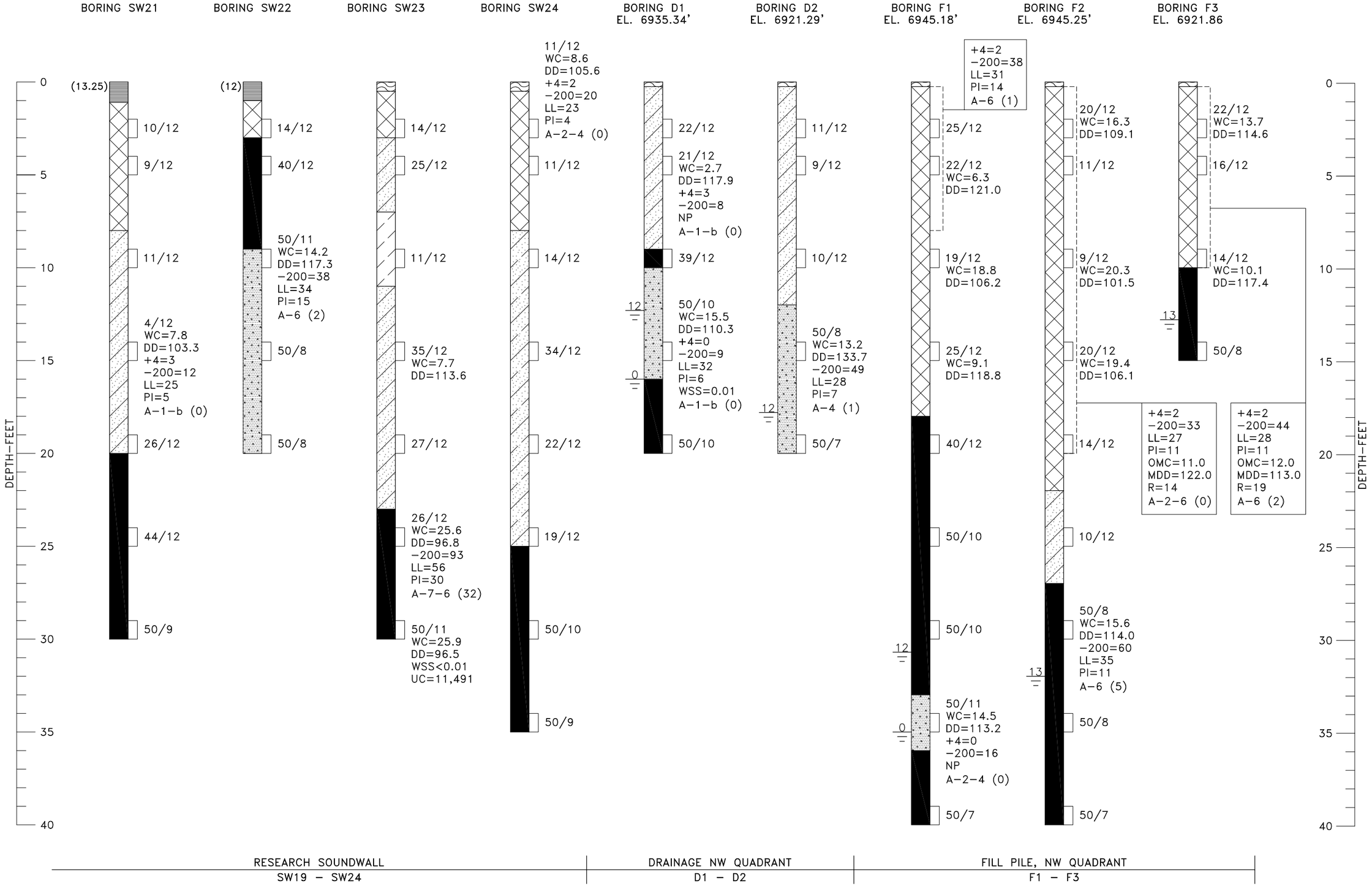
17−2−183A	Kumar & Associates		LOGS OF EXPLORATORY BORINGS	Fig. 2



17−2−183A	Kumar & Associates		LOGS OF EXPLORATORY BORINGS	Fig. 3



17-2-183A	Kumar & Associates		LOGS OF EXPLORATORY BORINGS	Fig. 4

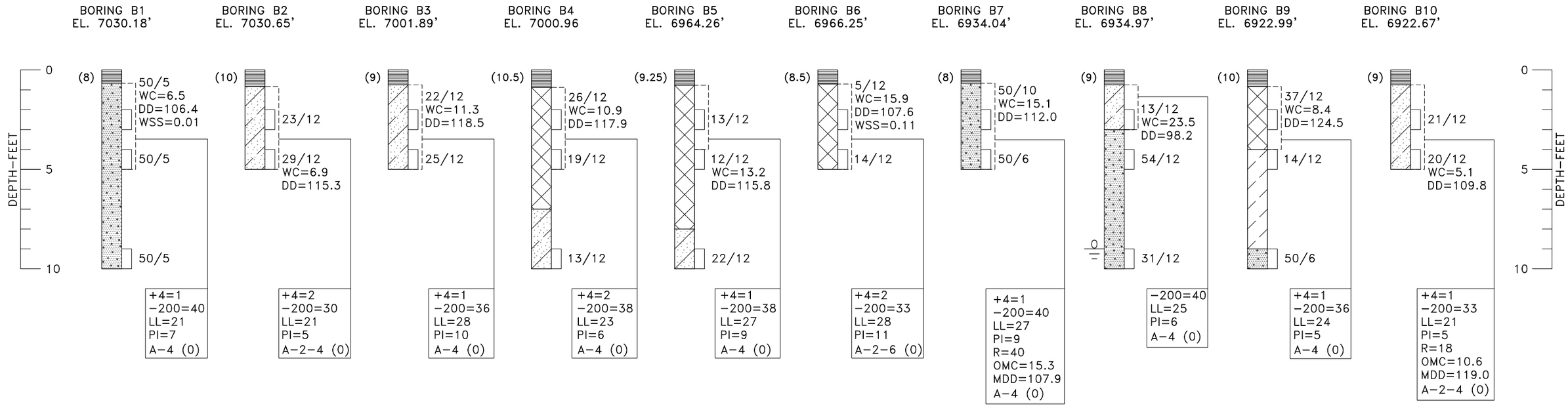


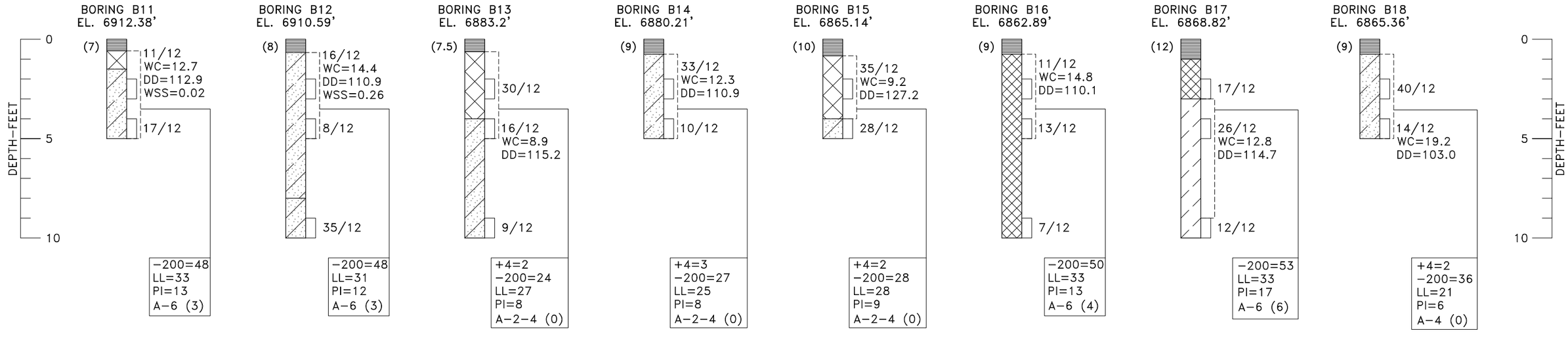
RESEARCH SOUNDWALL
SW19 – SW24

DRAINAGE NW QUADRANT
D1 – D2

FILL PILE, NW QUADRANT
F1 – F3

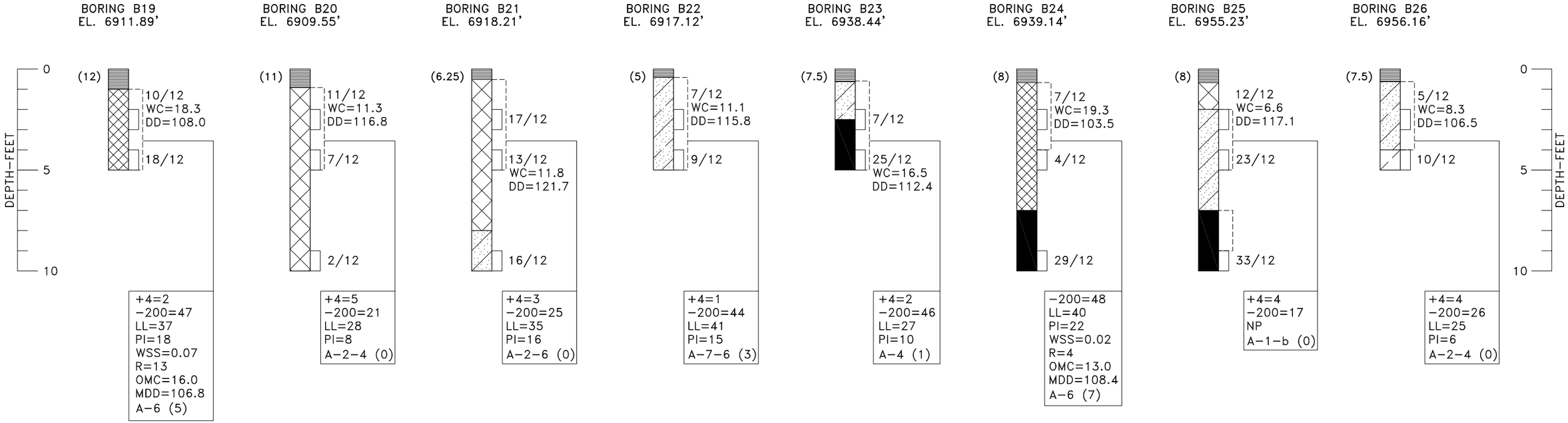
17−2−183A	Kumar & Associates		LOGS OF EXPLORATORY BORINGS	Fig. 5





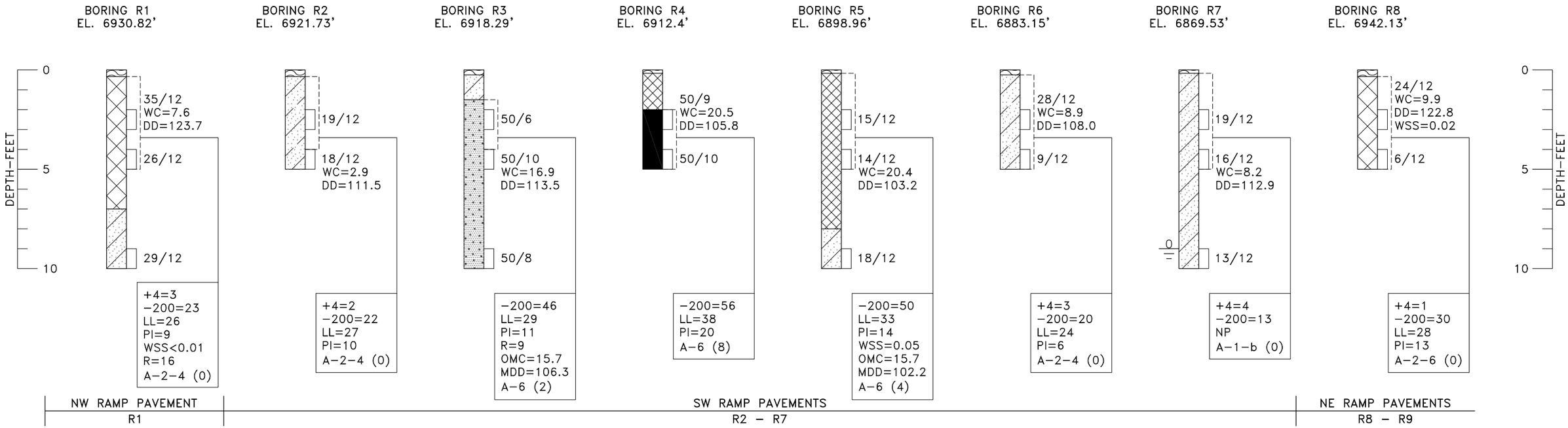
MAINLINE POWERS PAVEMENTS
B1 − B18

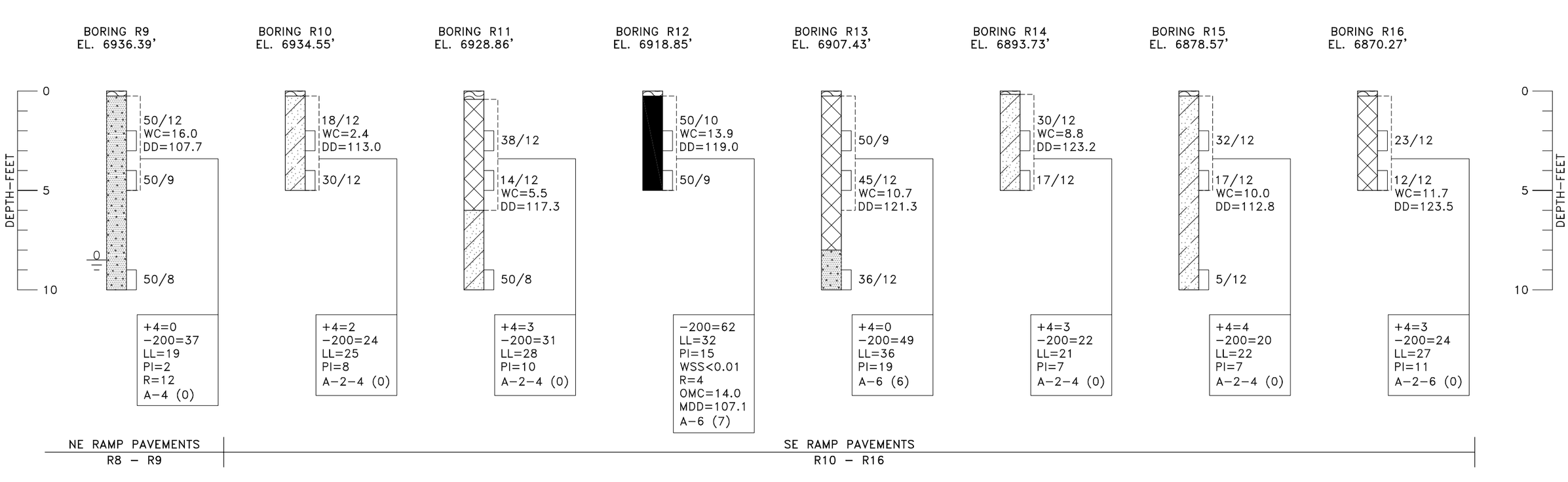
17−2−183A	Kumar & Associates		LOGS OF EXPLORATORY BORINGS	Fig. 6



MAINLINE RESEARCH PAVEMENTS
B19 – B26

17−2−183A	Kumar & Associates		LOGS OF EXPLORATORY BORINGS	Fig. 7





17-2-183A	Kumar & Associates		LOGS OF EXPLORATORY BORINGS	Fig. 8

LEGEND

TOPSOIL.

(8) ASPHALT, THICKNESS IN INCHES SHOWN IN PARENTHESES TO LEFT OF THE LOG.

FILL: SILTY TO CLAYEY SAND (SM, SC–SM, SC), WITH OCCASIONAL SANDY LEAN CLAY (CL), FINE TO COARSE GRAINED, MOIST, BROWN, DARK BROWN, GRAY, AND DARK GRAY.

FILL: SANDY LEAN TO FAT CLAY (CL, CH), WITH OCCASIONAL CLAYEY SAND (SC), FINE TO COARSE GRAINED, MOIST, BROWN AND GRAY.

SILTY SAND (SM), AND POORLY TO WELL GRADED SAND WITH SILT OR CLAY (SP–SM, SW–SM, SP–SC, SW–SC), FINE TO COARSE GRAINED, LOOSE TO DENSE, MOIST TO WET, TAN, BROWN, REDDISH–BROWN AND GRAY.

SILTY TO CLAYEY SAND (SC–SM, SC), FINE TO MEDIUM GRAINED, LOOSE TO DENSE, MOIST, BROWN AND GRAY.

SANDY LEAN CLAY (CL), WITH OCCASIONAL CLAYEY SAND (SC), FINE TO COARSE GRAINED, STIFF TO VERY STIFF, MOIST TO WET, BROWN AND GRAY.

CLAYSTONE BEDROCK, OCCASIONALLY SANDY AND WITH OCCASIONAL CLAYEY SANDSTONE LAYERS, FINE TO COARSE GRAINED, FIRM TO VERY HARD, MOIST TO WET, GRAY.

SANDSTONE BEDROCK, OCCASIONALLY CLAYEY AND WITH OCCASIONAL SANDY CLAYSTONE LAYERS, FINE TO COARSE GRAINED, MEDIUM HARD TO VERY HARD, MOIST TO WET, BROWN TO GRAY.

DRIVE SAMPLE, 2–INCH I.D. CALIFORNIA LINER SAMPLER.

DRIVE SAMPLE, 1 3/8–INCH I.D. SPLIT SPOON SAMPLER.

DISTURBED BULK SAMPLE.

4/12 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 4 BLOWS OF A 140–POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.

7 DEPTH TO WATER LEVEL AND NUMBER OF DAYS AFTER DRILLING MEASUREMENT WAS MADE.

DEPTH AT WHICH BORING CAVED.

NOTES

1. BORINGS S1 THRU S4 AND B1 THRU B26 WERE DRILLED BETWEEN SEPTEMBER 19 AND OCTOBER 13, 2017. BORINGS S1A–S2A, W1–W4, SW1–SW24, D1–D2, F1–F3, AND R1–R16 WERE DRILLED BETWEEN SEPTEMBER 19 AND OCTOBER 15, 2018. THE BORINGS WERE DRILLED WITH 4 AND 6–INCH DIAMETER CONTINUOUS FLIGHT POWER AUGERS.

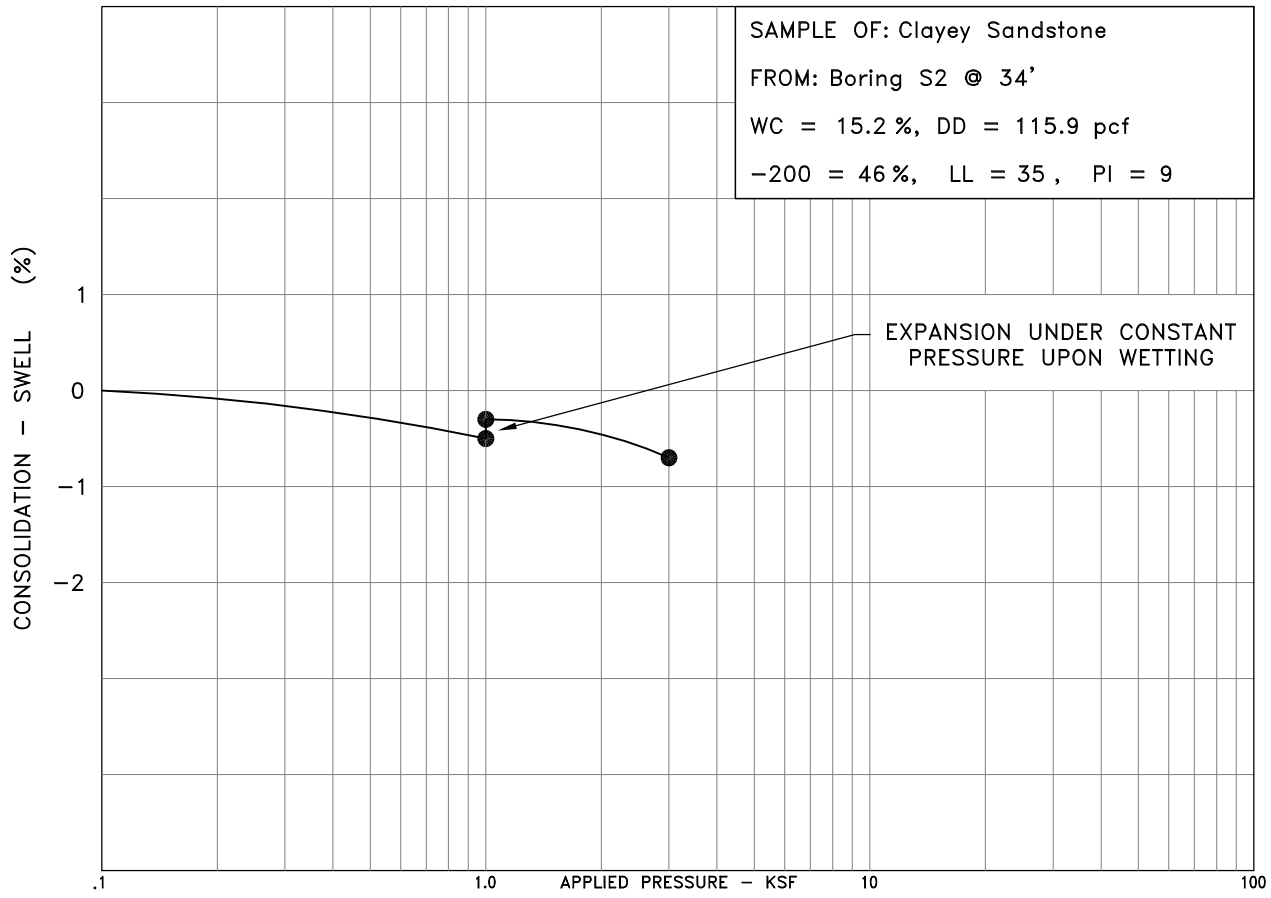
2. THE LOCATIONS OF THE EXPLORATORY BORINGS WERE MEASURED APPROXIMATELY BY TAPING FROM FEATURES SHOWN ON THE SITE PLAN PROVIDED AND SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

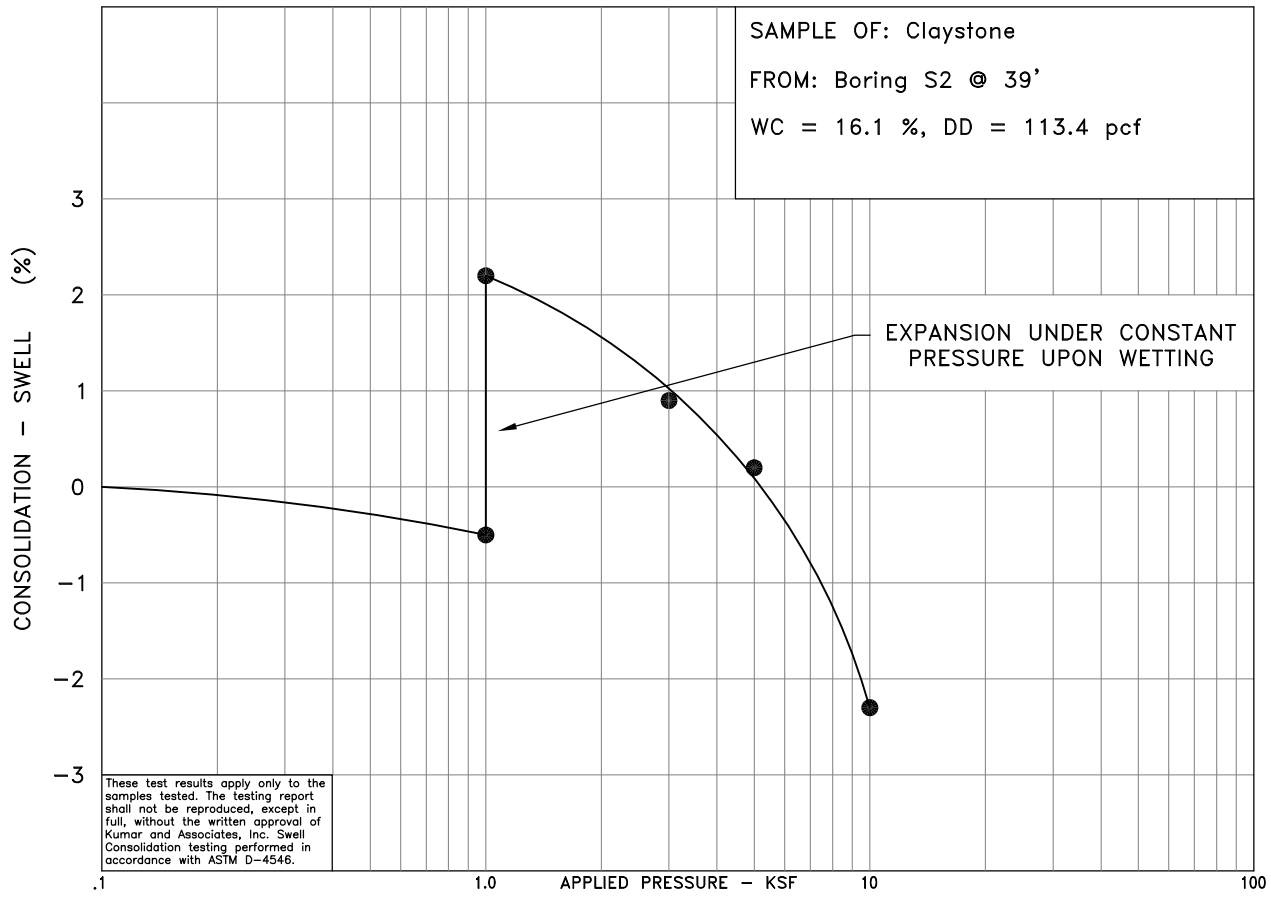
3. THE EXPLORATORY BORING LOCATIONS AND ELEVATIONS WERE SURVEYED BY 105 WEST INC. UPON COMPLETION OF DRILLING.

4. THE LINES BETWEEN MATERIALS SHOWN ON THE EXPLORATORY BORING LOGS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.

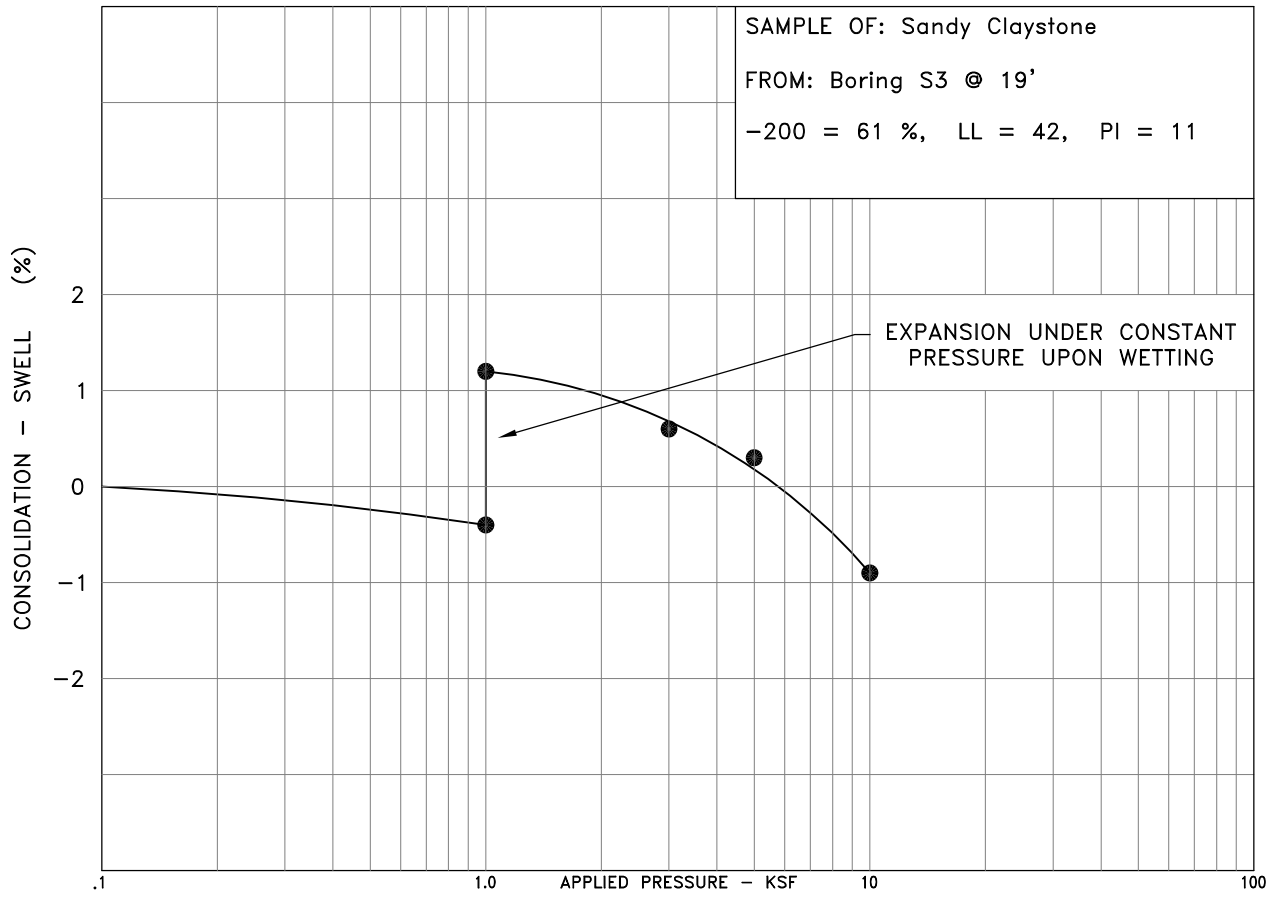
5. GROUNDWATER LEVELS SHOWN ON THE LOGS WERE MEASURED AT THE TIME AND UNDER CONDITIONS INDICATED. FLUCTUATIONS IN THE WATER LEVEL MAY OCCUR WITH TIME.

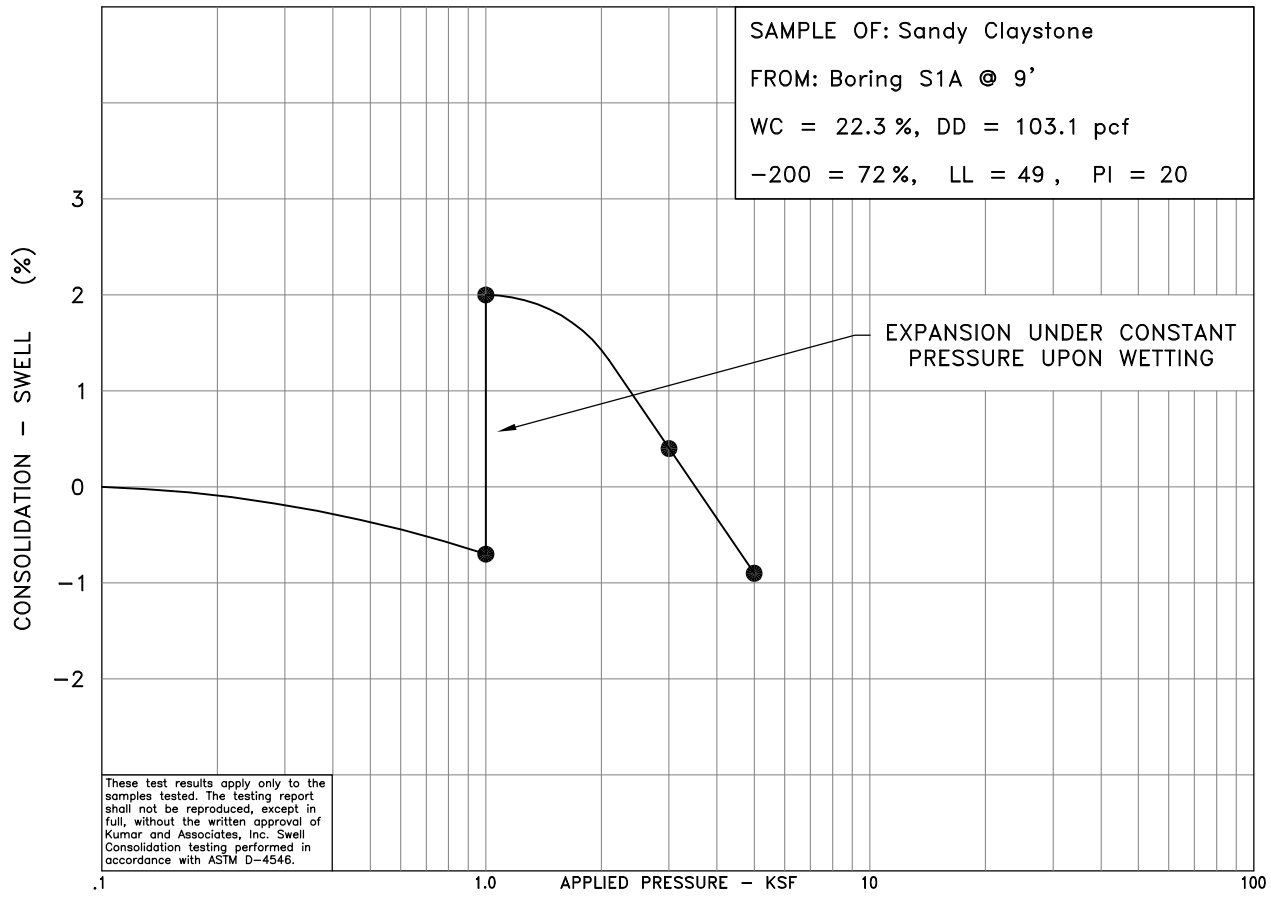
6. LABORATORY TEST RESULTS:
   WC = WATER CONTENT (%) (ASTM D 2216);
   DD = DRY DENSITY (pcf) (ASTM D 2216);
   +4 = PERCENTAGE RETAINED ON NO. 4 SIEVE (ASTM D 422);
   –200= PERCENTAGE PASSING NO. 200 SIEVE (ASTM D 1140);
   LL = LIQUID LIMIT (ASTM D 4318);
   PI = PLASTICITY INDEX (ASTM D 4318);
   NP = NON–PLASTIC (ASTM D 4318);
   WSS = WATER SOLUBLE SULFATES (%) (CP–L 2103);
   R = HVEEM R–VALUE (AT 300 psi) (ASTM D 2844);
   A–2–4 (0) = AASHTO CLASSIFICATION (GROUP INDEX) (AASHTO M 145);
   UC = UNCONFINED COMPRESSIVE STRENGTH (psf) (ASTM D 2166);
   OMC = OPTIMUM MOISTURE CONTENT (%) (ASTM D 698);
   MDD = MAXIMUM DRY DENSITY (pcf) (ASTM D 698).



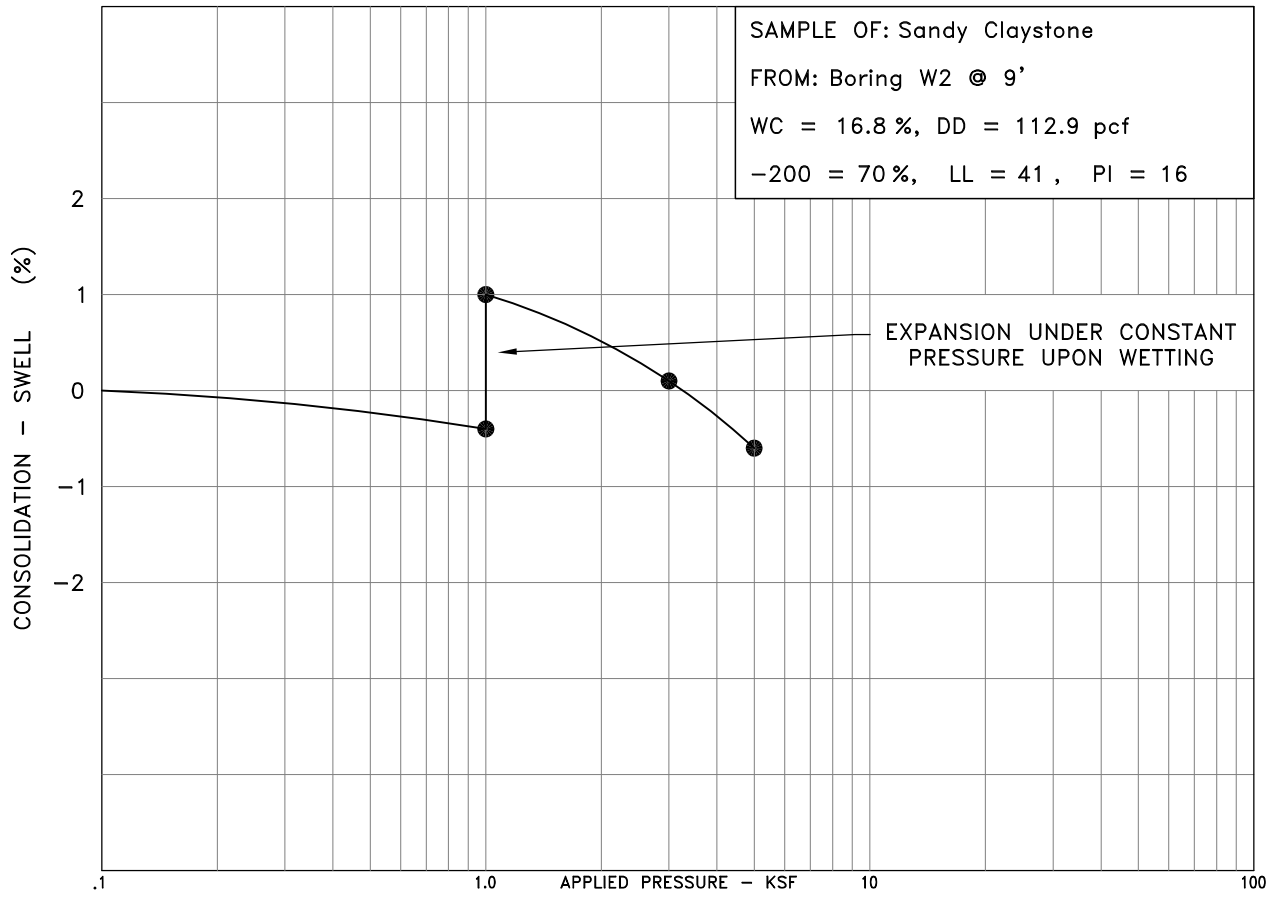


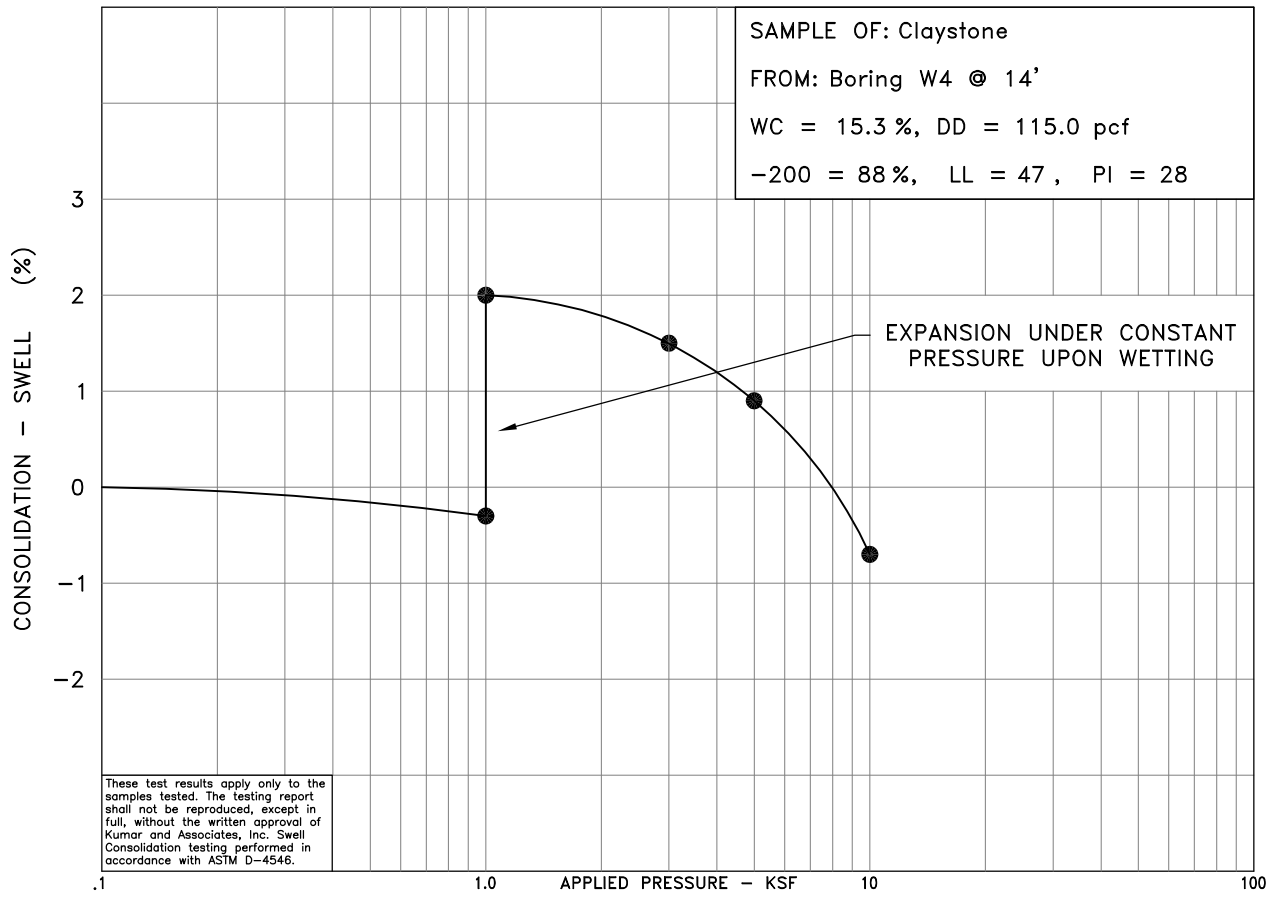
17-2-183A	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 10





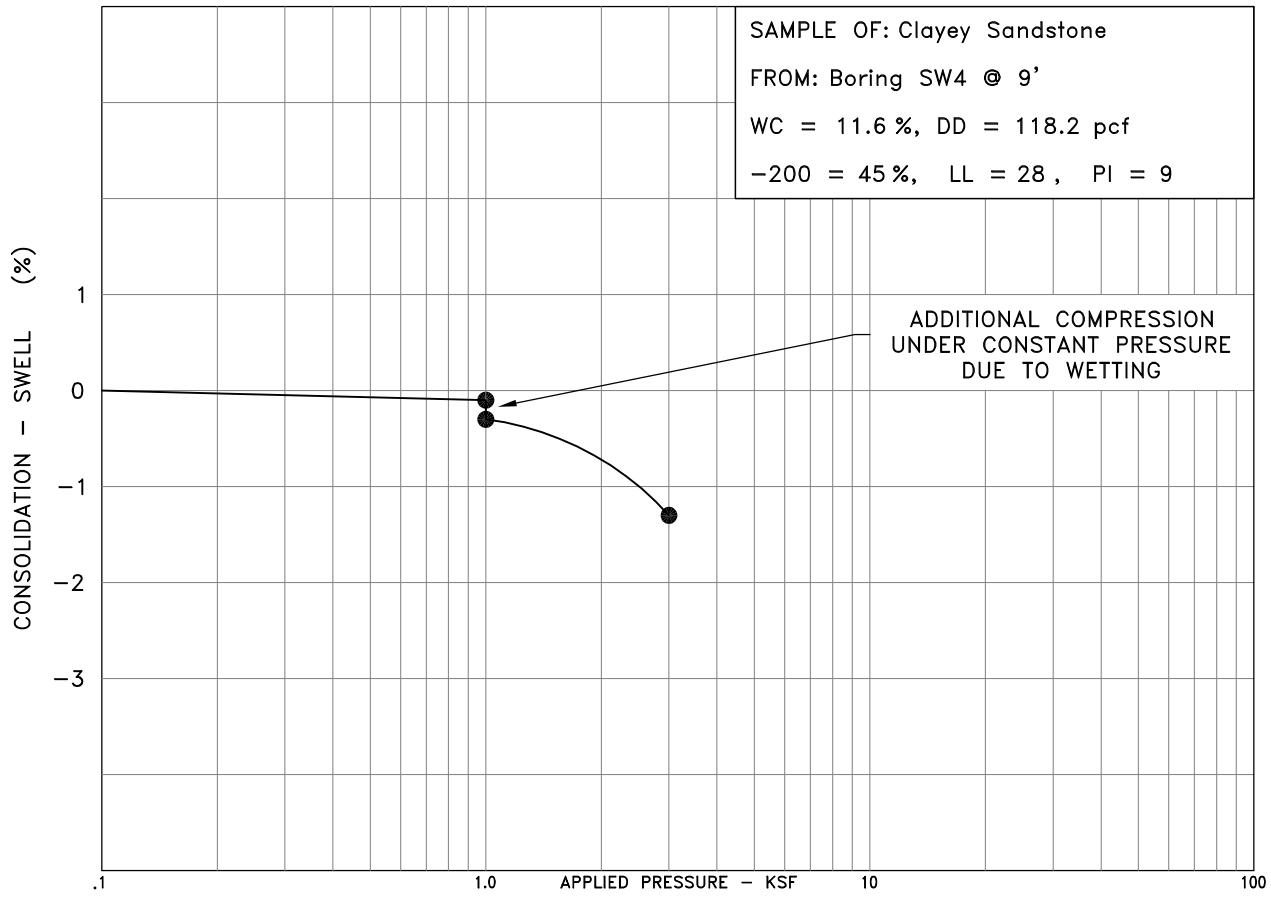
17-2-183A	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 11

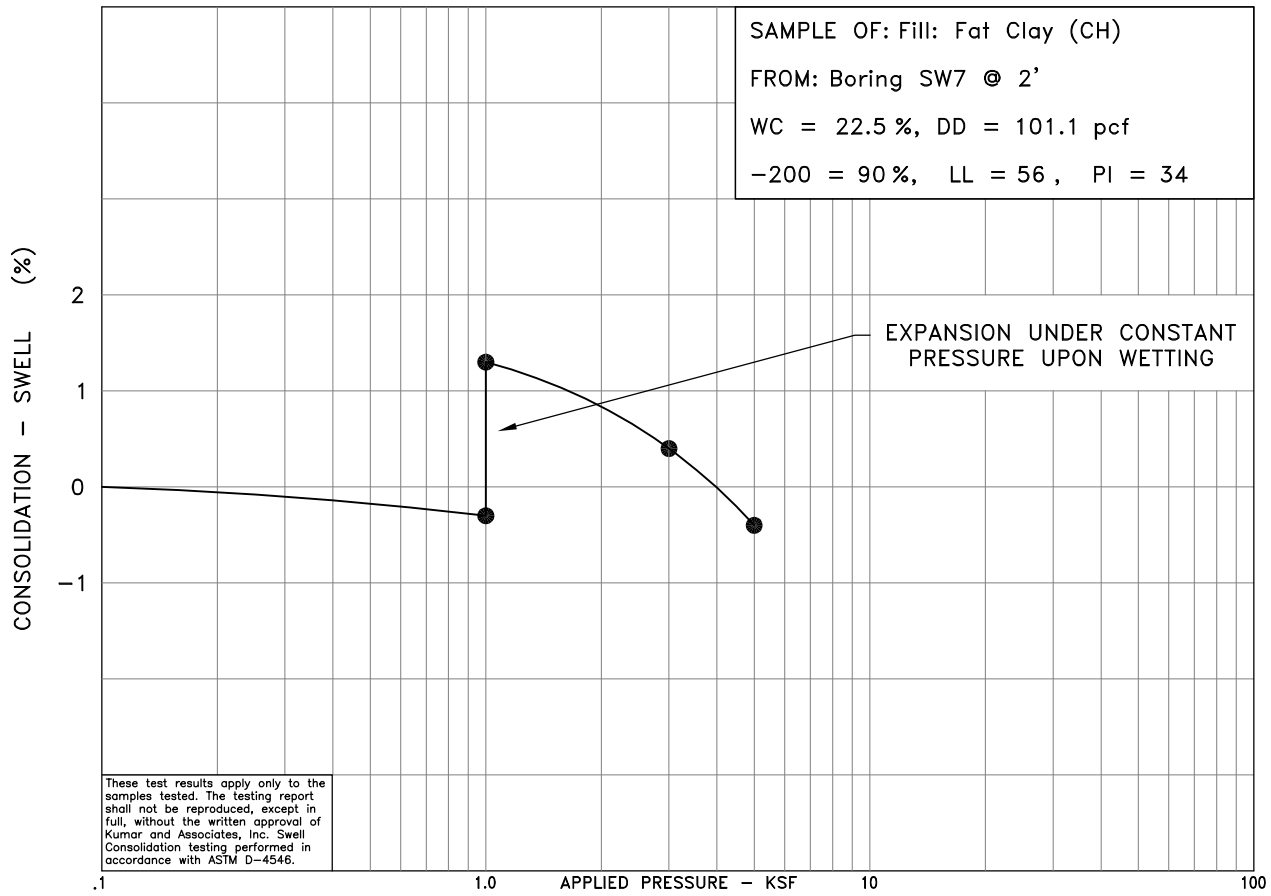




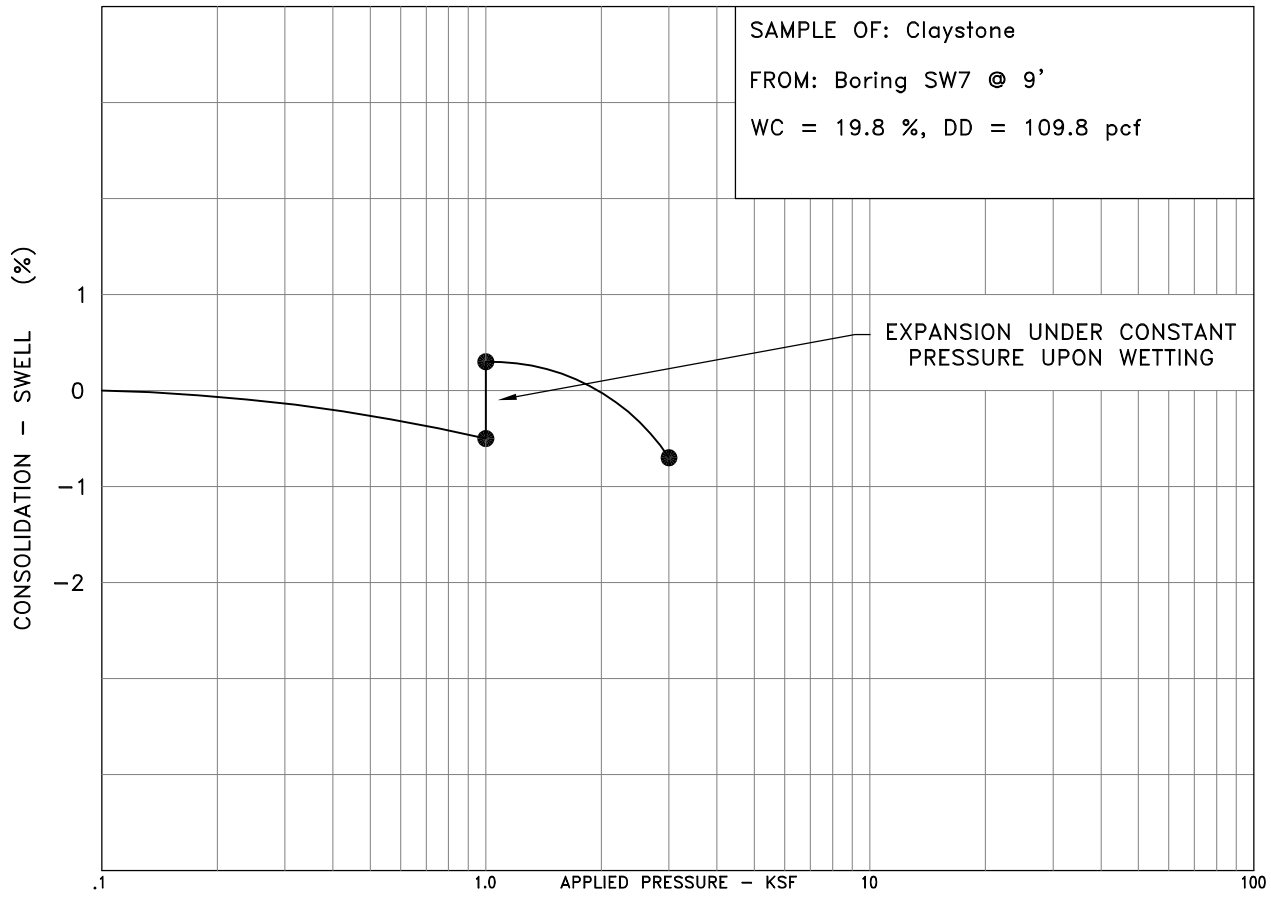
These test results apply only to the samples tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Swell Consolidation testing performed in accordance with ASTM D−4546.

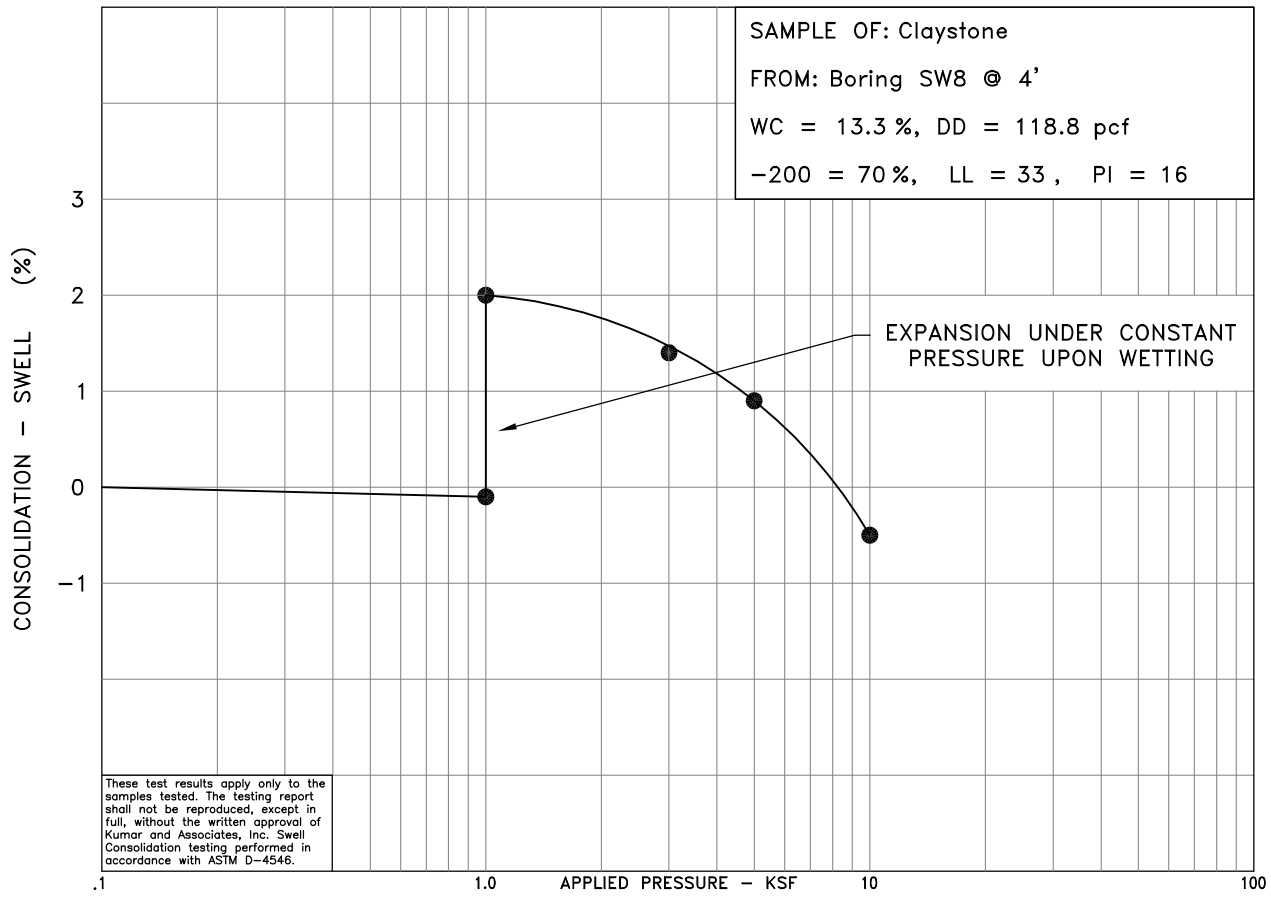
17−2−183A	Kumar & Associates	SWELL−CONSOLIDATION TEST RESULTS	Fig. 12



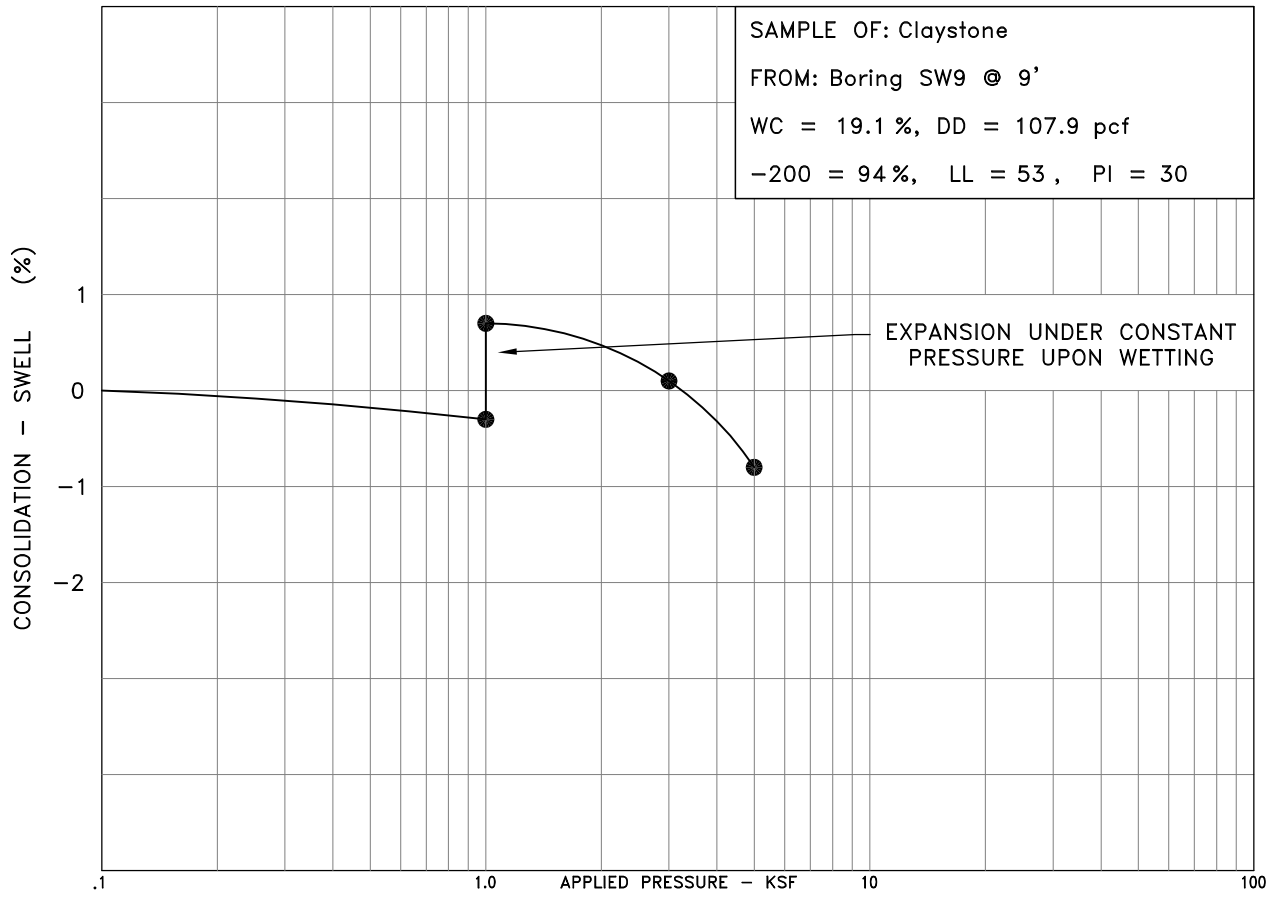


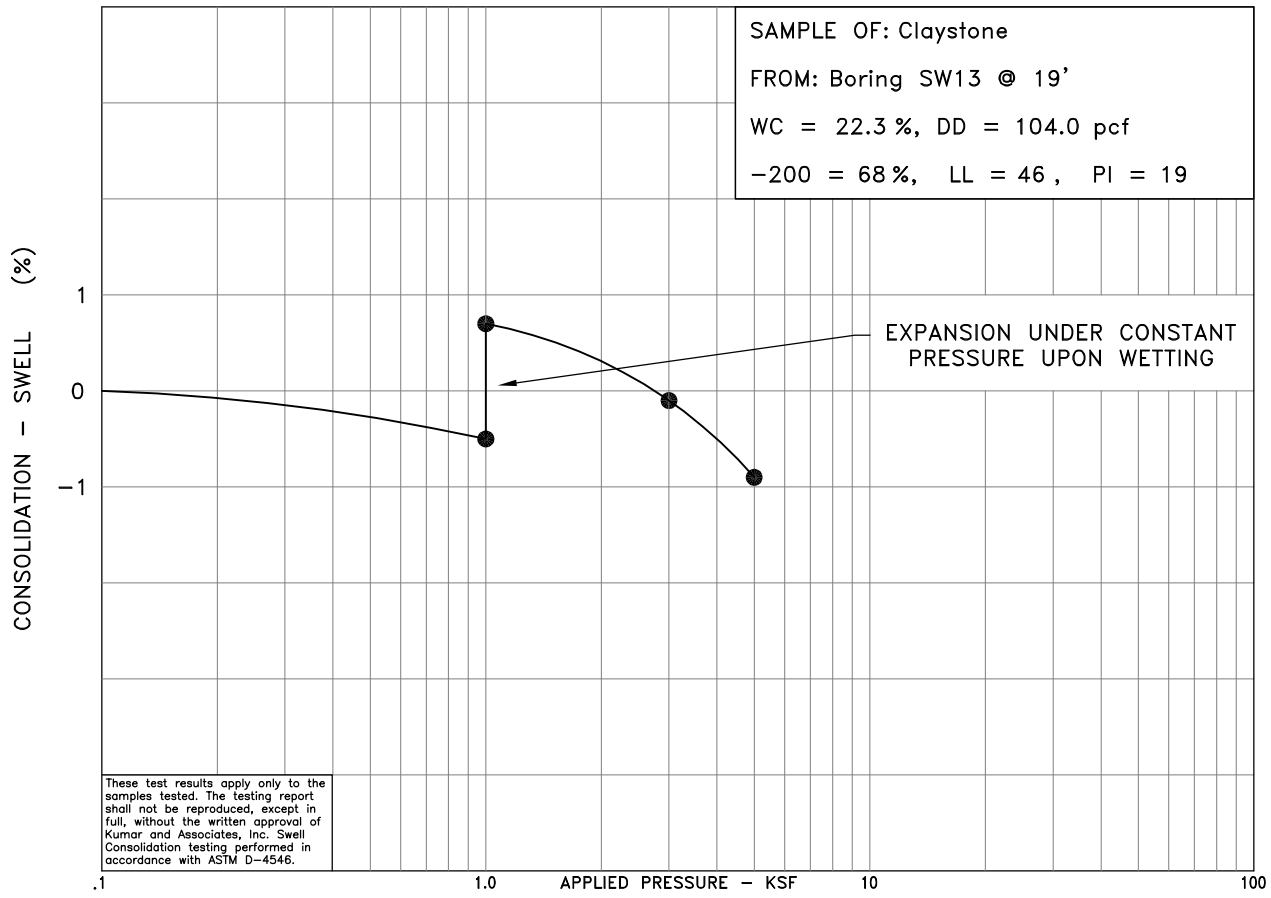
17−2−183A	Kumar & Associates	SWELL−CONSOLIDATION TEST RESULTS	Fig. 13



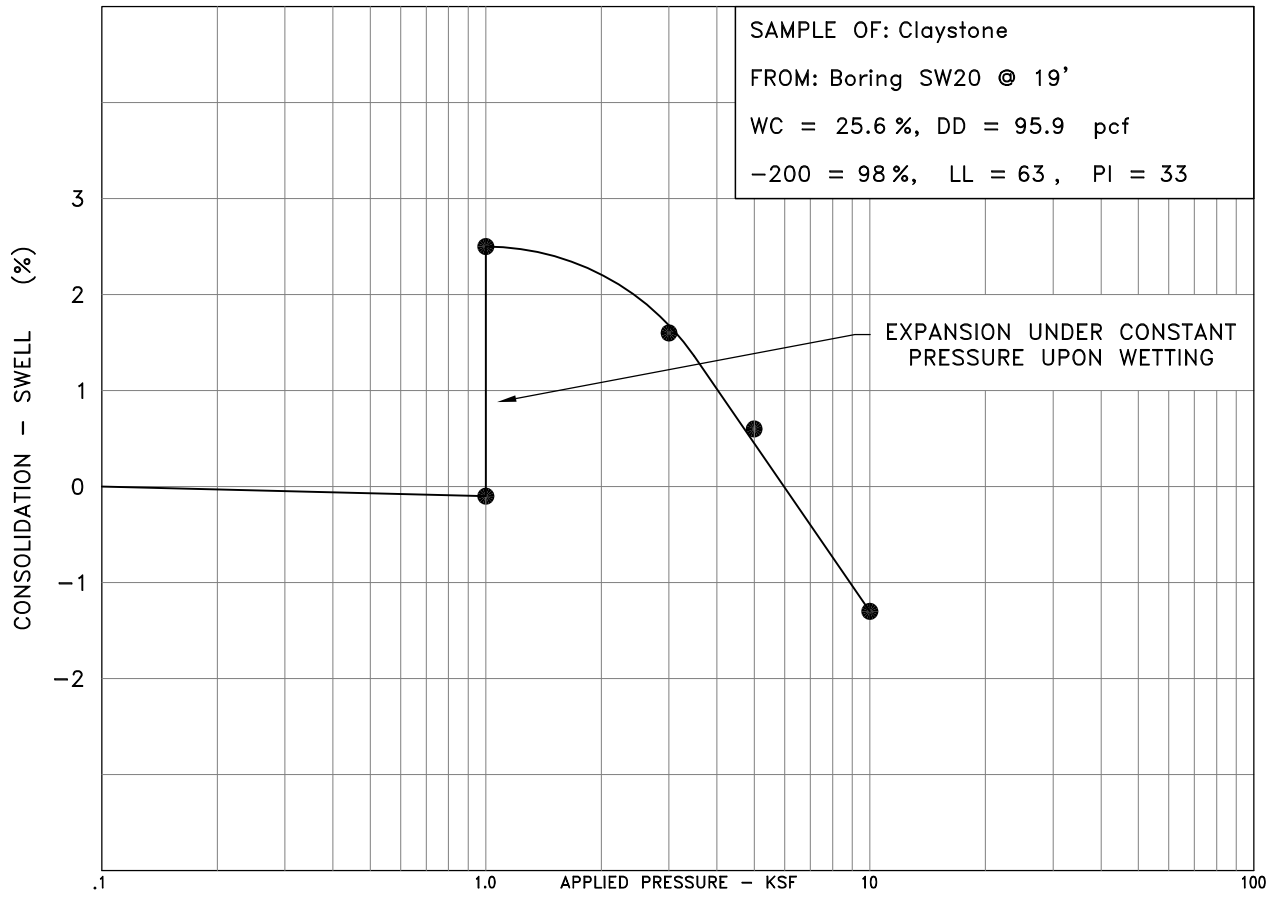


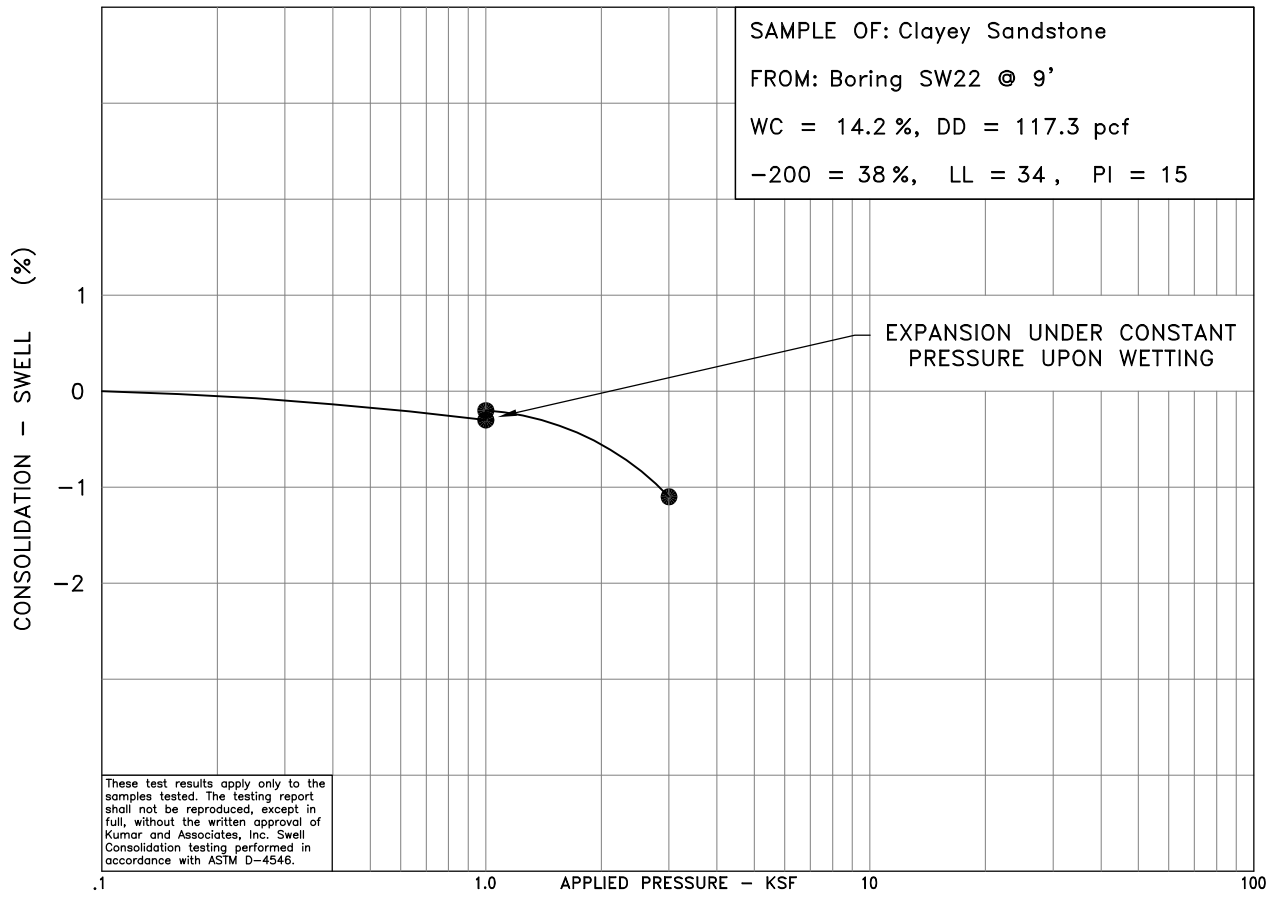
17-2-183A	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 14



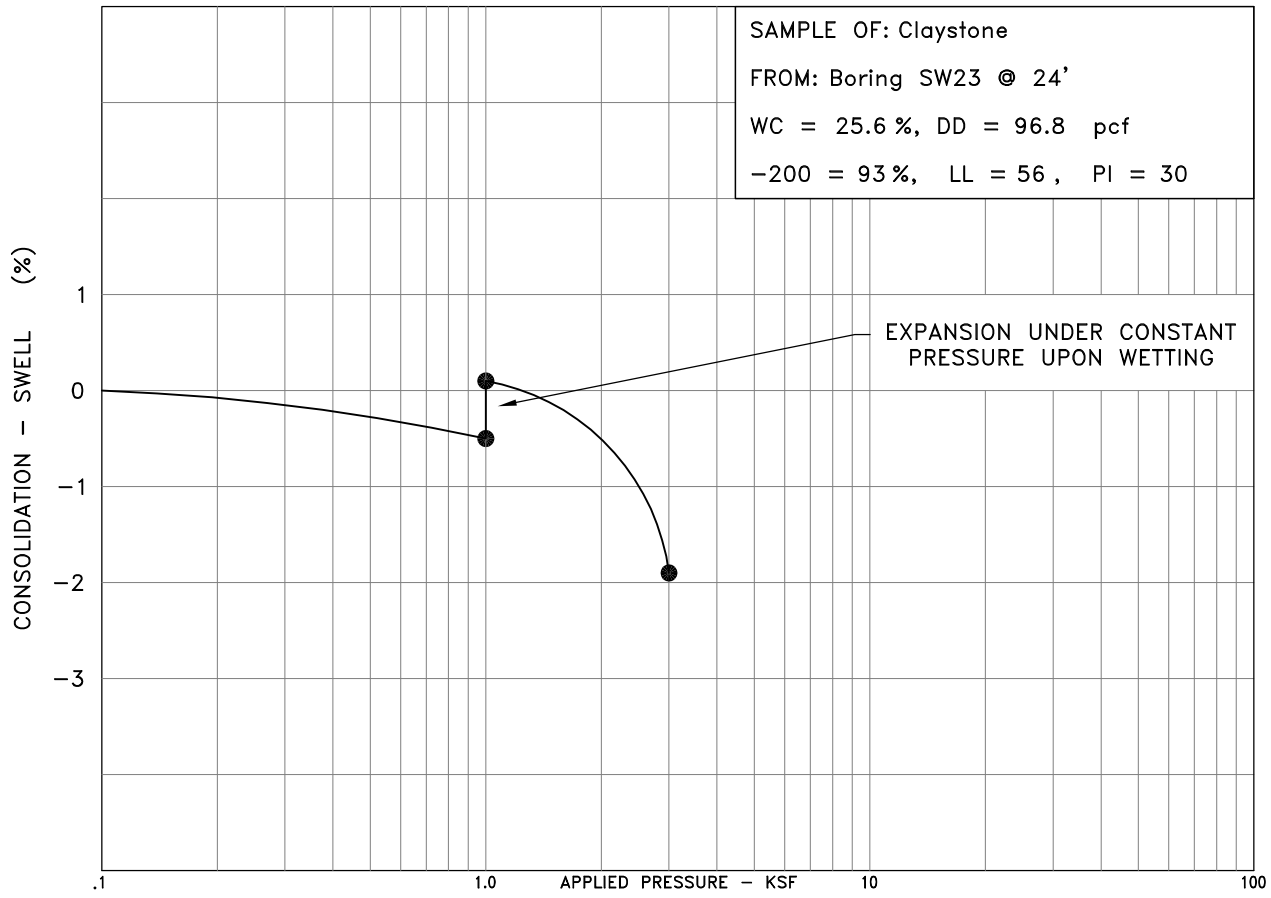


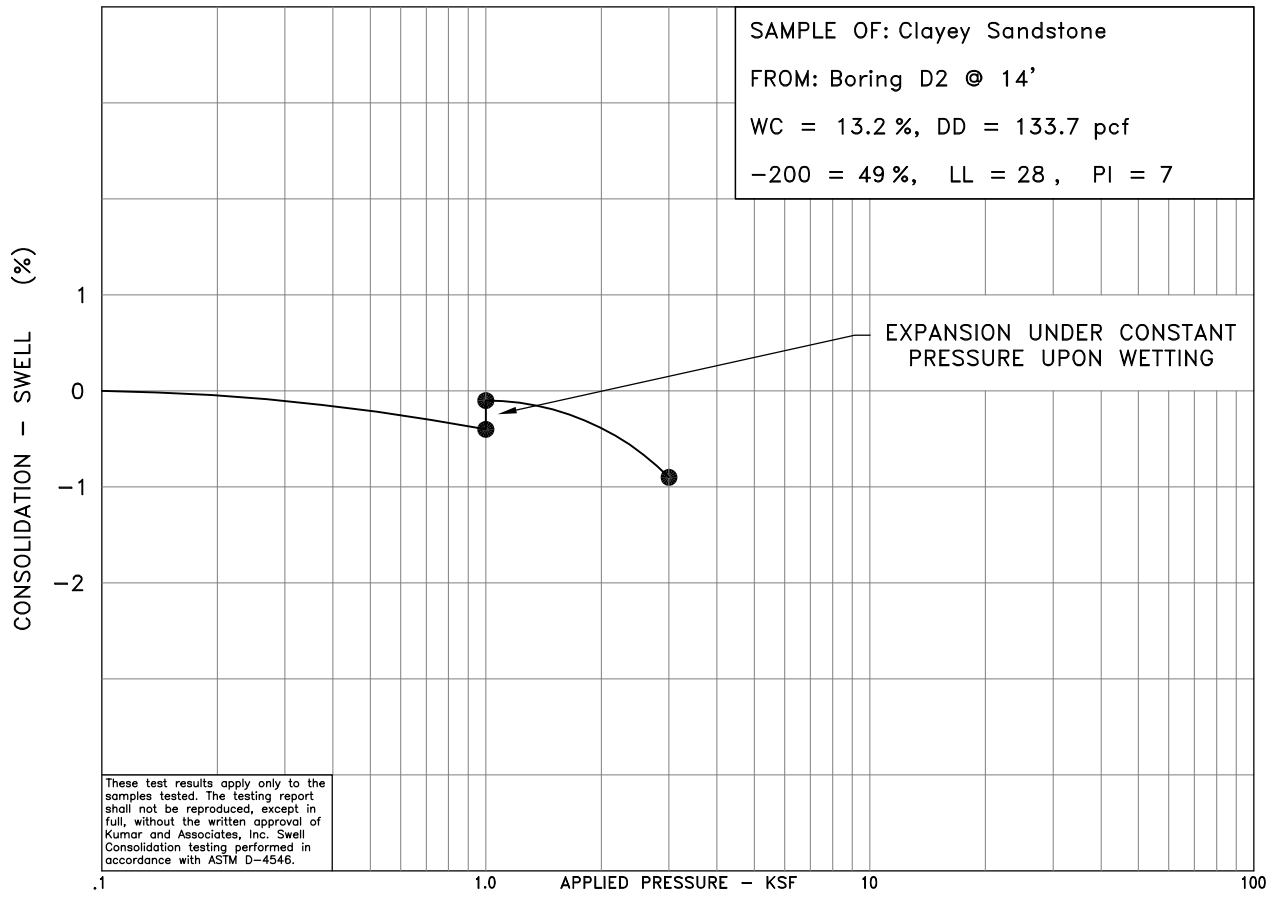
17-2-183A	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 15



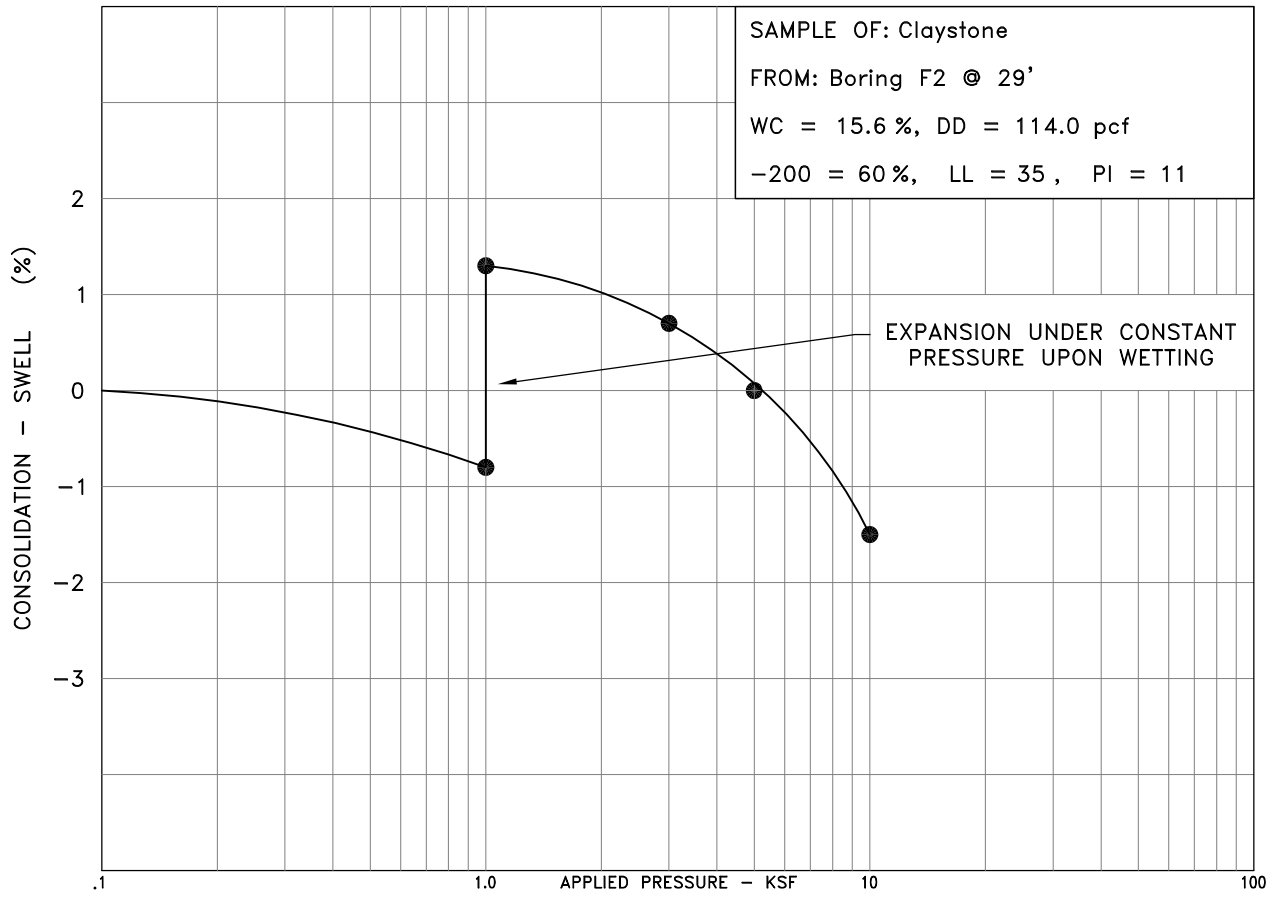


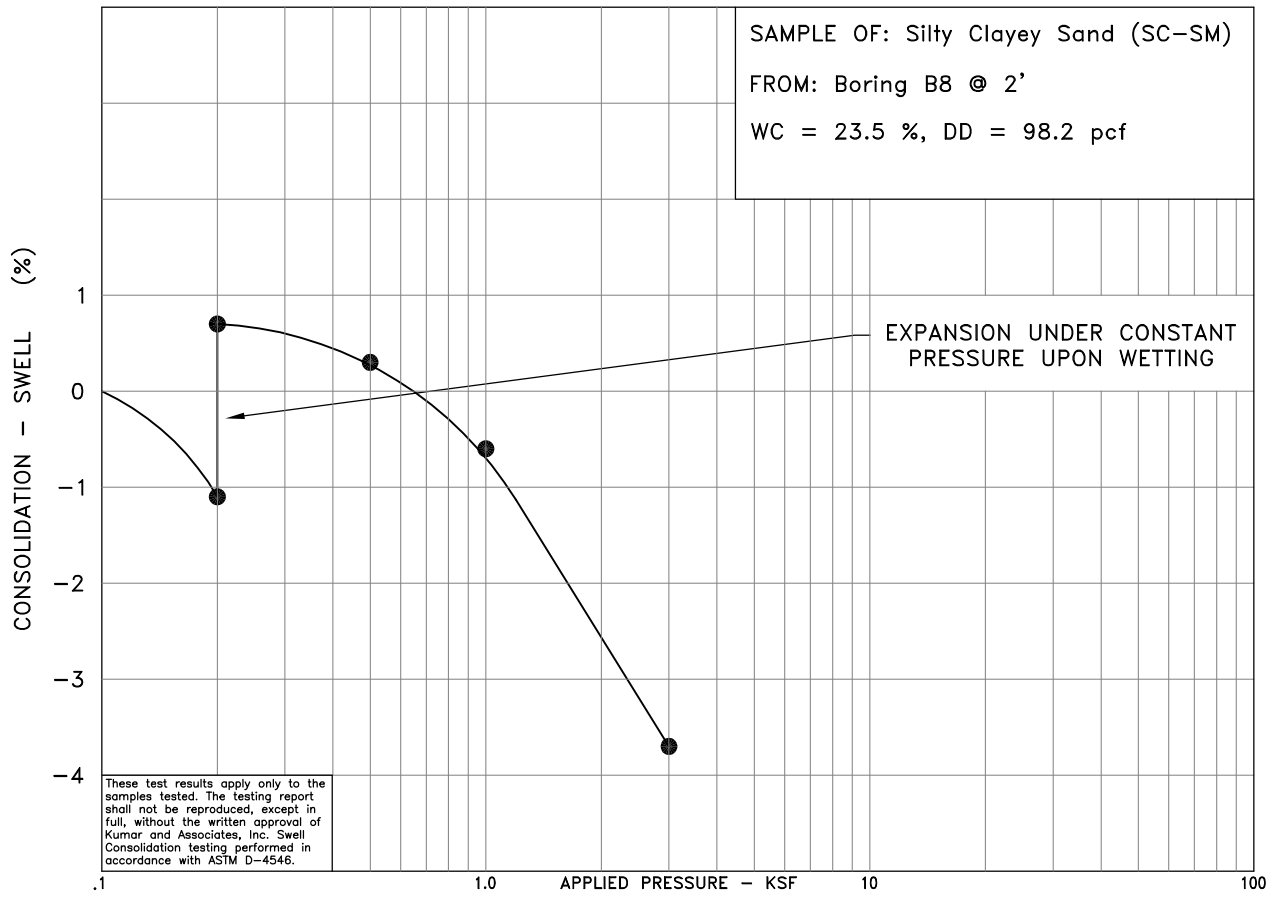
17−2−183A	Kumar & Associates	SWELL−CONSOLIDATION TEST RESULTS	Fig. 16



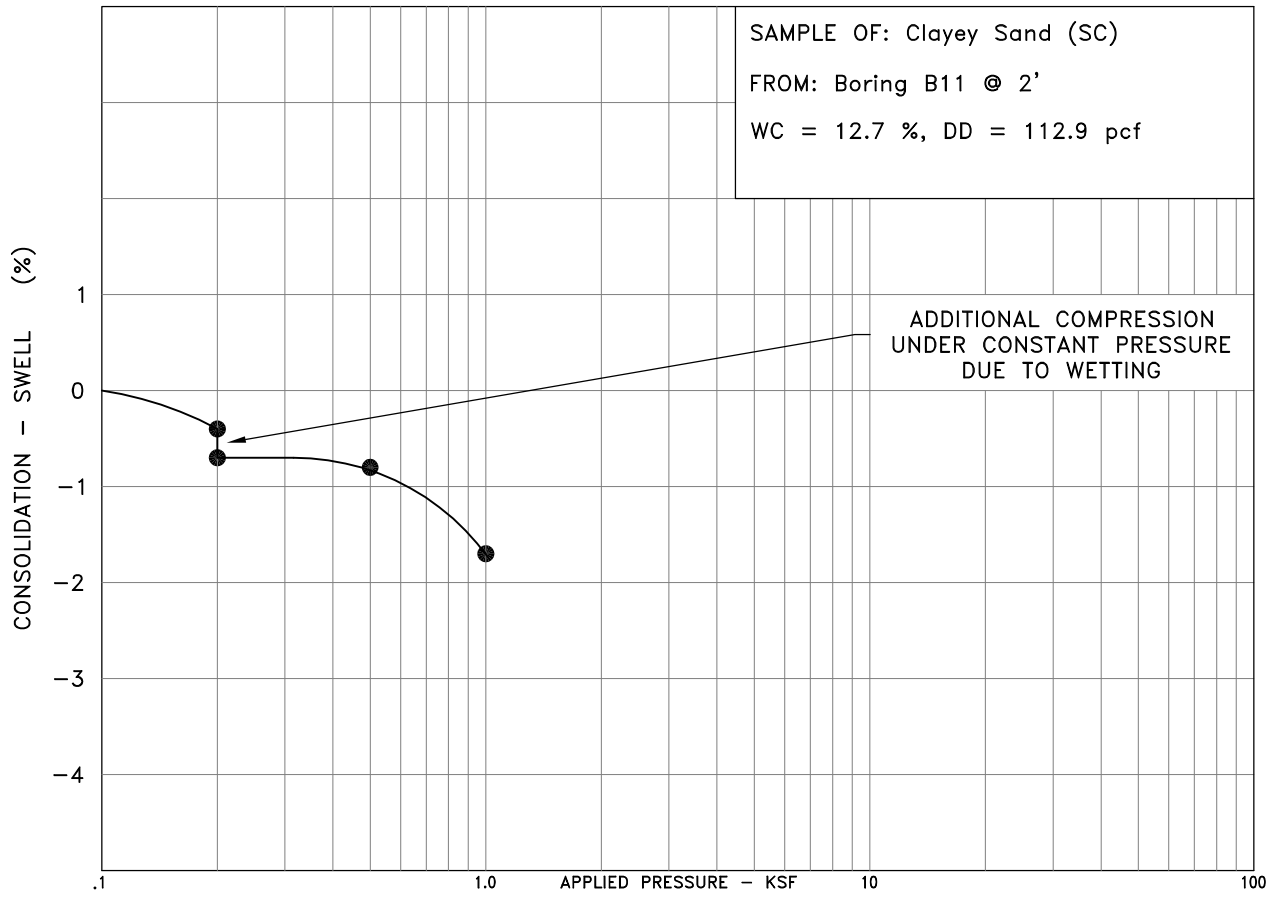


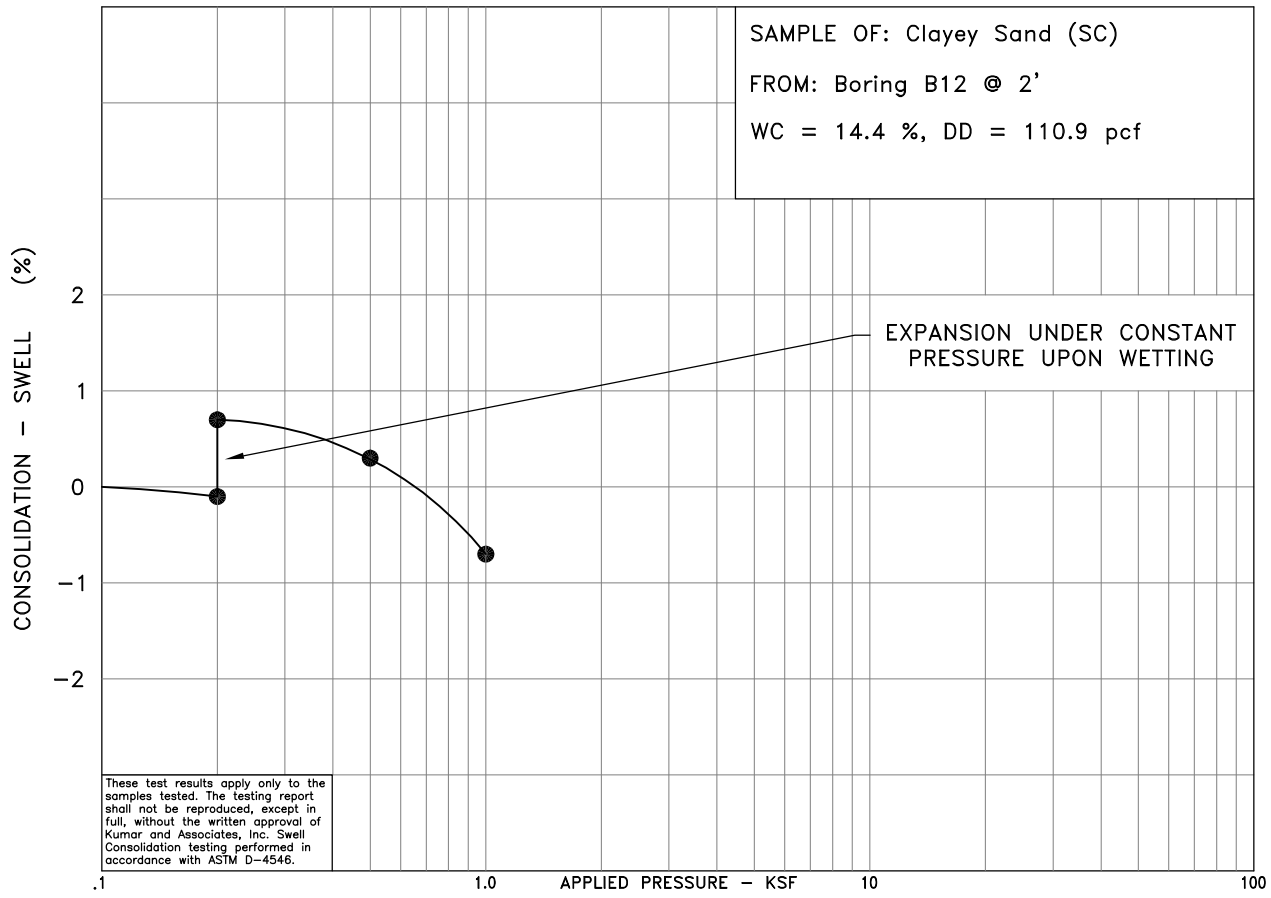
17−2−183A	Kumar & Associates	SWELL−CONSOLIDATION TEST RESULTS	Fig. 17



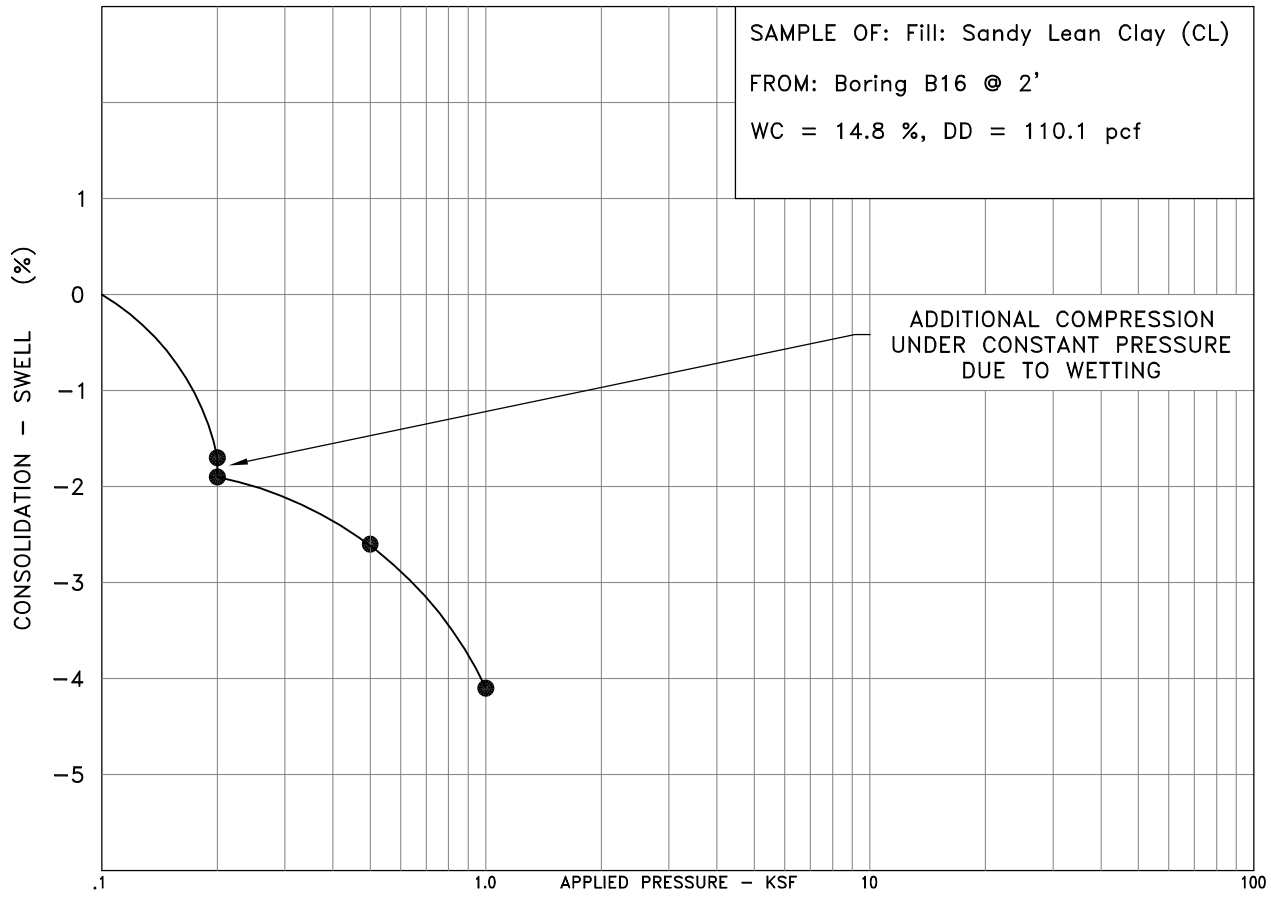


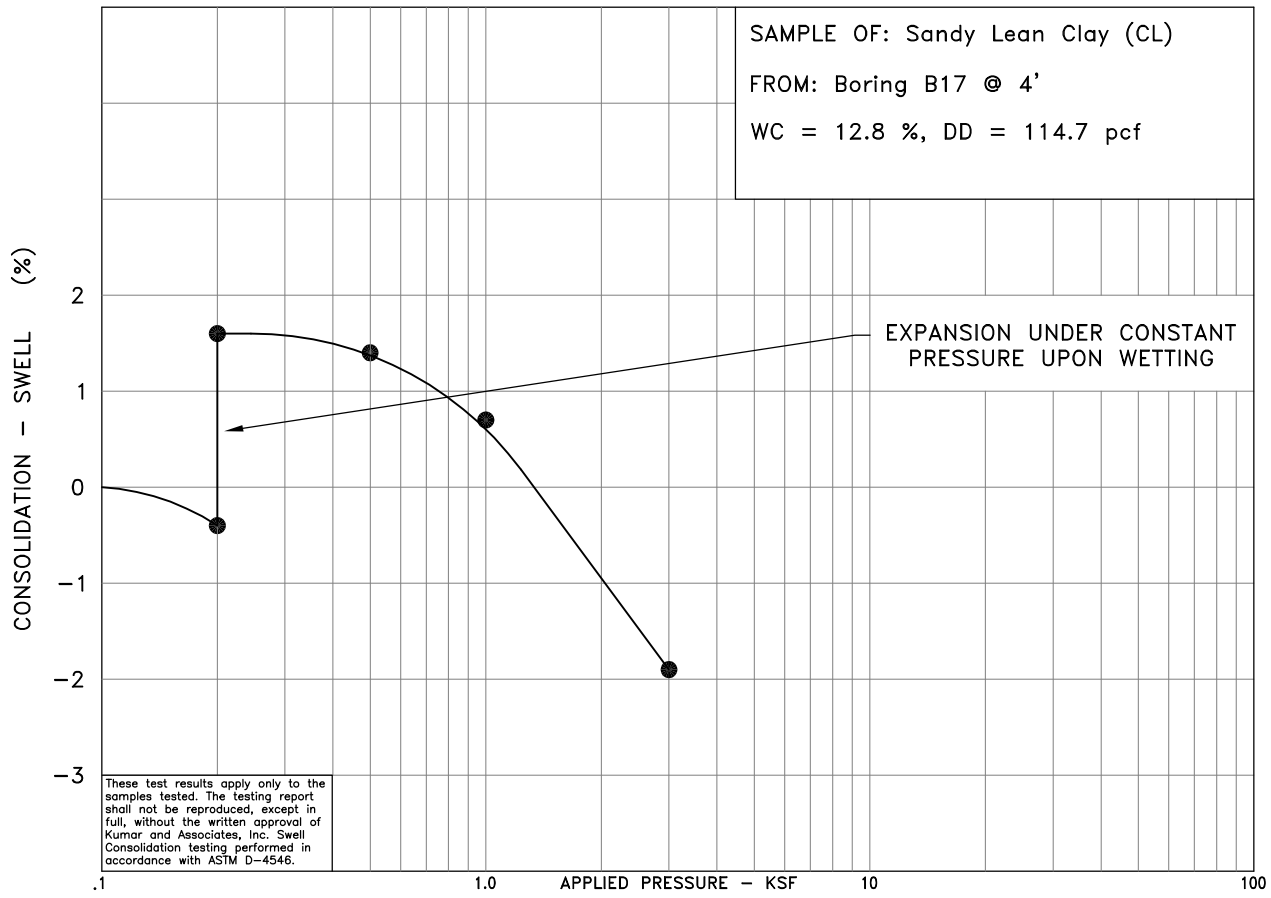
17−2−183A	Kumar & Associates	SWELL−CONSOLIDATION TEST RESULTS	Fig. 18



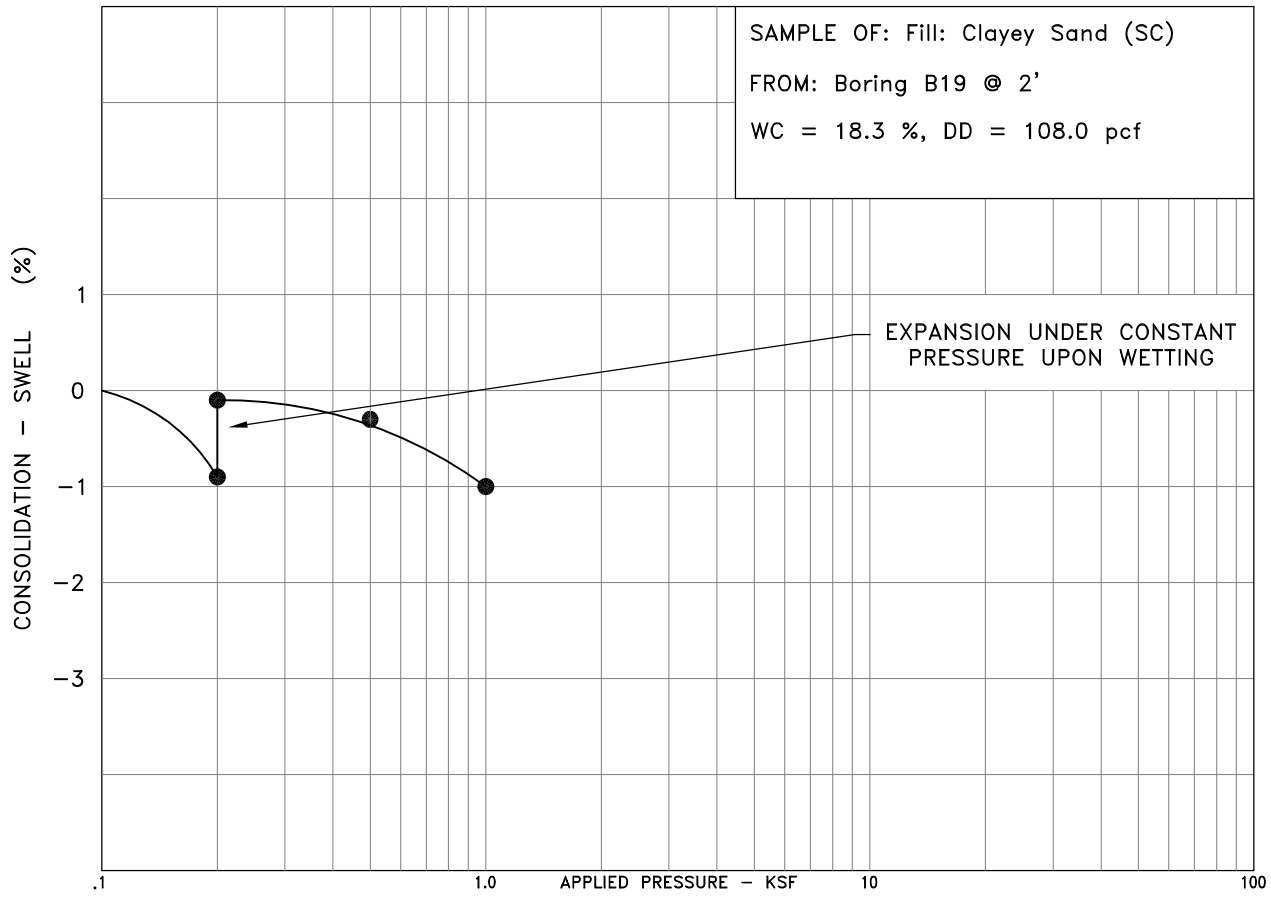


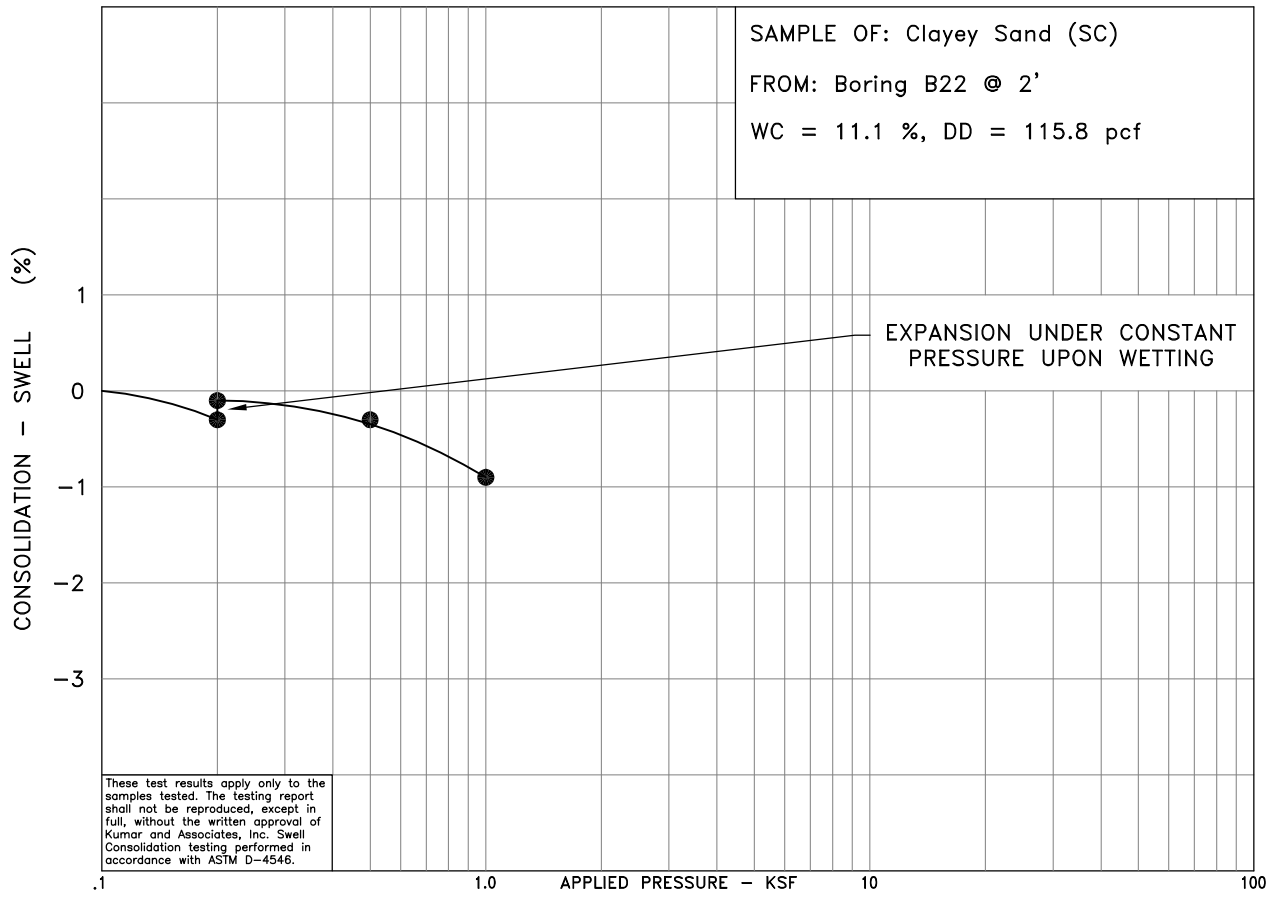
17-2-183A	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 19



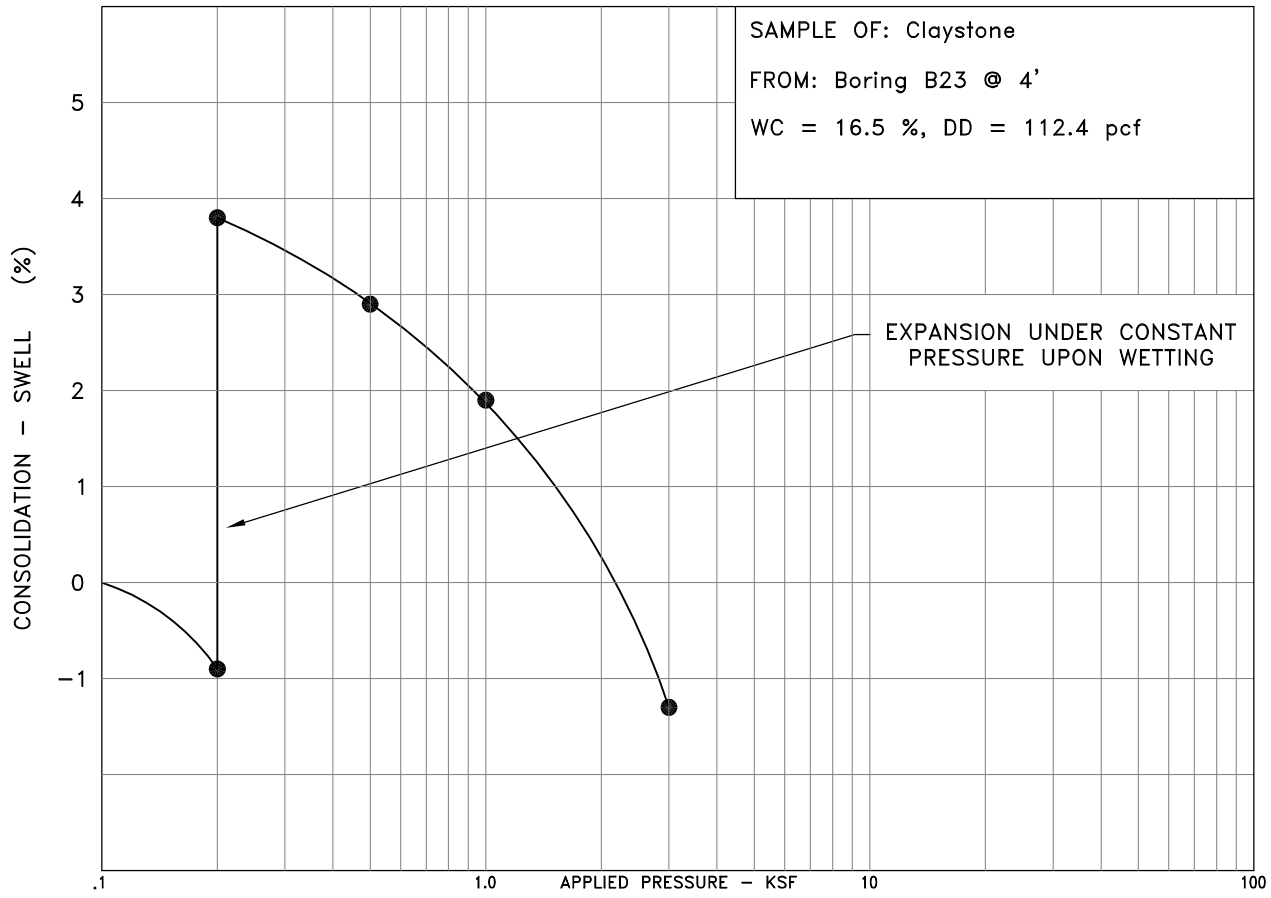


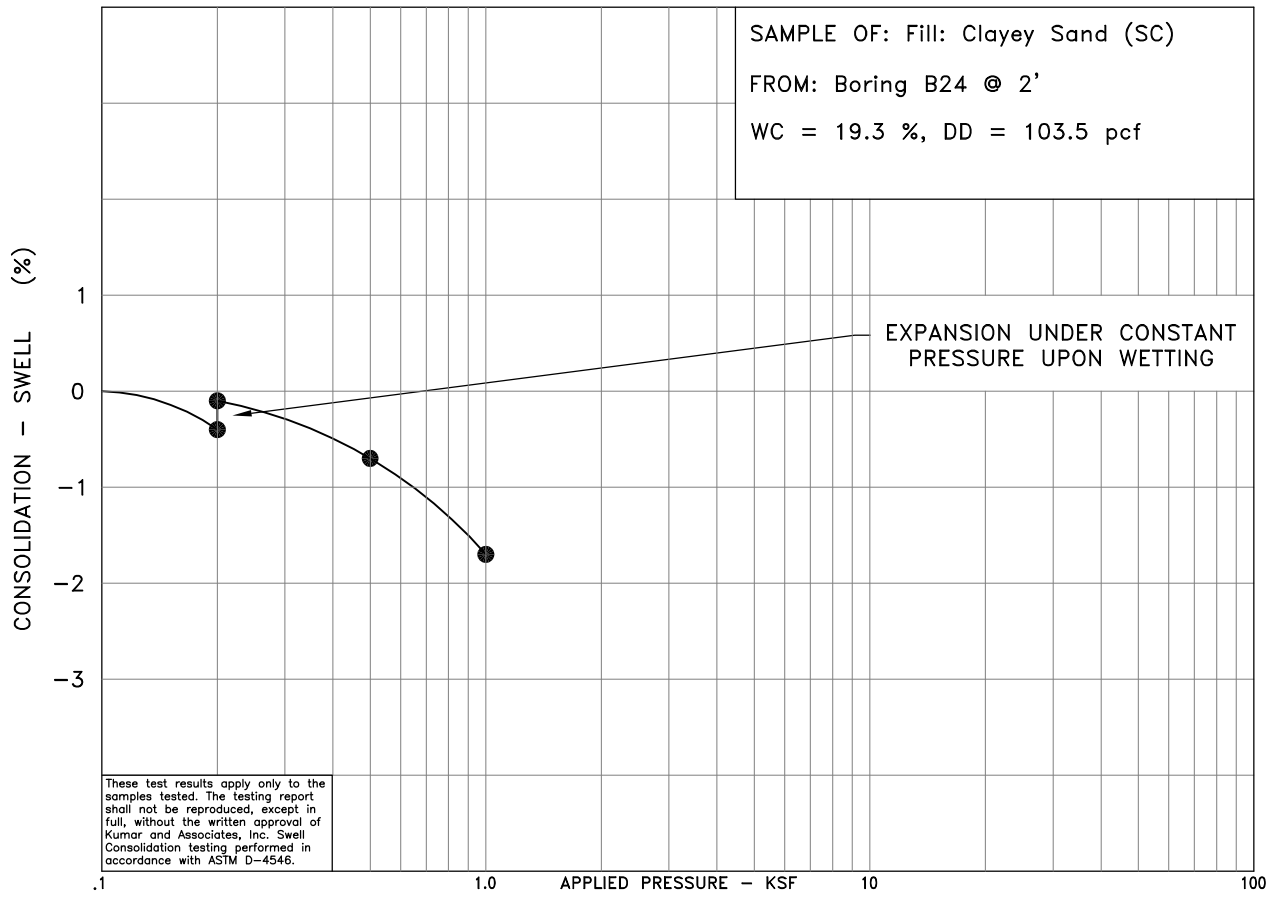
17-2-183A	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 20



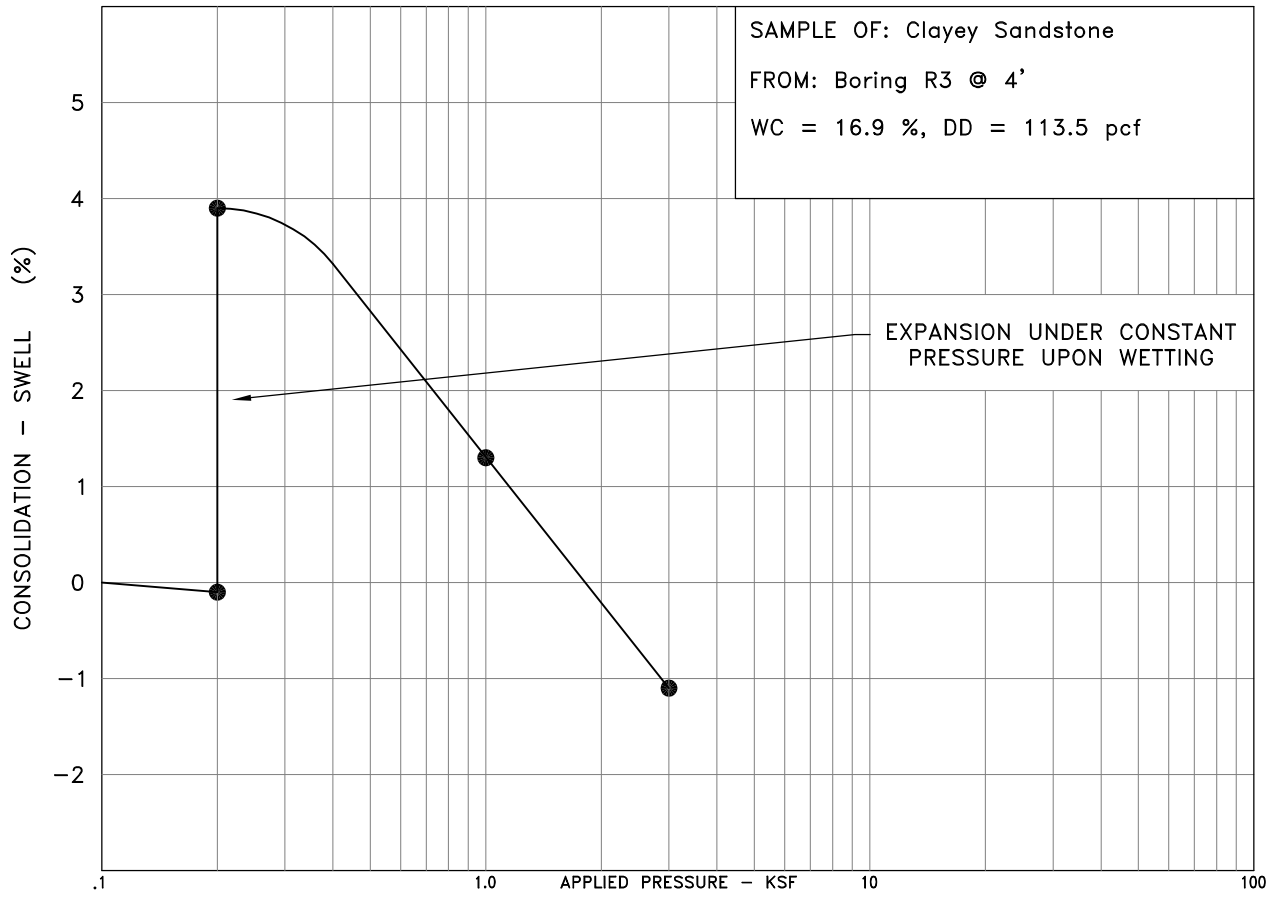


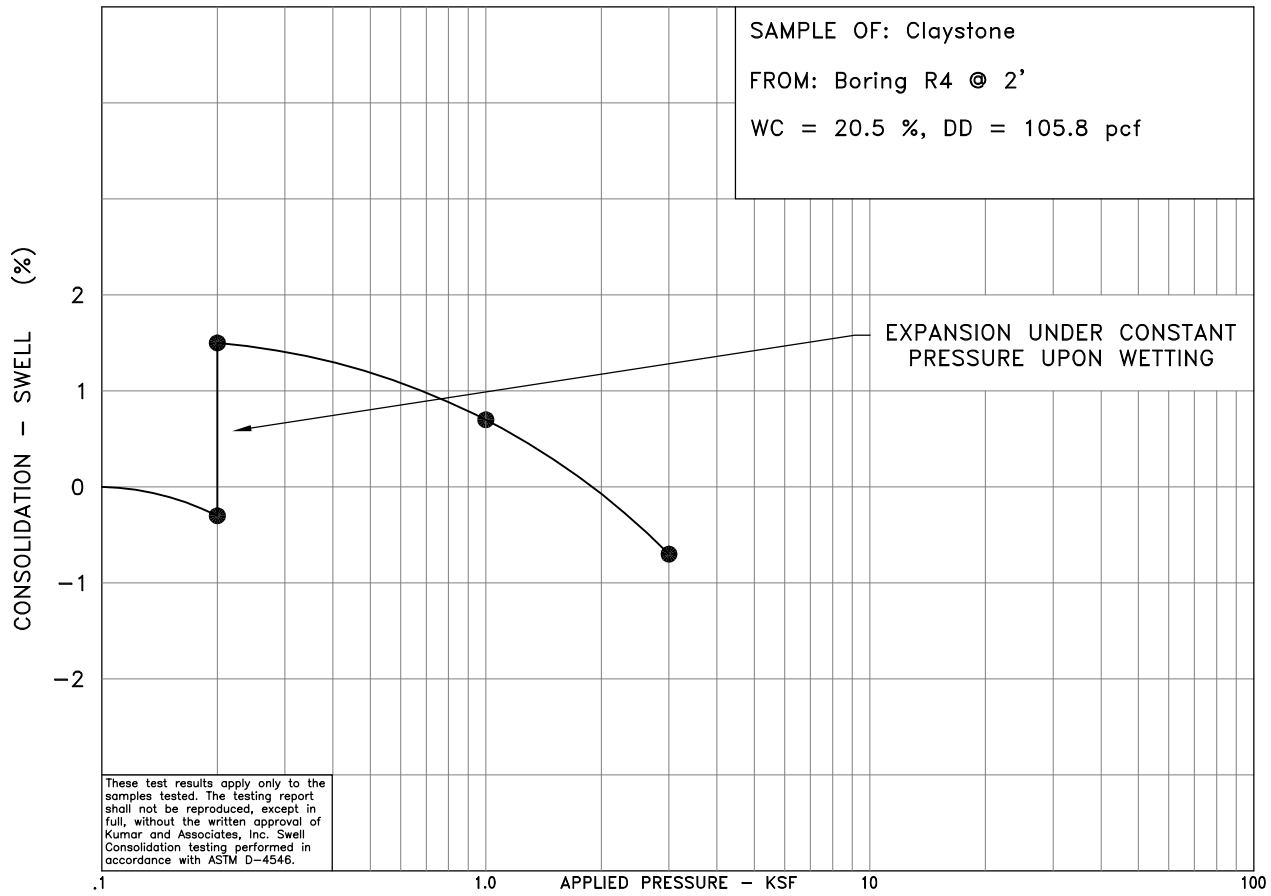
17-2-183A	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 21



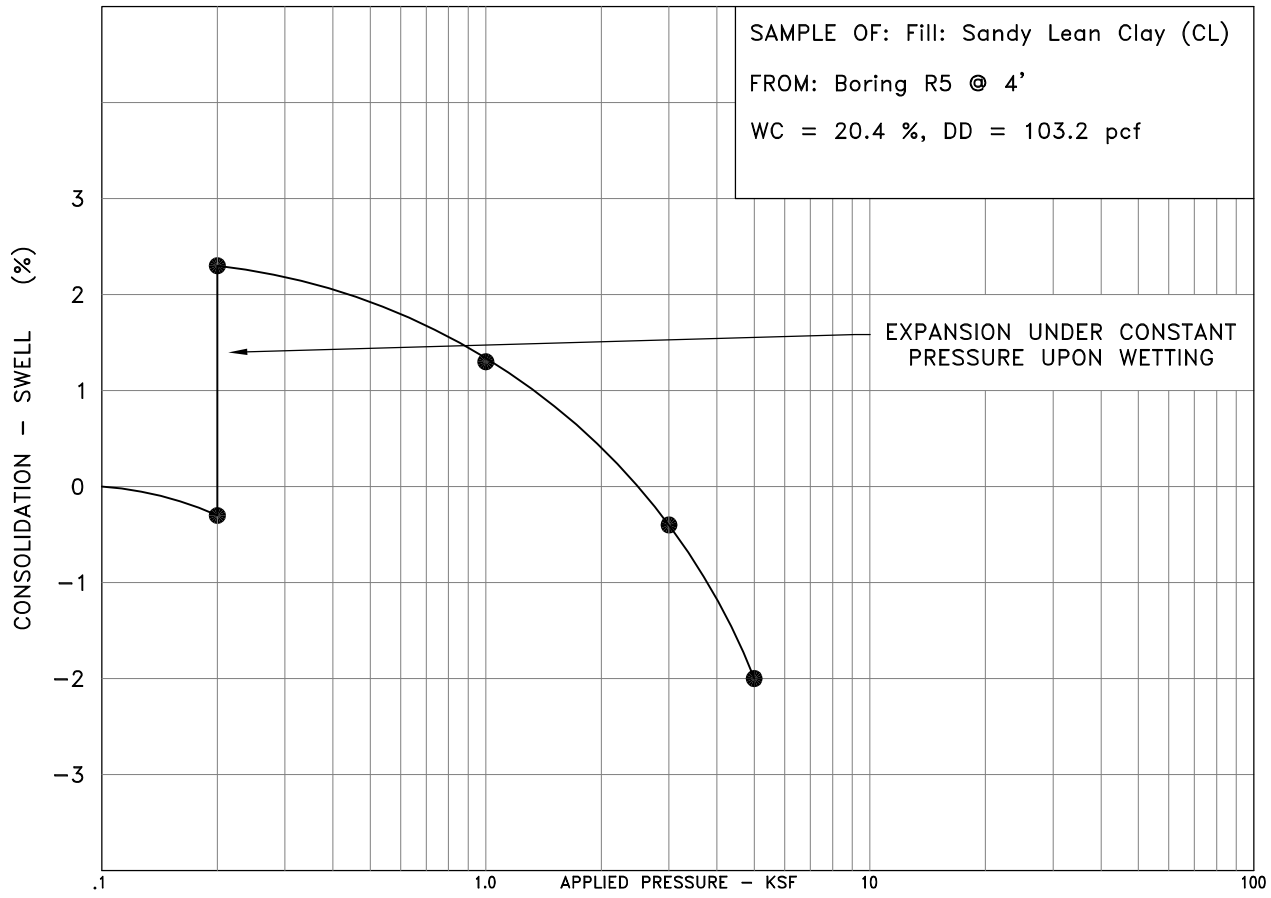


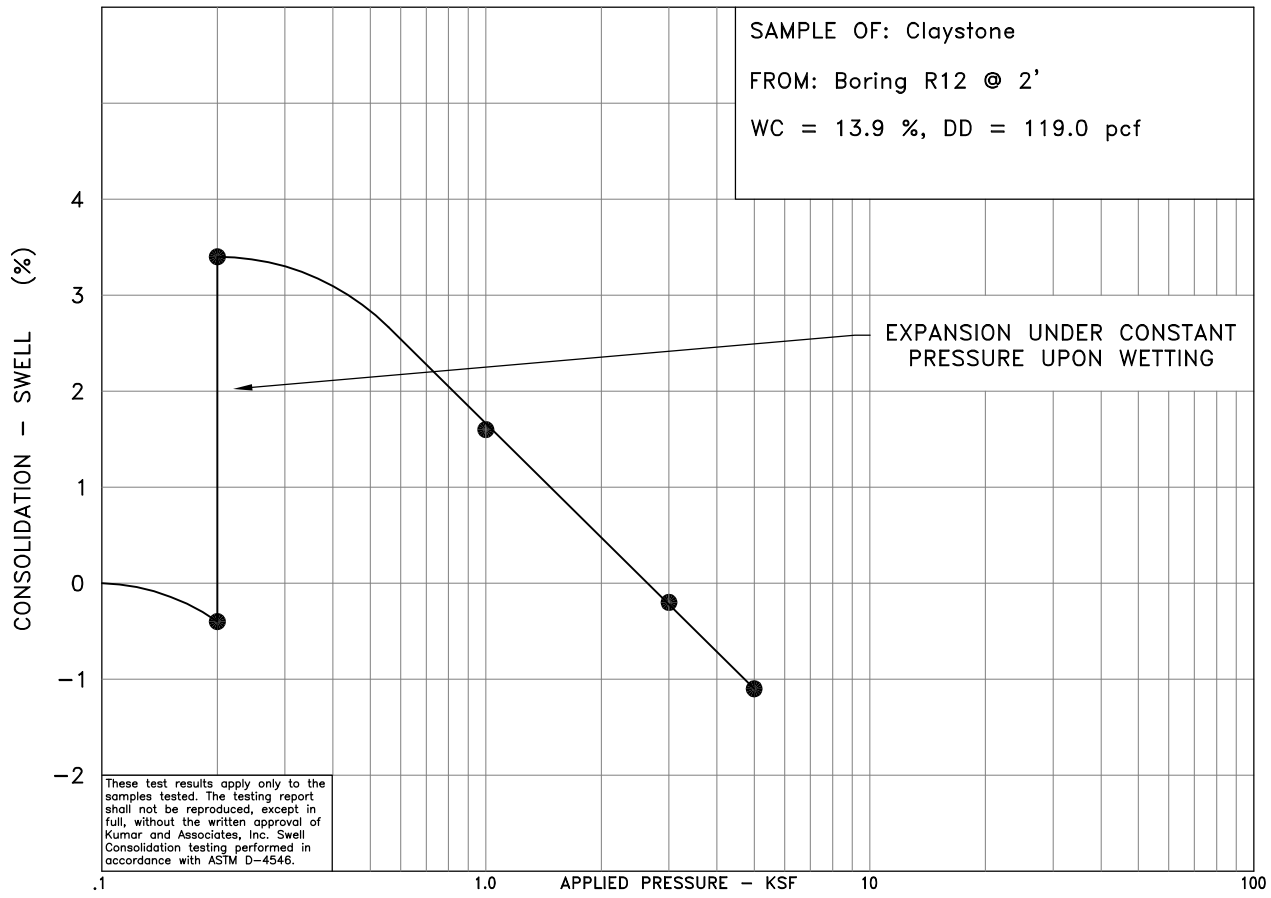
17-2-183A	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 22



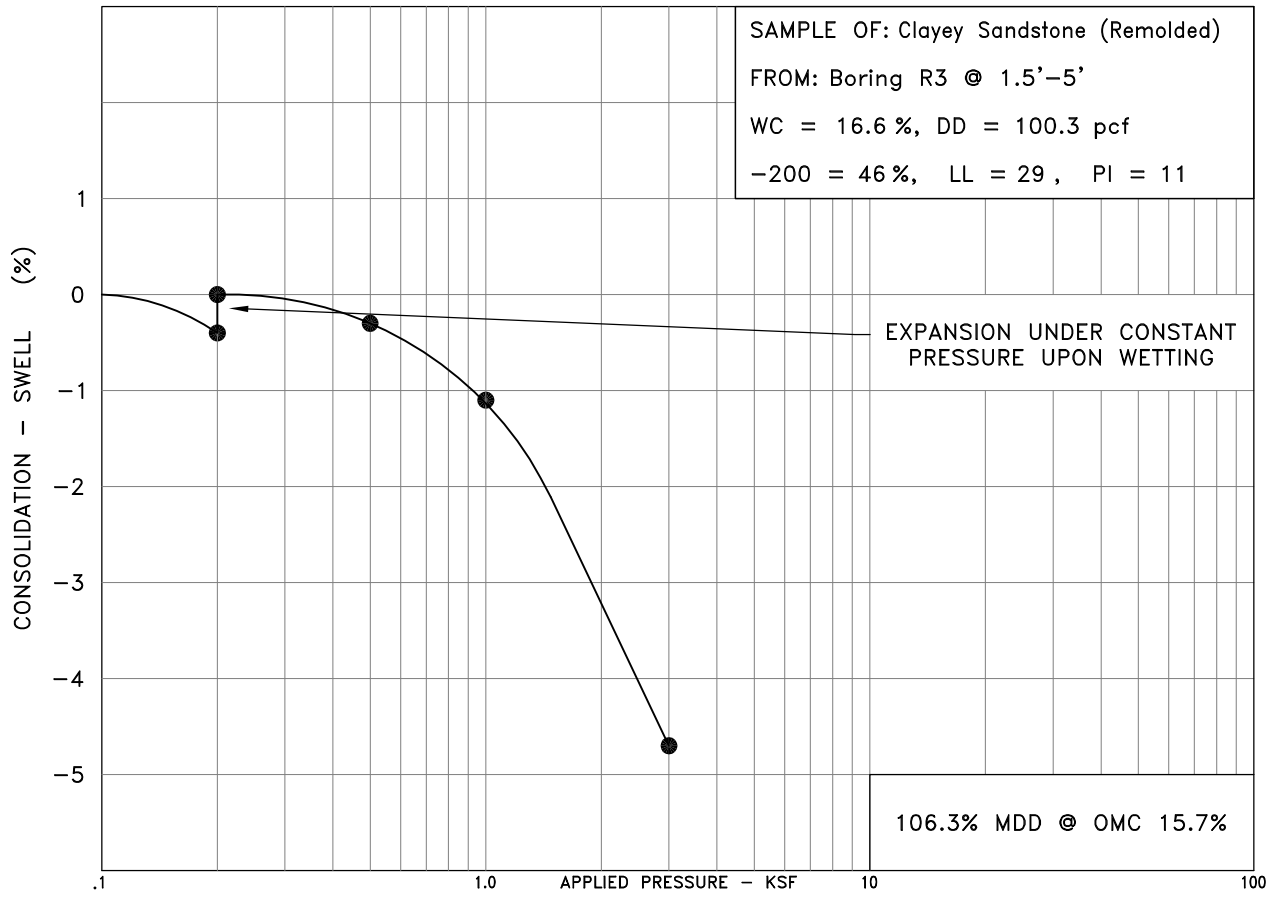


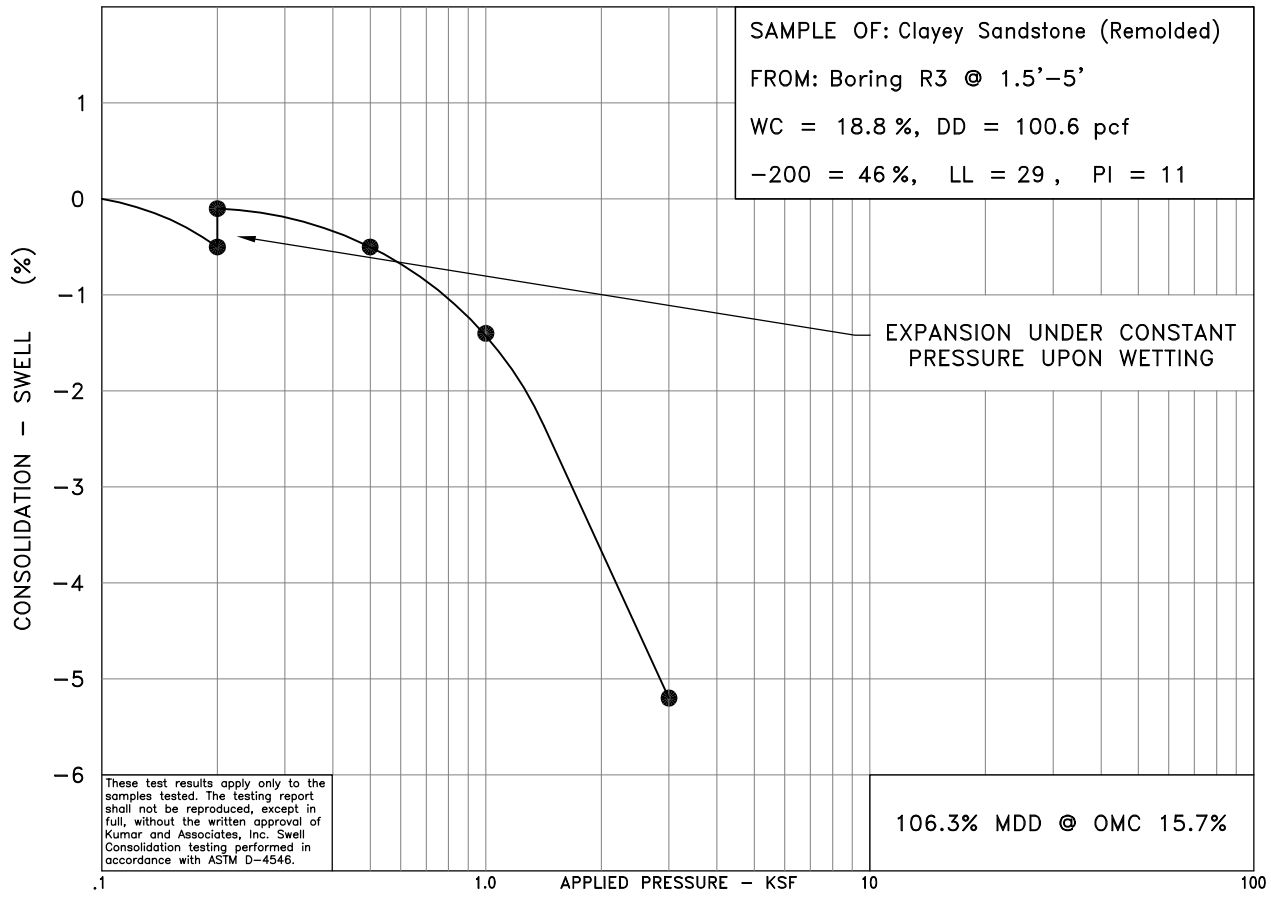
17-2-183A	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 23



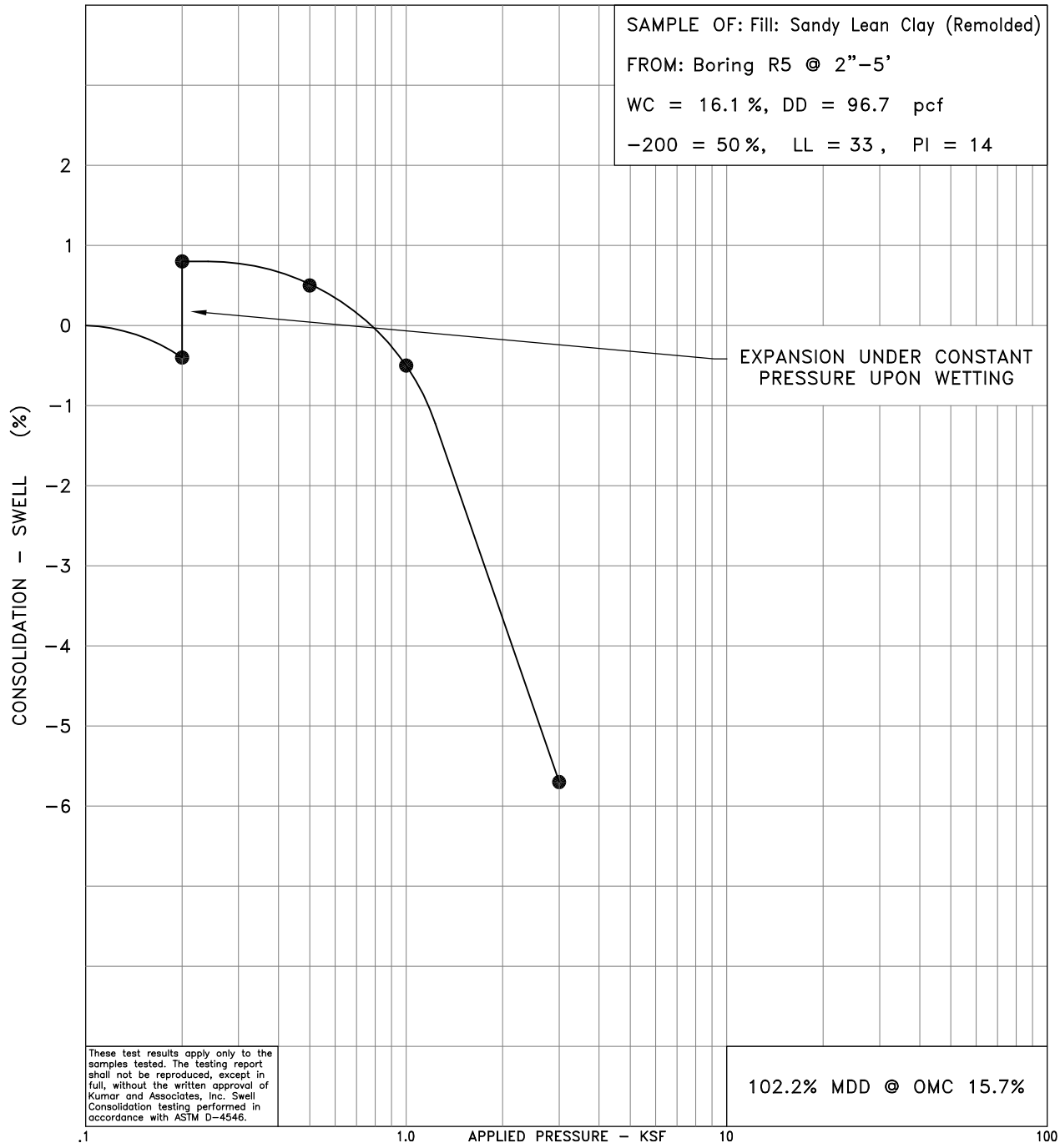


17-2-183A	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 24

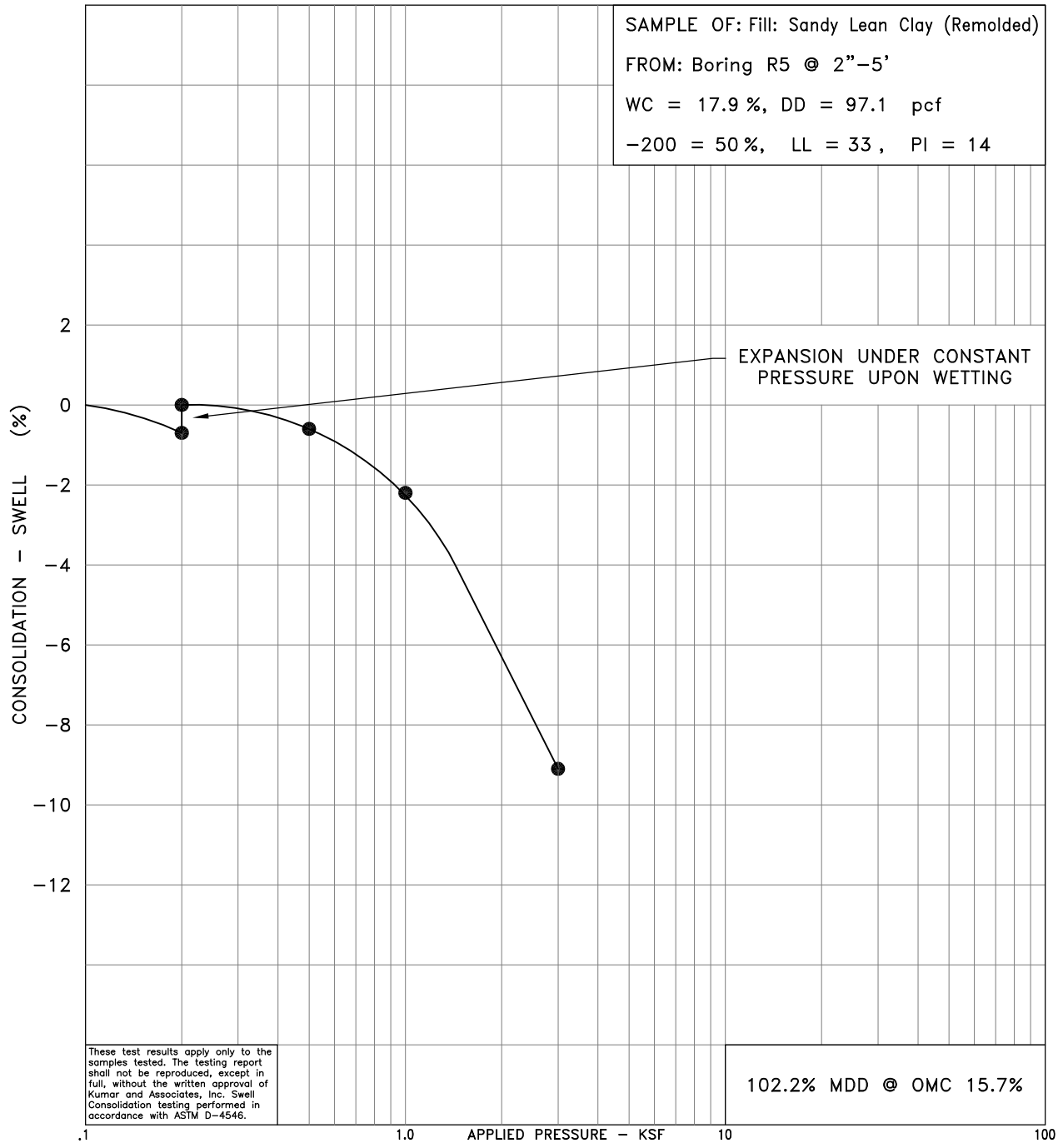




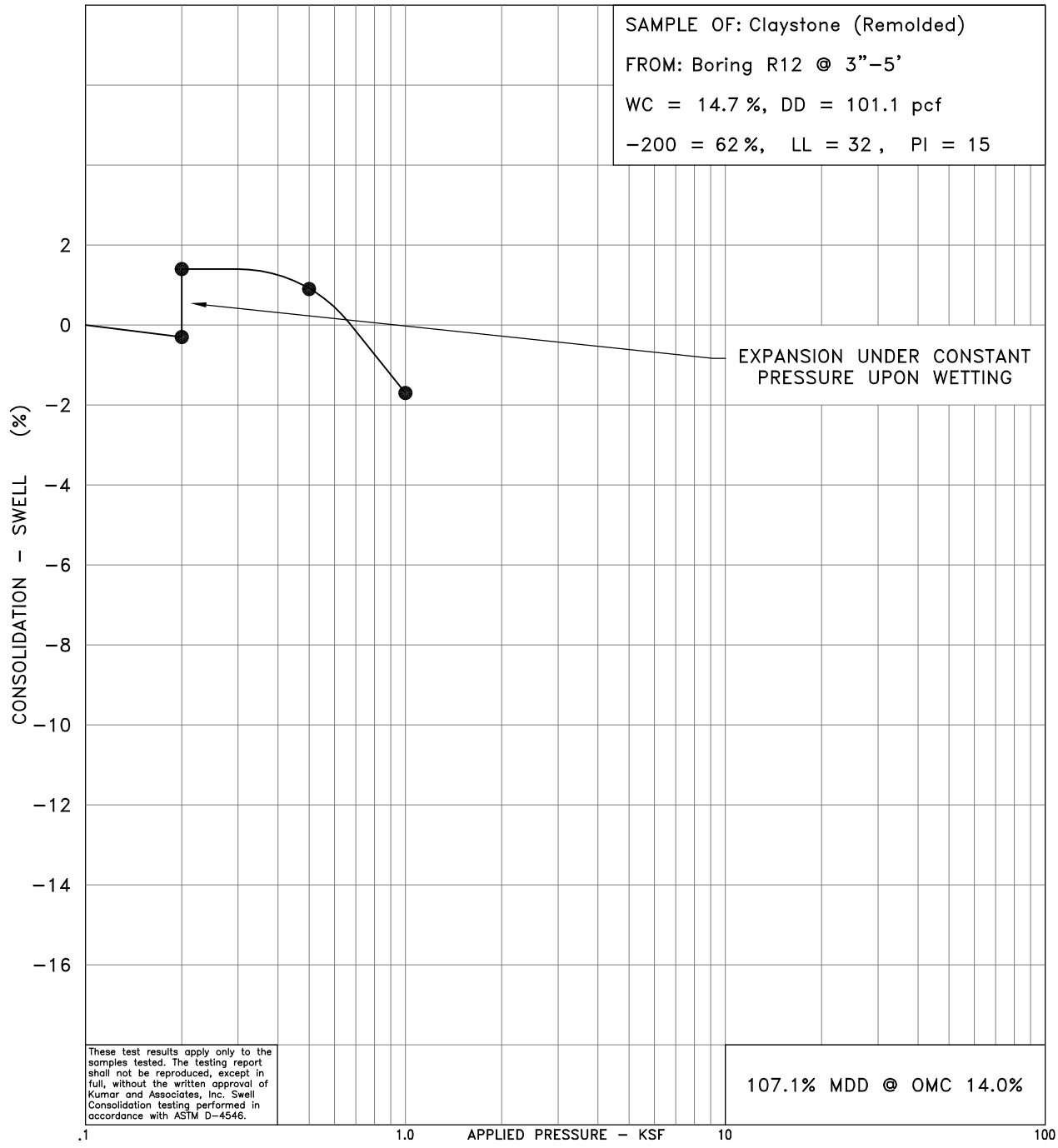
17–2–183A	Kumar & Associates	REMOLDED SWELL–CONSOLIDATION TEST RESULTS	Fig. 25



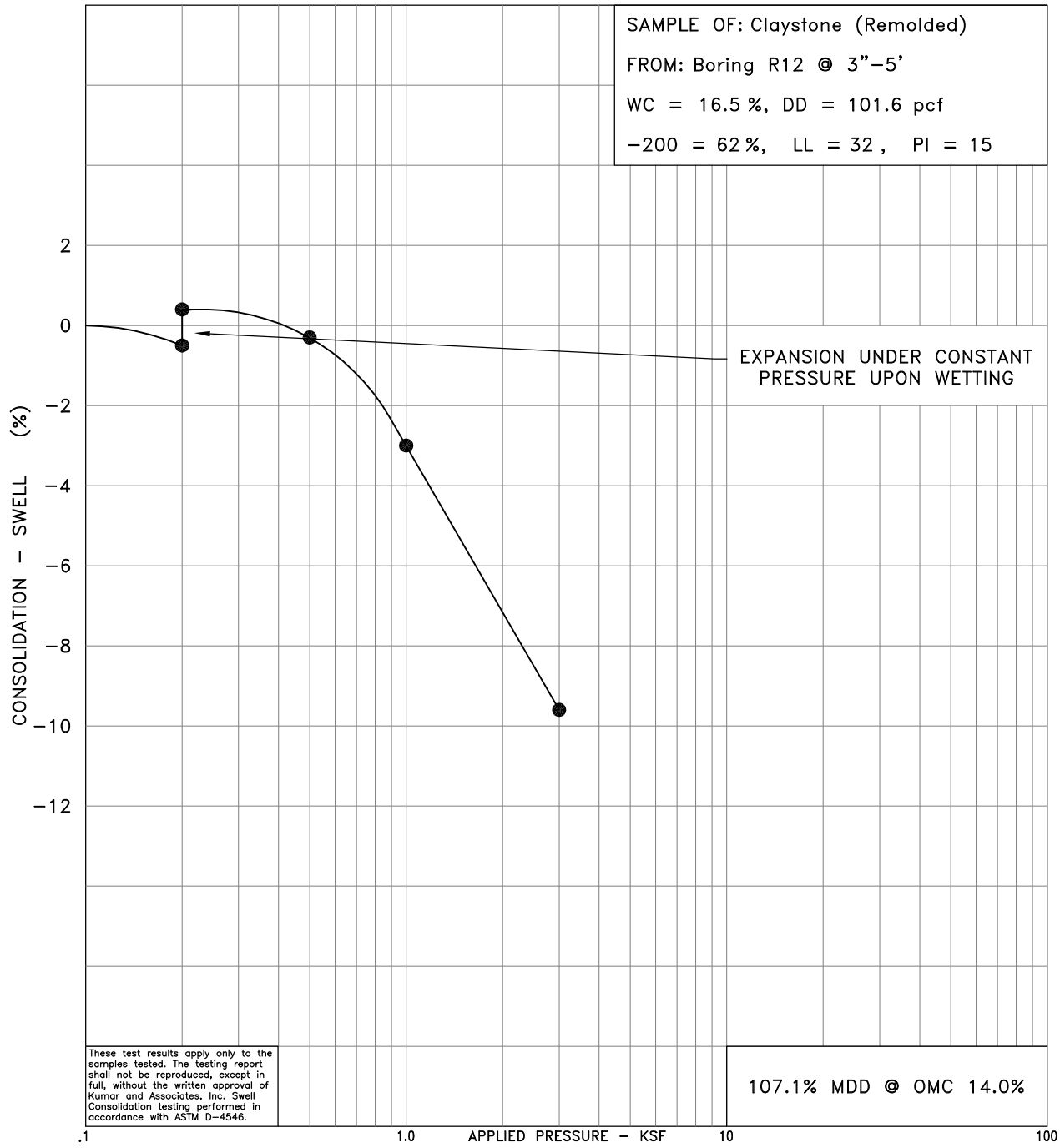
17–2–183A	Kumar & Associates	REMOLDED SWELL–CONSOLIDATION TEST RESULT	Fig. 26



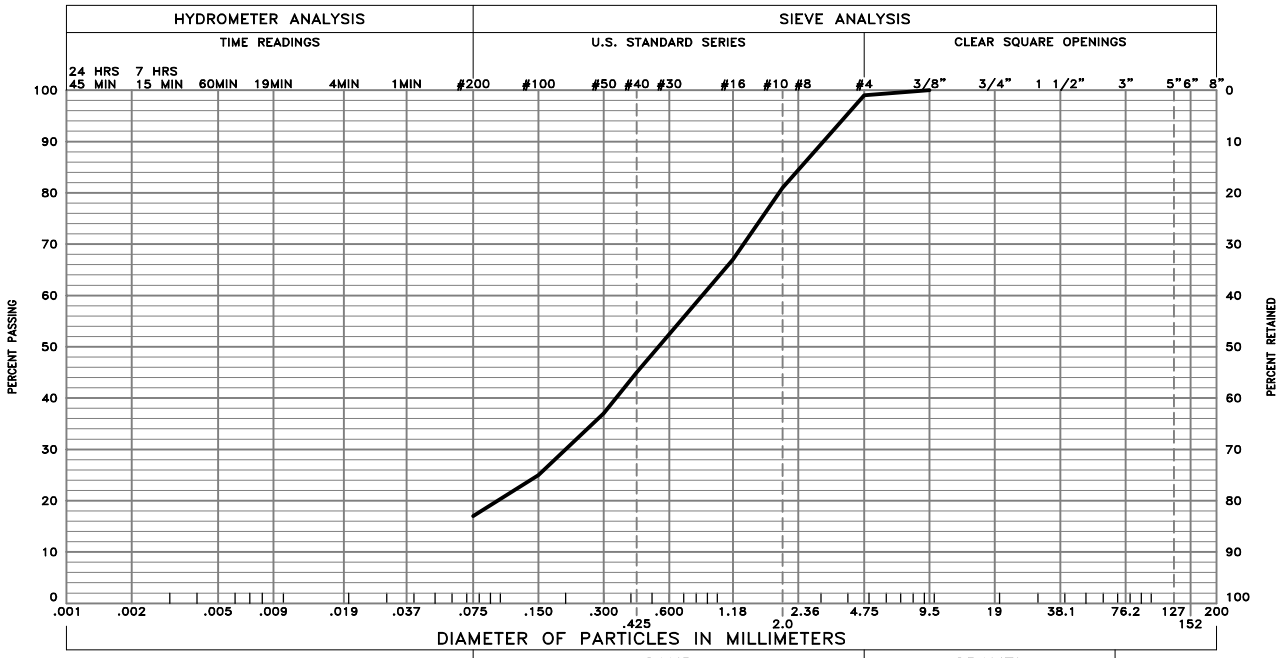
17–2–183A	Kumar & Associates	REMOLDED SWELL–CONSOLIDATION TEST RESULT	Fig. 27



17–2–183A	Kumar & Associates	REMOLDED SWELL–CONSOLIDATION TEST RESULT	Fig. 28



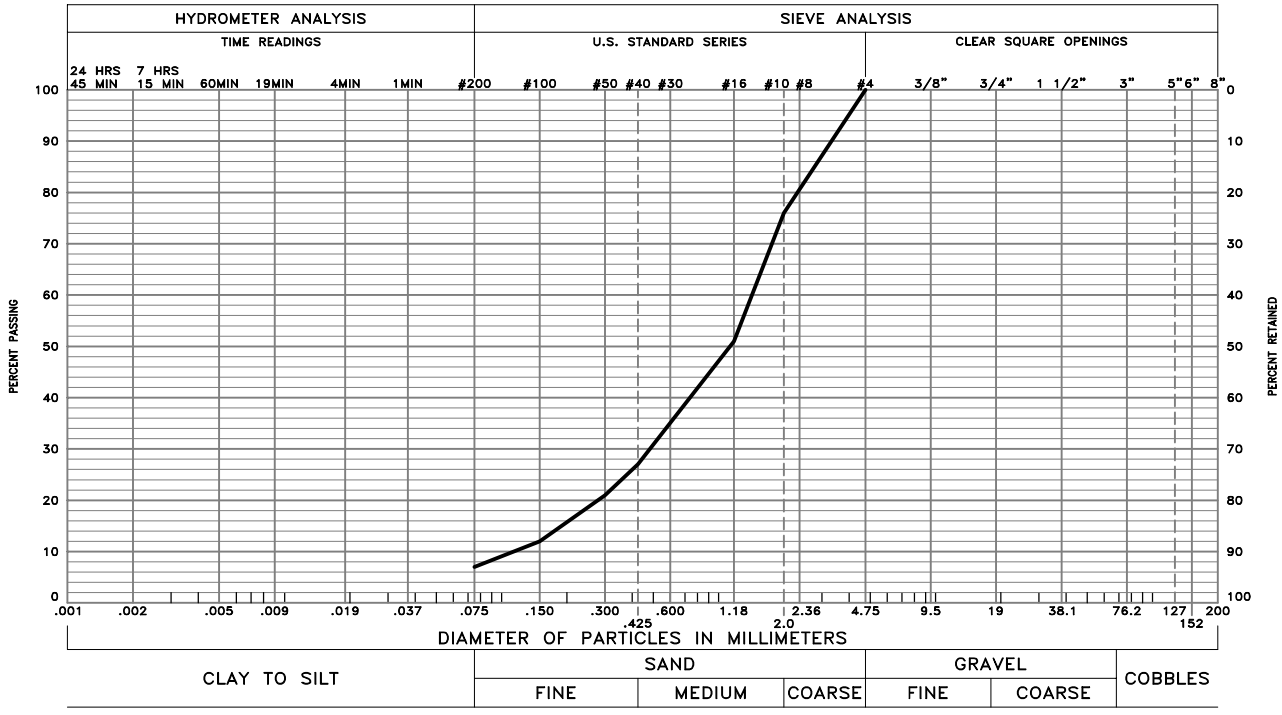
17–2–183A	Kumar & Associates	REMOLDED SWELL–CONSOLIDATION TEST RESULT	Fig. 29



GRAVEL 1 % SAND 82 % SILT AND CLAY 17 %

LIQUID LIMIT 26 PLASTICITY INDEX 7

SAMPLE OF: Fill: Silty Clayey Sand (SCSM) FROM: Boring S1 @ 2'

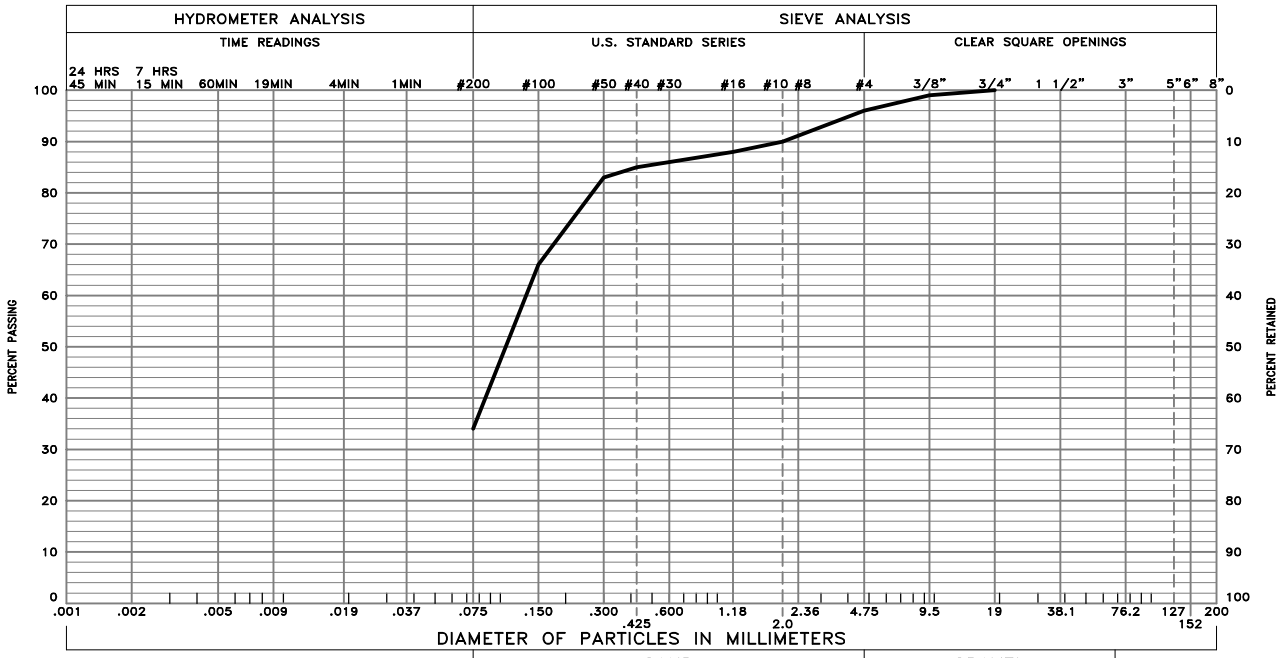


GRAVEL 0 % SAND 93 % SILT AND CLAY 7 %

LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Sandstone FROM: Boring S1 @ 24'

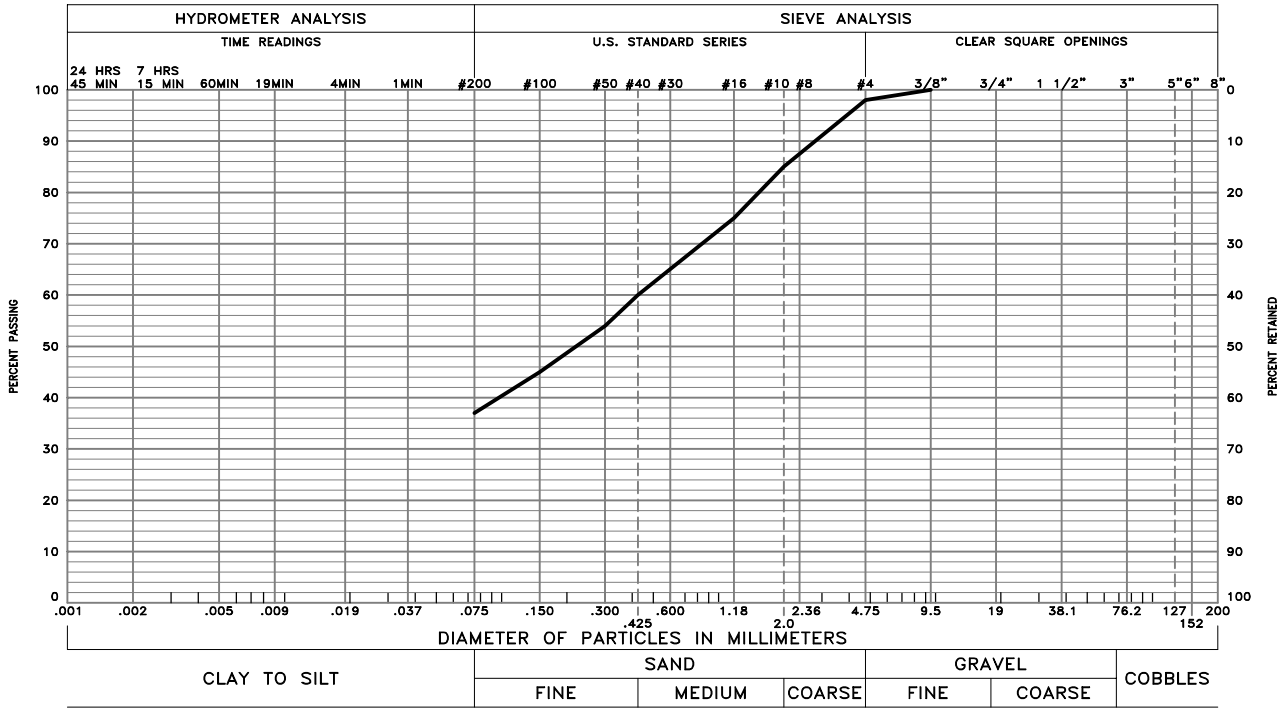
17-2-183A	Kumar & Associates	GRADATION TEST RESULTS	Fig. 30



GRAVEL 4 % SAND 62 % SILT AND CLAY 34 %

LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Silty Sand (SM) FROM: Boring S2 @ 4'

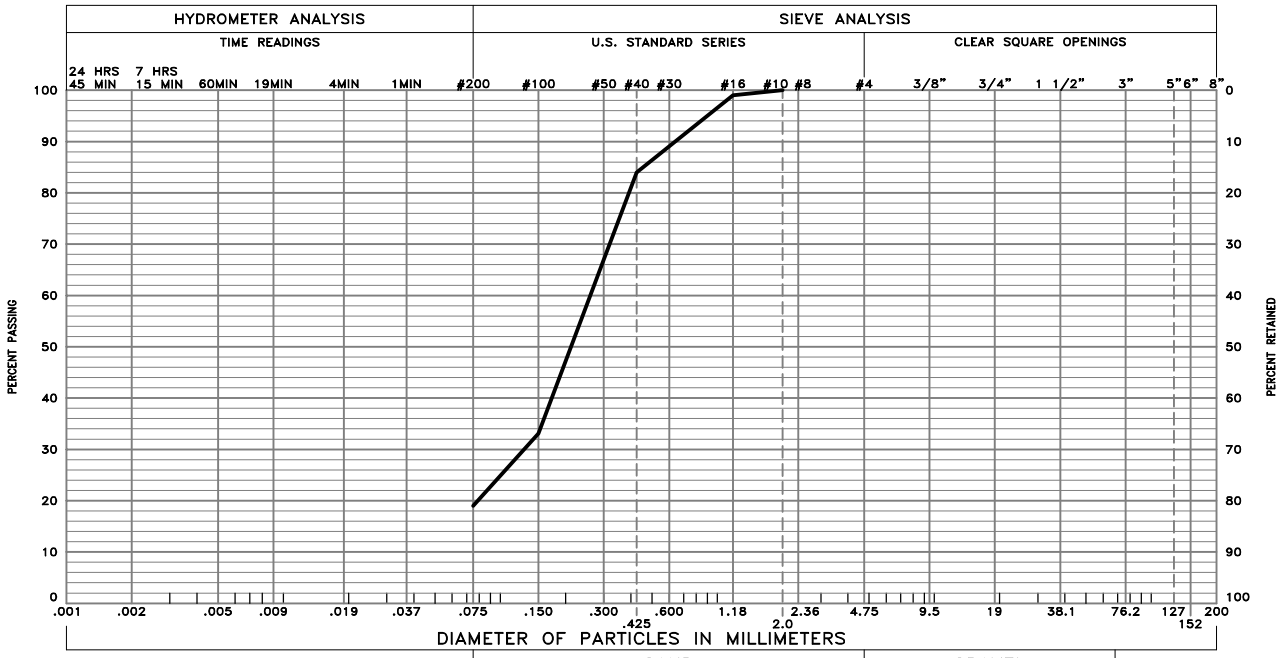


GRAVEL 2 % SAND 61 % SILT AND CLAY 37 %

LIQUID LIMIT 32 PLASTICITY INDEX 16

SAMPLE OF: Fill: Clayey Sand (SC) FROM: Boring S4 @ 4'

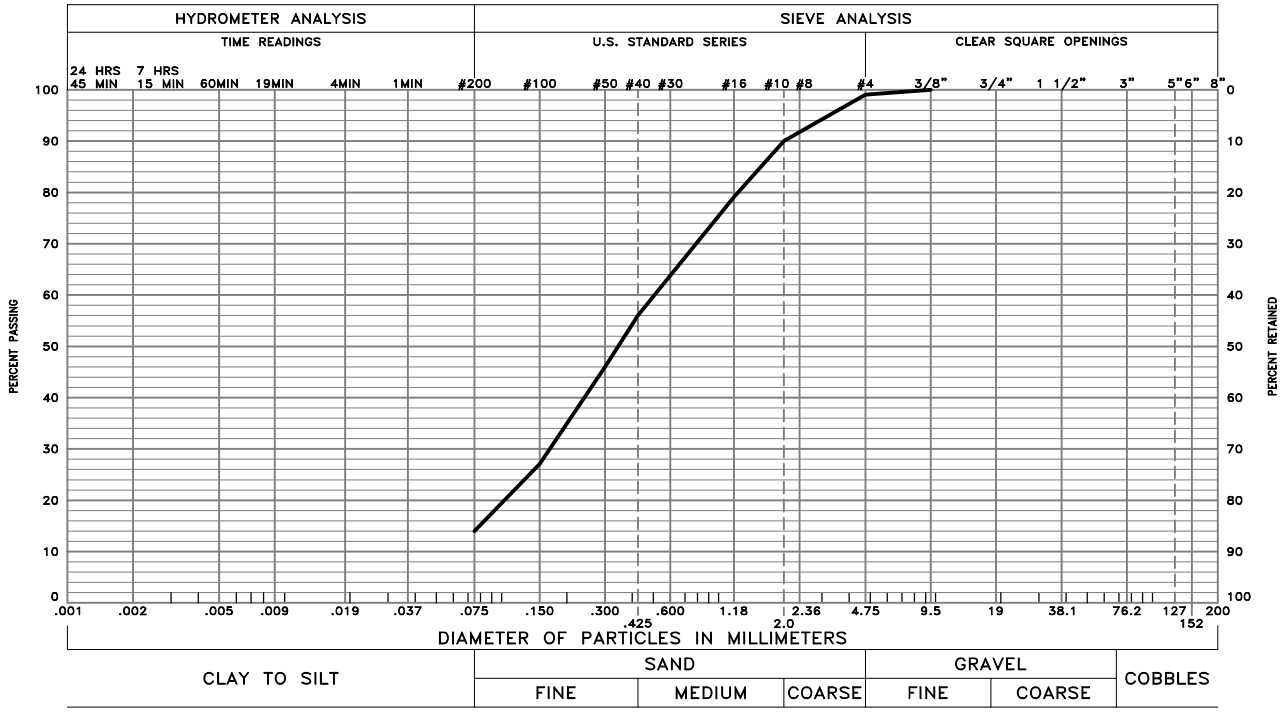
17-2-183A	Kumar & Associates	GRADATION TEST RESULTS	Fig. 31



GRAVEL 0 % SAND 81 % SILT AND CLAY 19 %

LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Sandstone FROM: Boring S2A @ 14'

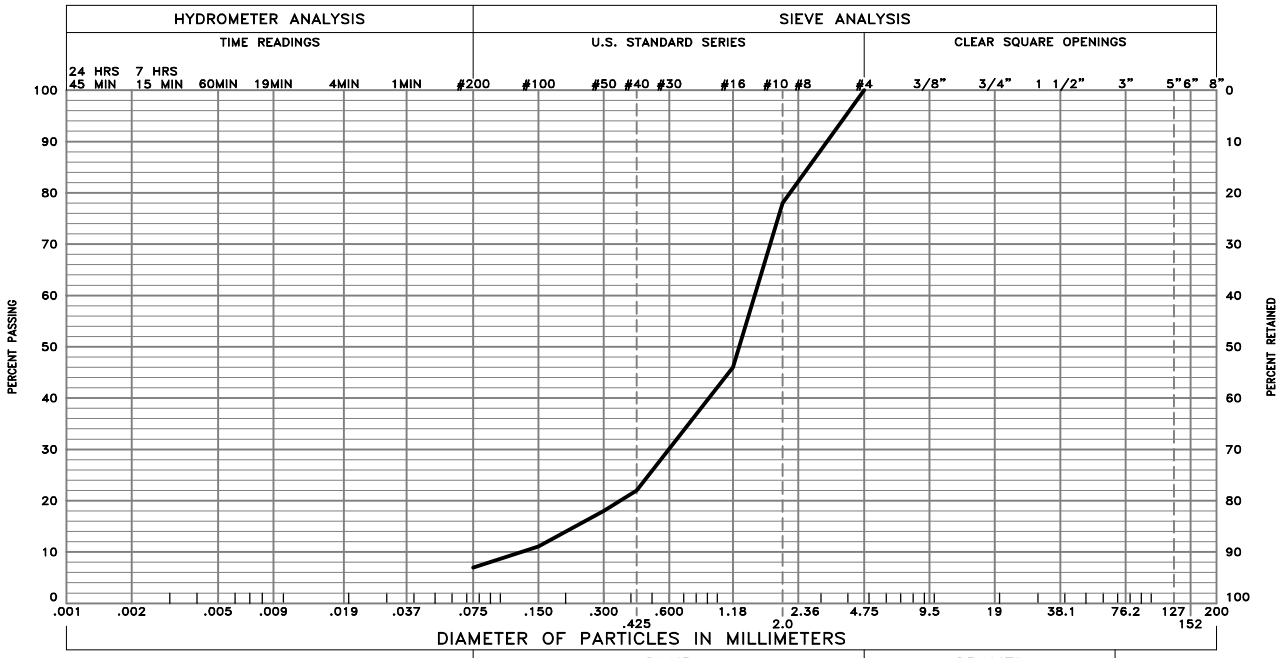


GRAVEL 1 % SAND 85 % SILT AND CLAY 14 %

LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Silty Sand (SM) FROM: Boring W1 @ 4'

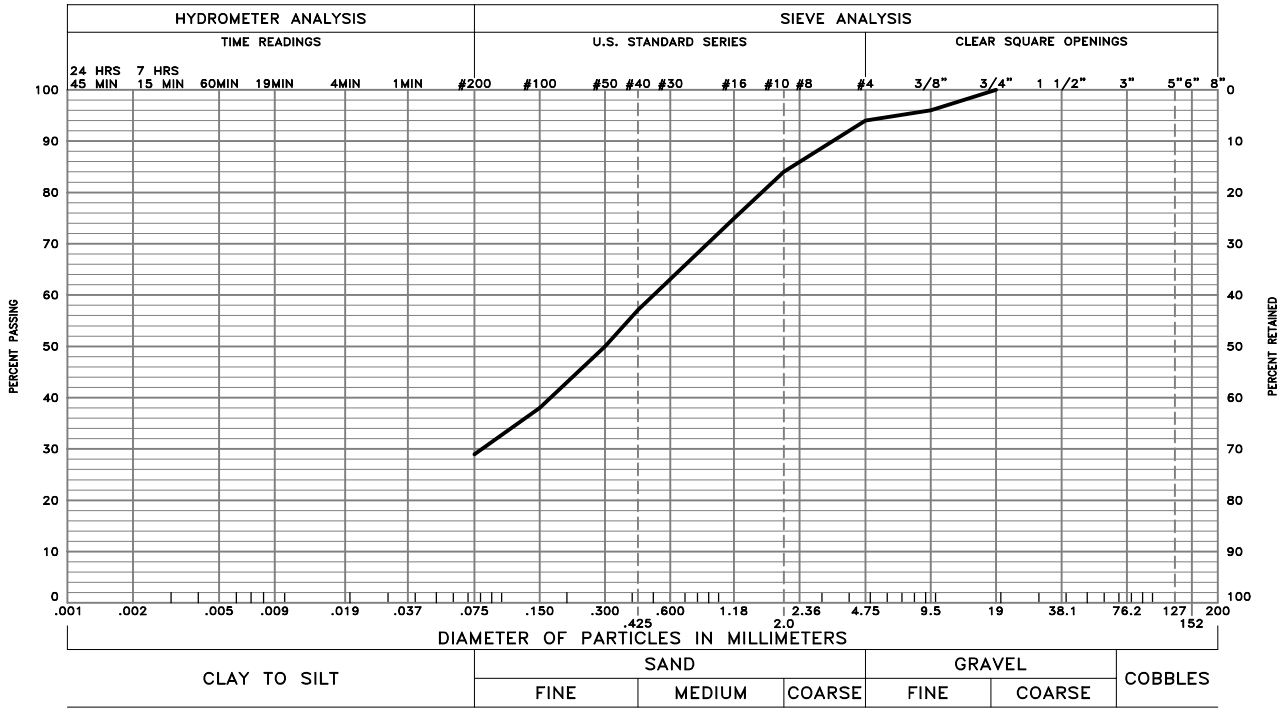
17-2-183A	Kumar & Associates	GRADATION TEST RESULTS	Fig. 32



GRAVEL 0 % SAND 93 % SILT AND CLAY 7 %

LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Well Graded Sand with Silt (SW–SM) FROM: Boring W2 @ 2'

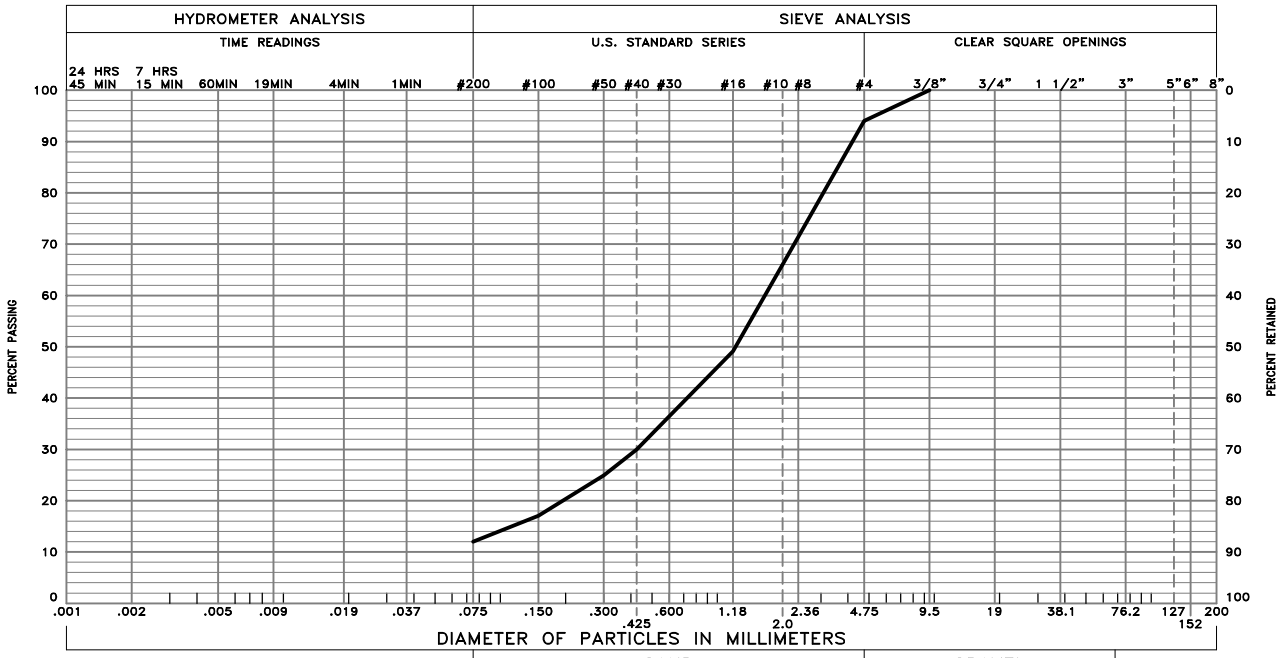


GRAVEL 6 % SAND 65 % SILT AND CLAY 29 %

LIQUID LIMIT 33 PLASTICITY INDEX 16

SAMPLE OF: Fill: Clayey Sand (SC) FROM: Boring W3 @ 4'

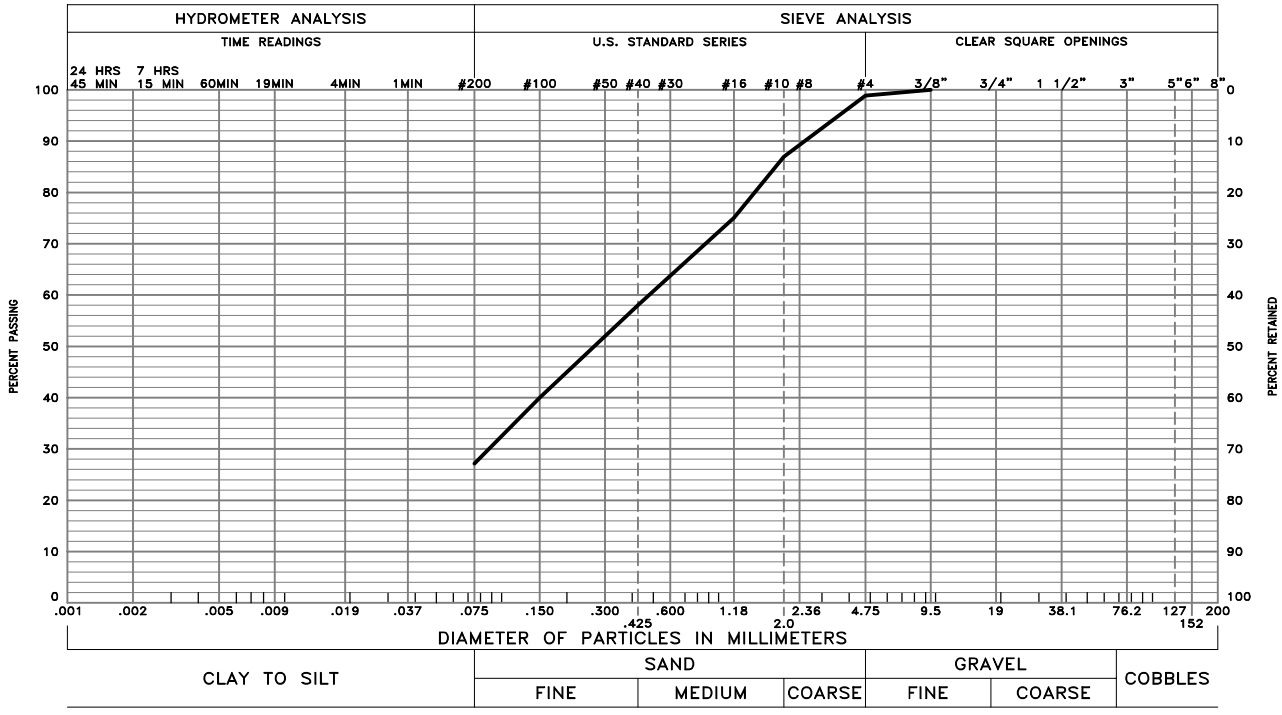
17-2-183A	Kumar & Associates	GRADATION TEST RESULTS	Fig. 33



GRAVEL 6 % SAND 82 % SILT AND CLAY 12 %

LIQUID LIMIT 26 PLASTICITY INDEX 6

SAMPLE OF: Sandstone FROM: Boring W4 @ 9'

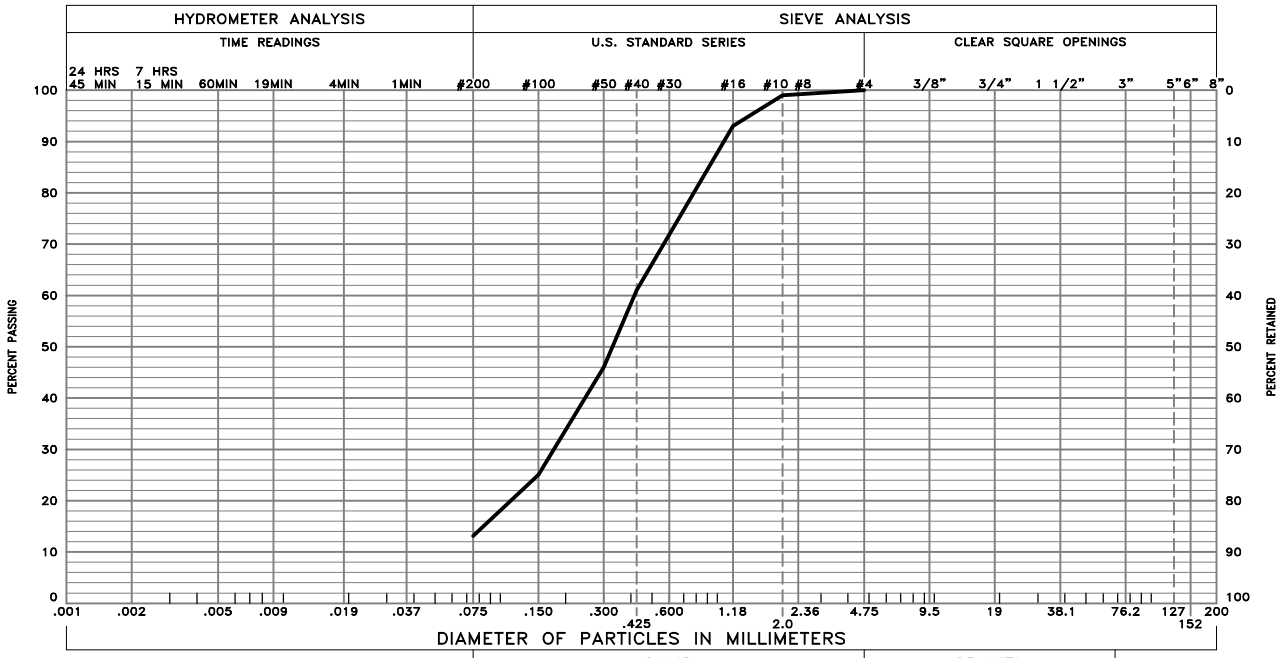


GRAVEL 1 % SAND 72 % SILT AND CLAY 27 %

LIQUID LIMIT 28 PLASTICITY INDEX 9

SAMPLE OF: Clayey Sand (SC) FROM: Boring SW1 @ 4'

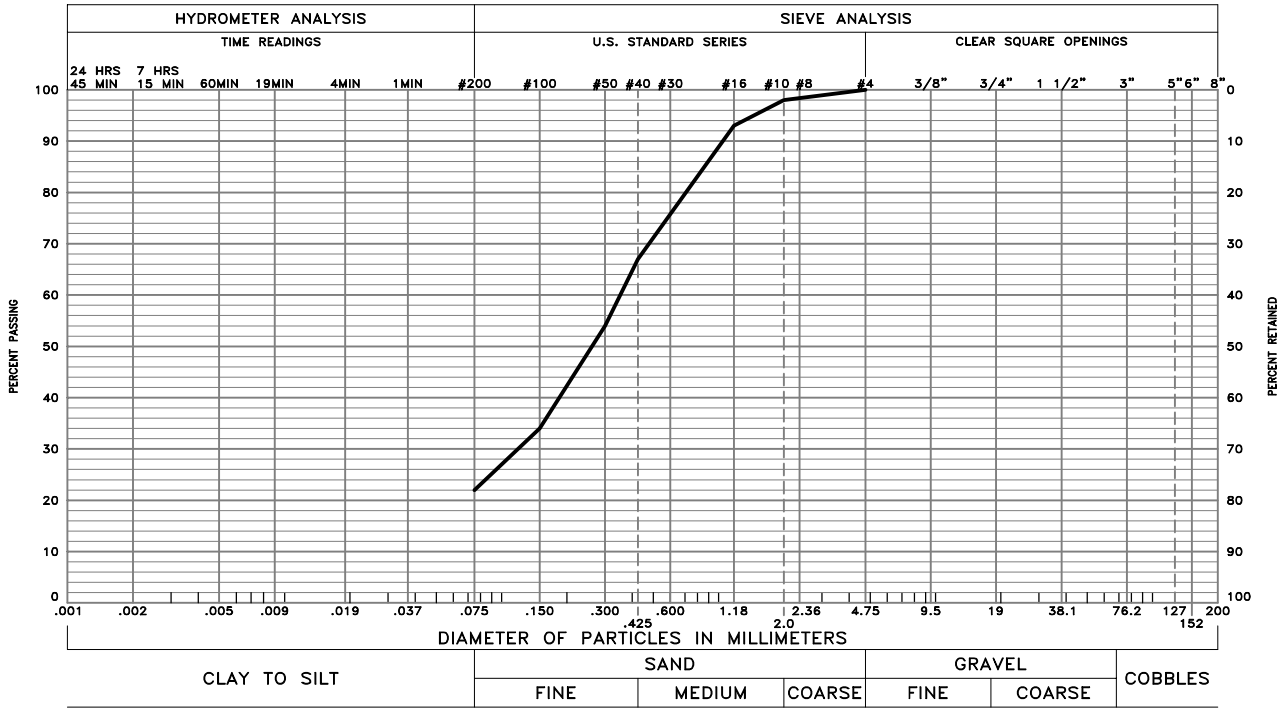
17-2-183A	Kumar & Associates	GRADATION TEST RESULTS	Fig. 34



GRAVEL 0 % SAND 87 % SILT AND CLAY 13 %

LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Sandstone FROM: Boring SW2 @ 19'

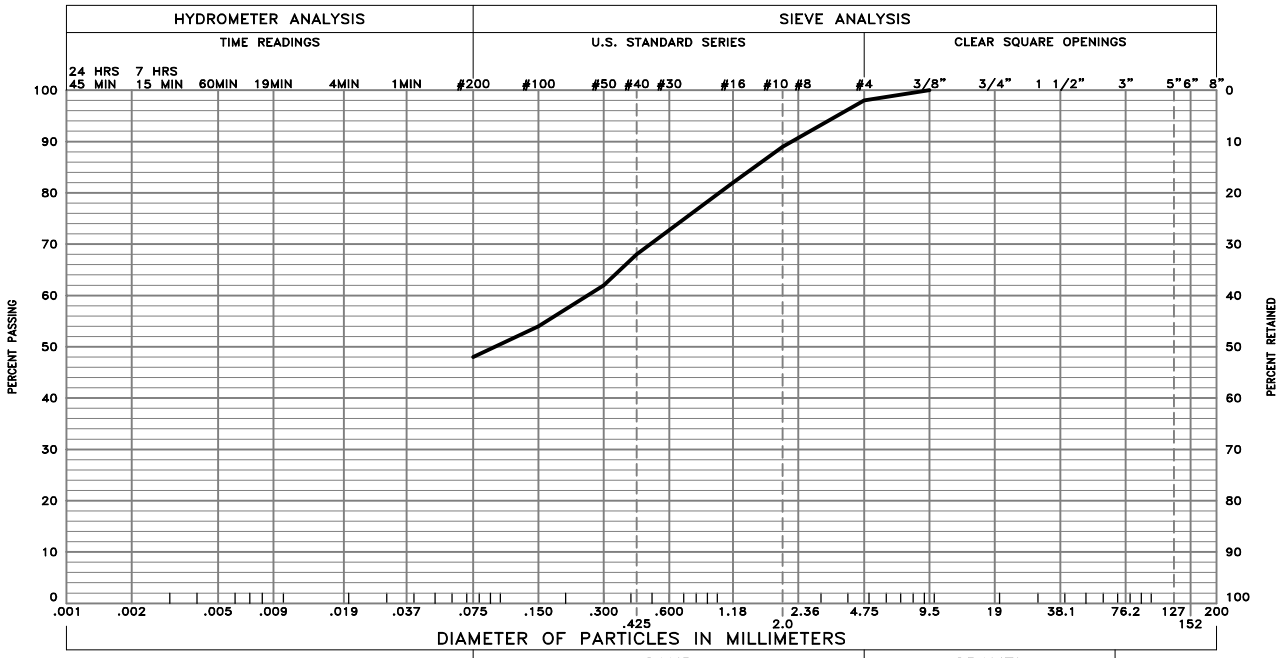


GRAVEL 0 % SAND 78 % SILT AND CLAY 22 %

LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Silty Sand (SM) FROM: Boring SW5 @ 4'

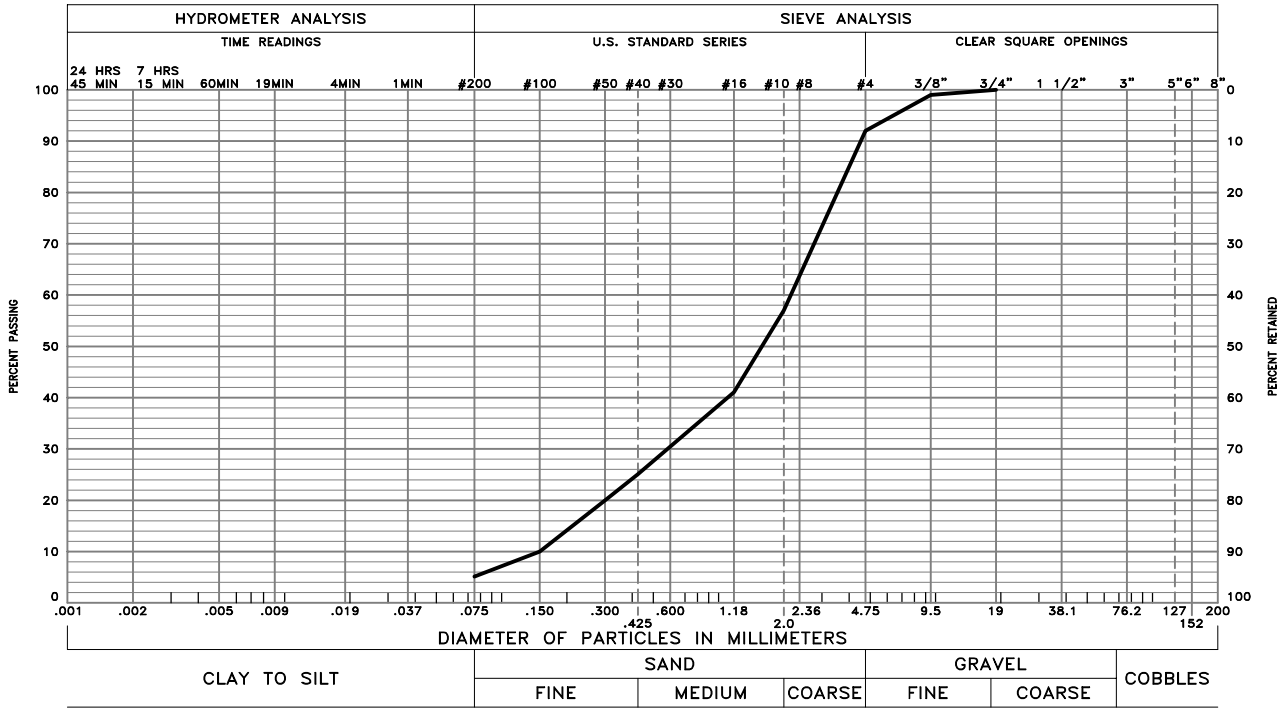
17-2-183A	Kumar & Associates	GRADATION TEST RESULTS	Fig. 35



GRAVEL 2 % SAND 50 % SILT AND CLAY 48 %

LIQUID LIMIT 34 PLASTICITY INDEX 17

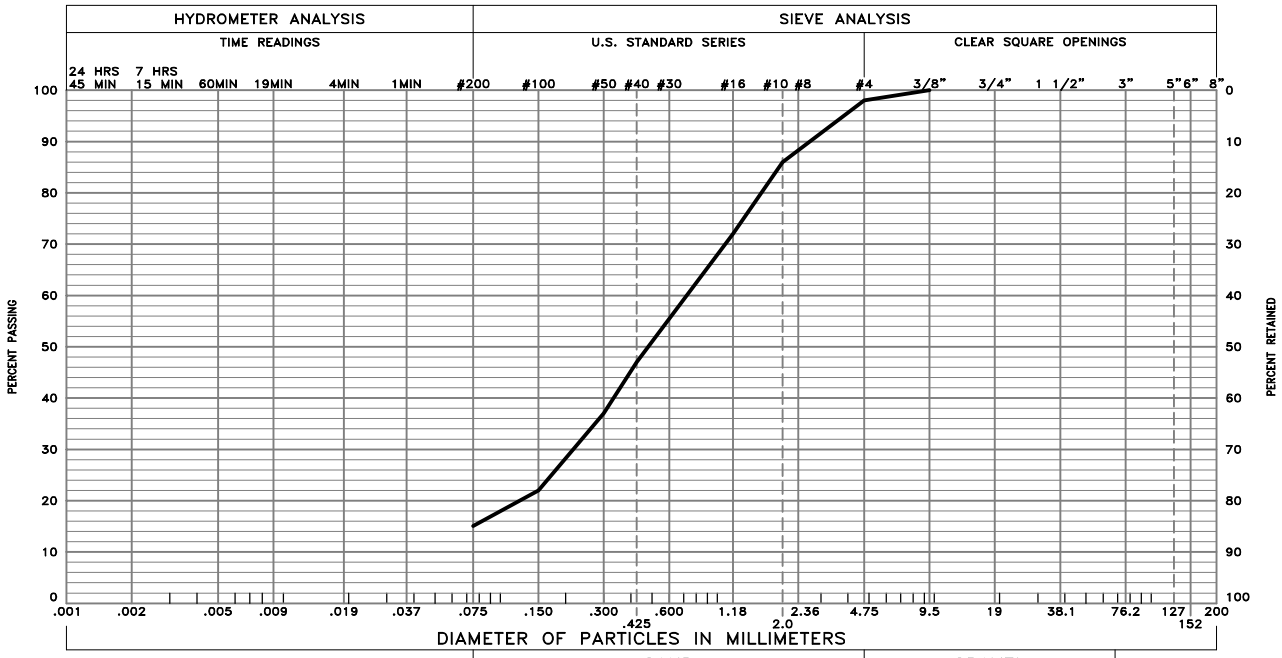
SAMPLE OF: Fill: Clayey Sand (SC) FROM: Boring SW11 @ 4'



GRAVEL 8 % SAND 87 % SILT AND CLAY 5 %

LIQUID LIMIT PLASTICITY INDEX NP

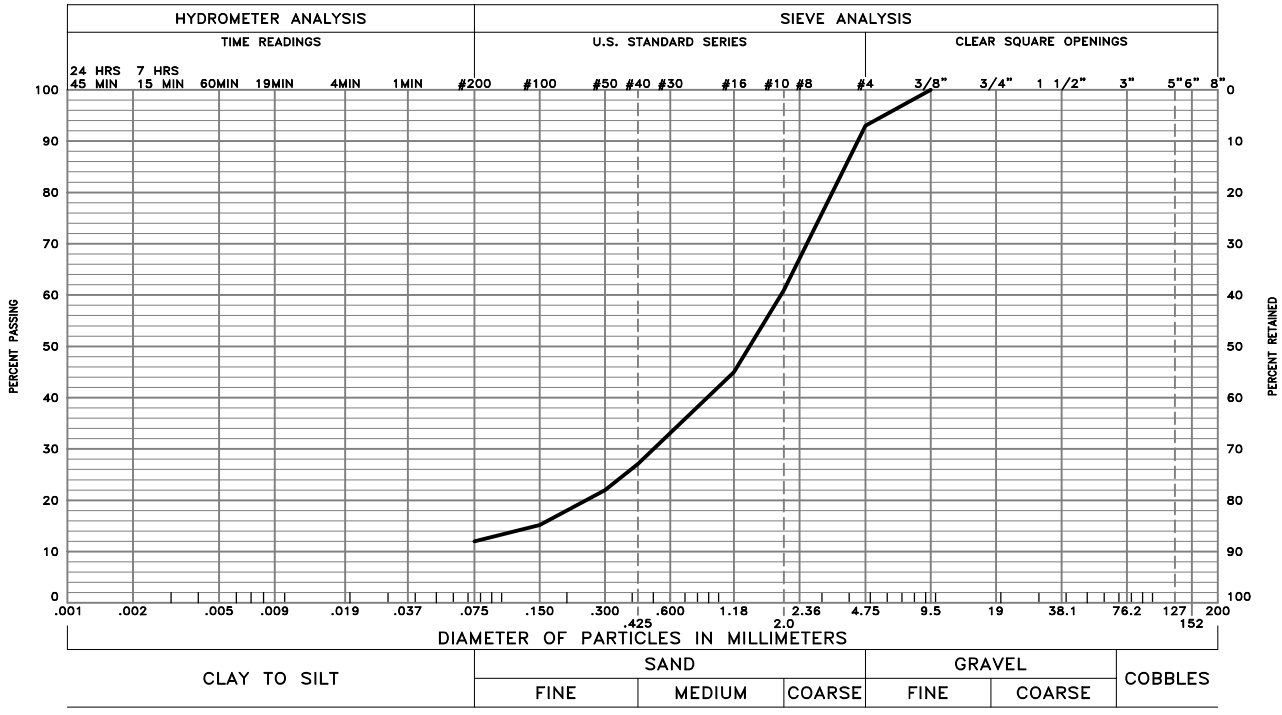
SAMPLE OF: Well Graded Sand with Silt (SW-SM) FROM: Boring SW13 @ 9'



GRAVEL 2 % SAND 83 % SILT AND CLAY 15 %

LIQUID LIMIT 18 PLASTICITY INDEX 2

SAMPLE OF: Silty Sand (SM) FROM: Boring SW14 @ 9'

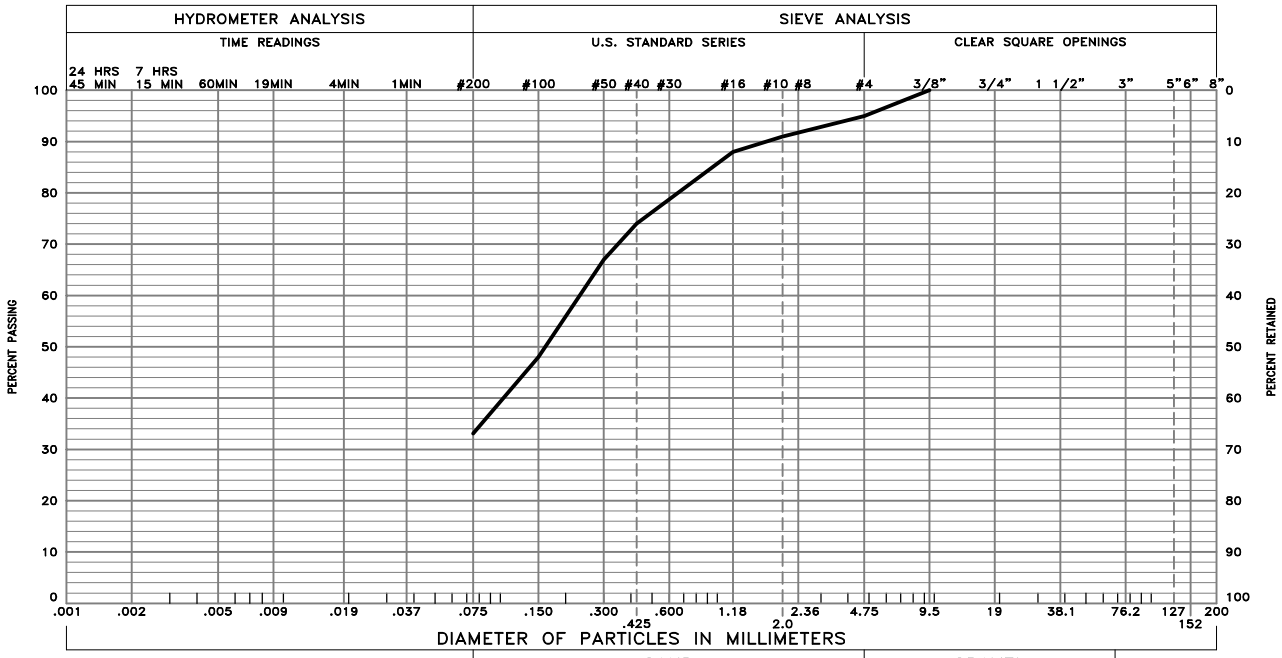


GRAVEL 7 % SAND 81 % SILT AND CLAY 12 %

LIQUID LIMIT 26 PLASTICITY INDEX 11

SAMPLE OF: Well Graded Sand with Clay (SW-SC) FROM: Boring SW15 @ 14'

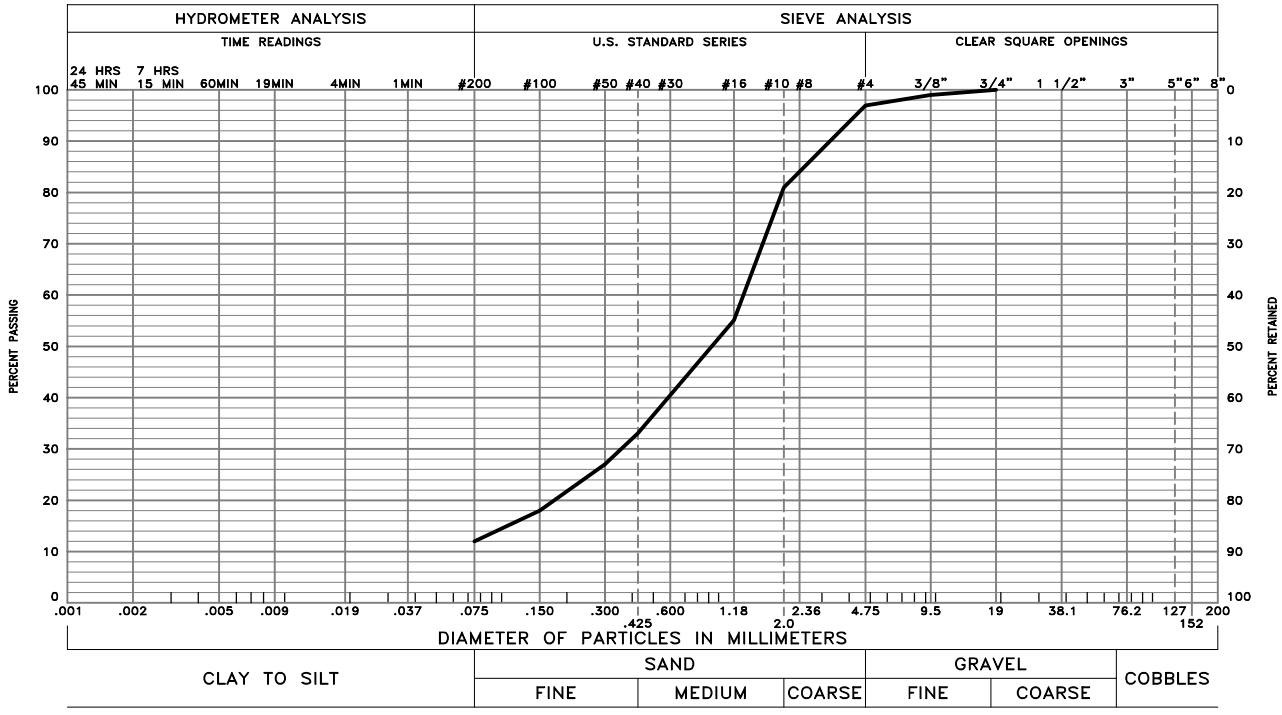
17-2-183A	Kumar & Associates	GRADATION TEST RESULTS	Fig. 37



GRAVEL 5 % SAND 62 % SILT AND CLAY 33 %

LIQUID LIMIT 41 PLASTICITY INDEX 20

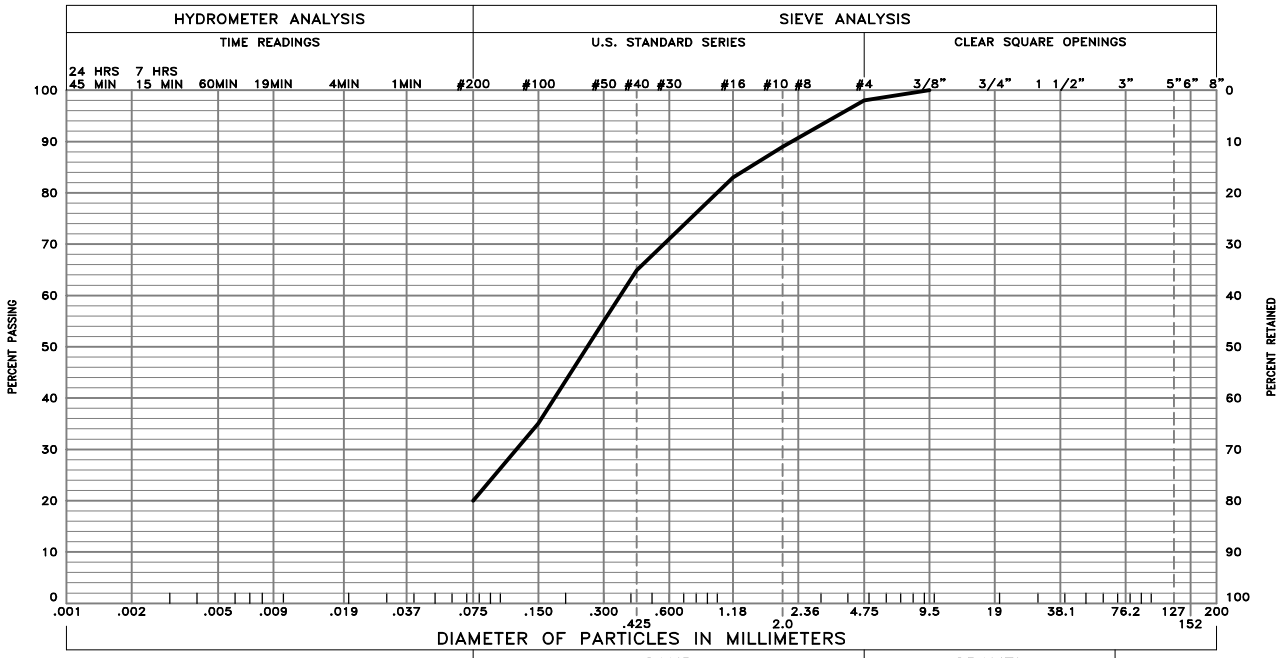
SAMPLE OF: Fill: Clayey Sand (SC) FROM: Boring SW19 @ 4'



GRAVEL 3 % SAND 85 % SILT AND CLAY 12 %

LIQUID LIMIT 25 PLASTICITY INDEX 5

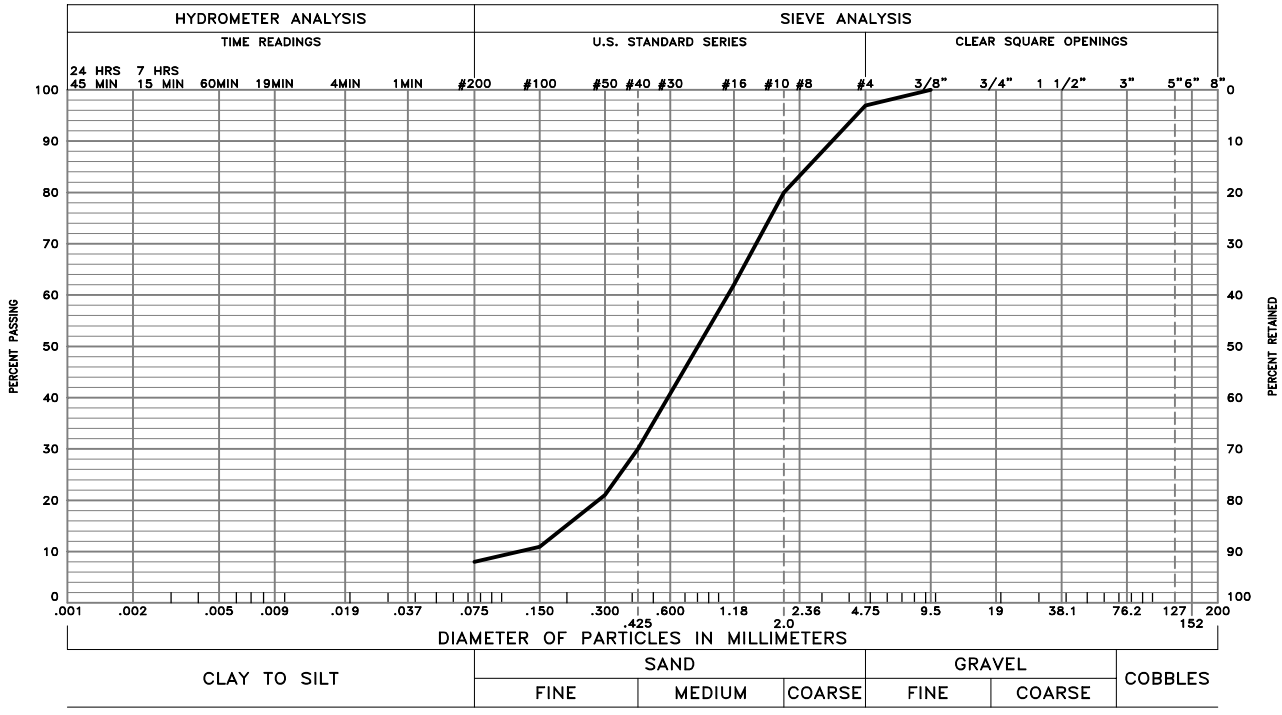
SAMPLE OF: Well Graded Sand with Silty Clay (SW-SC) FROM: Boring SW21 @ 14'



GRAVEL 2 % SAND 78 % SILT AND CLAY 20 %

LIQUID LIMIT 23 PLASTICITY INDEX 4

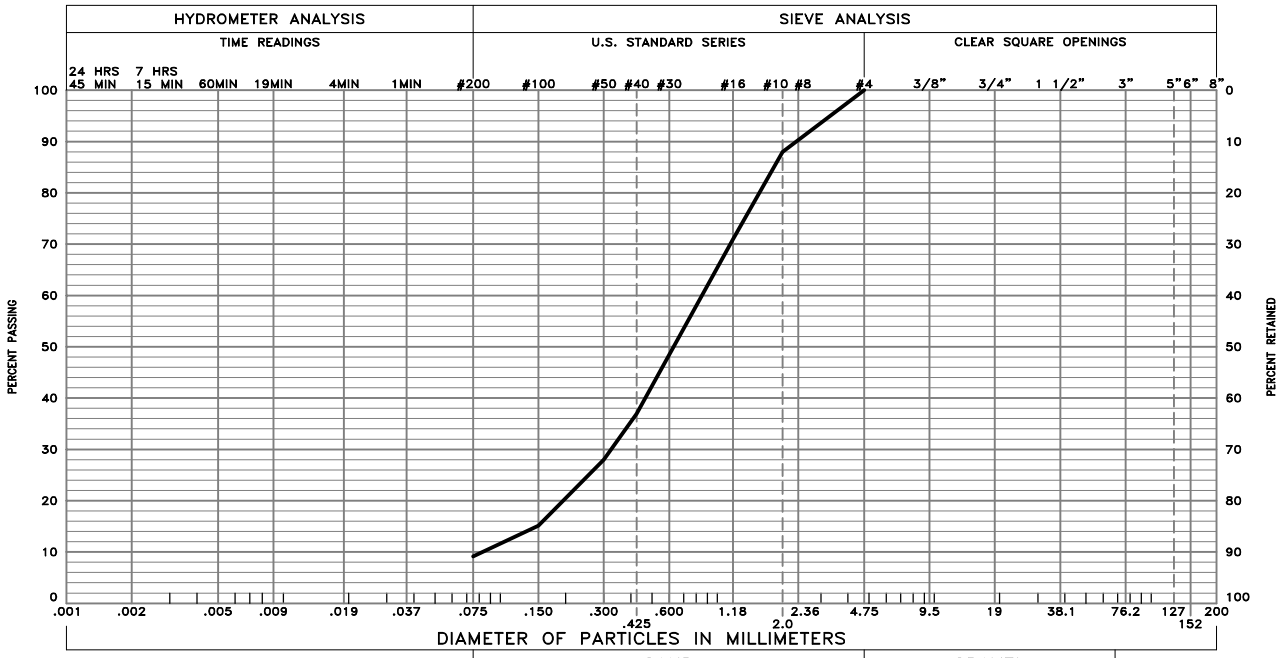
SAMPLE OF: Fill: Silty Clayey Sand (SC-SM) FROM: Boring SW24 @ 2'



GRAVEL 3 % SAND 89 % SILT AND CLAY 8 %

LIQUID LIMIT PLASTICITY INDEX NP

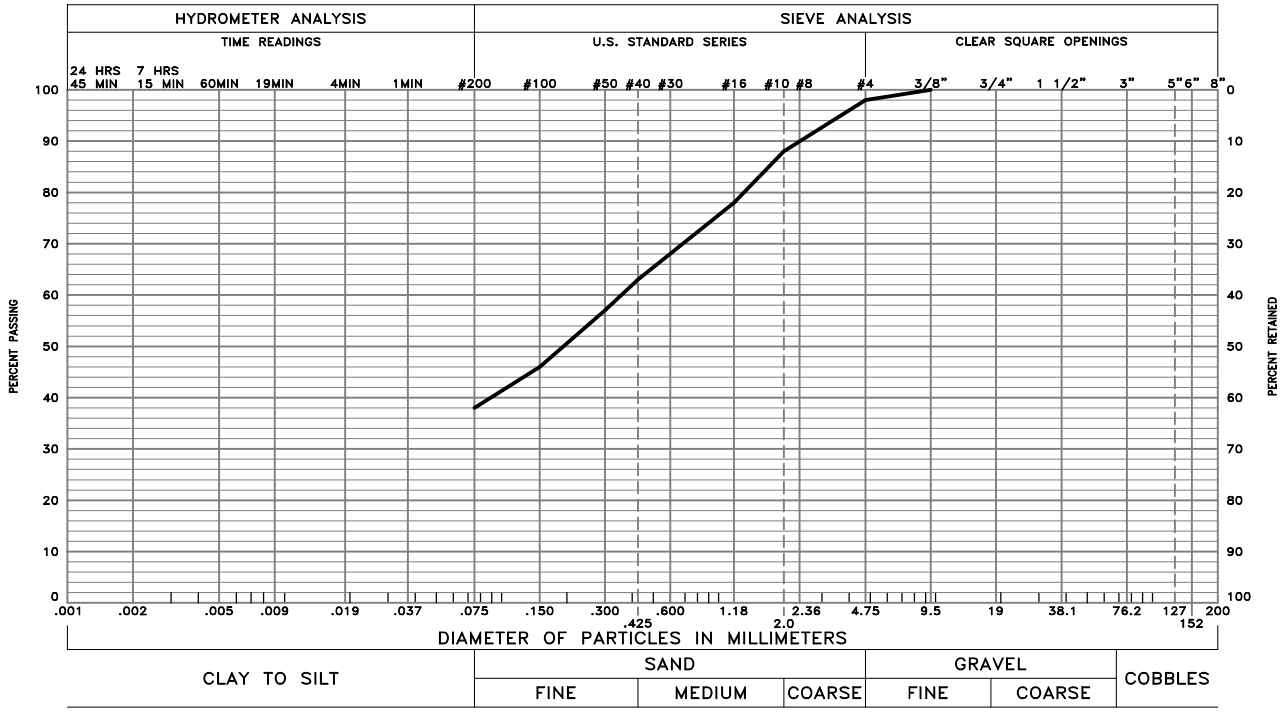
SAMPLE OF: Well Graded Sand with Silt (SW-SM) FROM: Boring D1 @ 4'



GRAVEL 0 % SAND 91 % SILT AND CLAY 9 %

LIQUID LIMIT 32 PLASTICITY INDEX 6

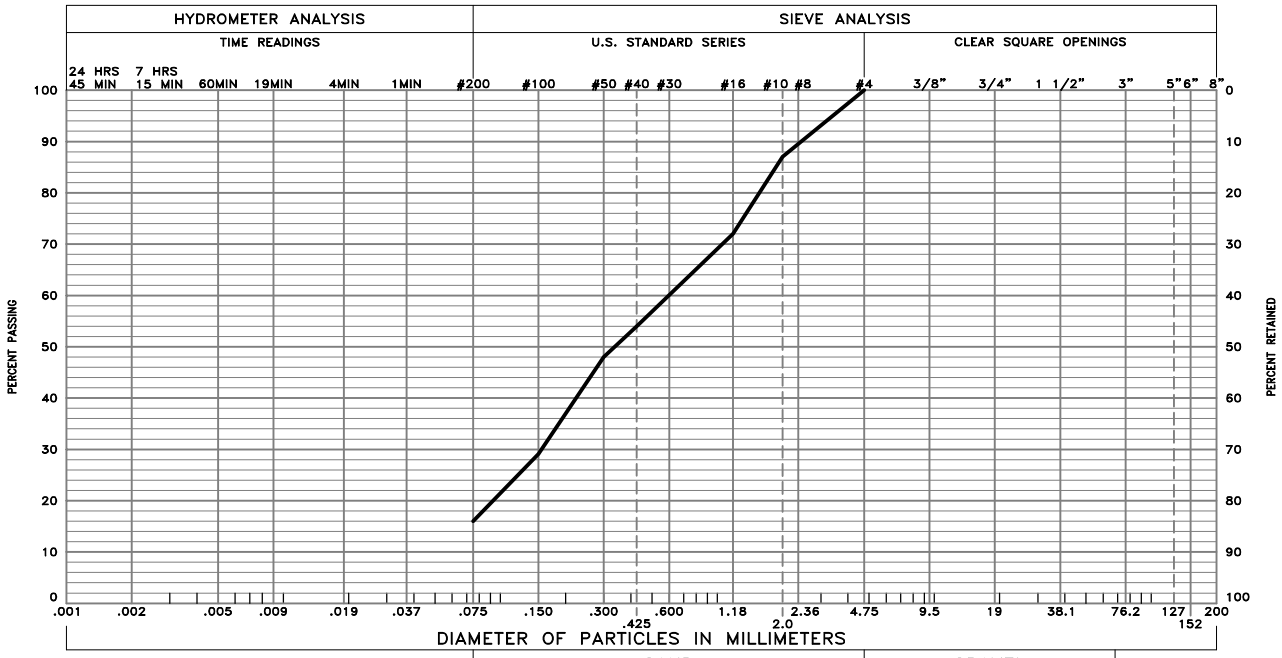
SAMPLE OF: Sandstone FROM: Boring D1 @ 14'



GRAVEL 2 % SAND 60 % SILT AND CLAY 38 %

LIQUID LIMIT 31 PLASTICITY INDEX 14

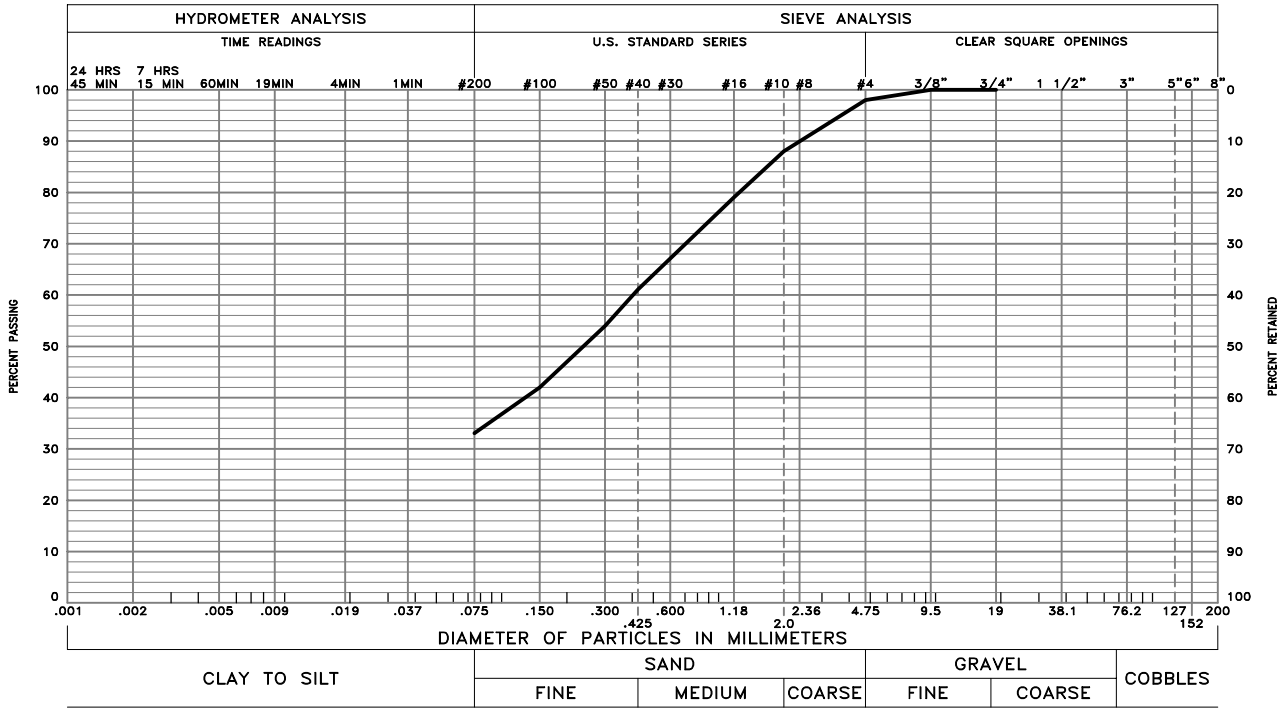
SAMPLE OF: Fill: Clayey Sand (SC) FROM: Boring F1 @ 3"-8'



GRAVEL 0 % SAND 84 % SILT AND CLAY 16 %

LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Sandstone FROM: Boring F1 @ 34'

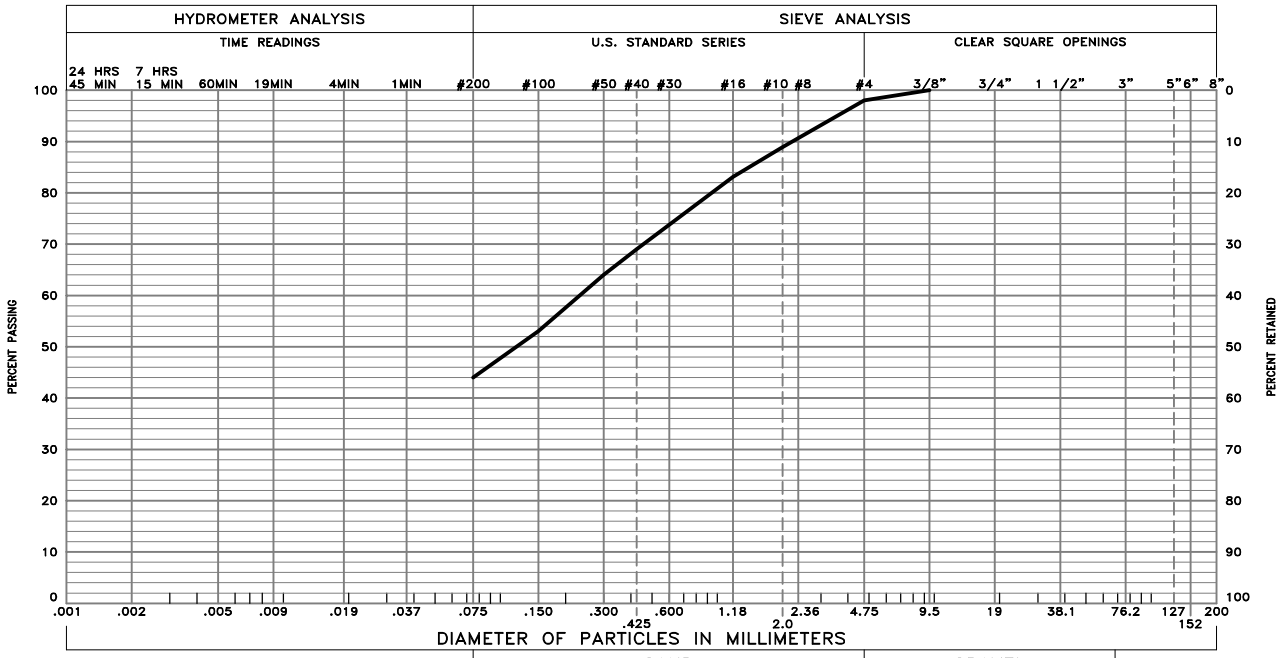


GRAVEL 2 % SAND 65 % SILT AND CLAY 33 %

LIQUID LIMIT 27 PLASTICITY INDEX 11

SAMPLE OF: Fill: Clayey Sand (SC) FROM: Boring F2 @ 3"–20'

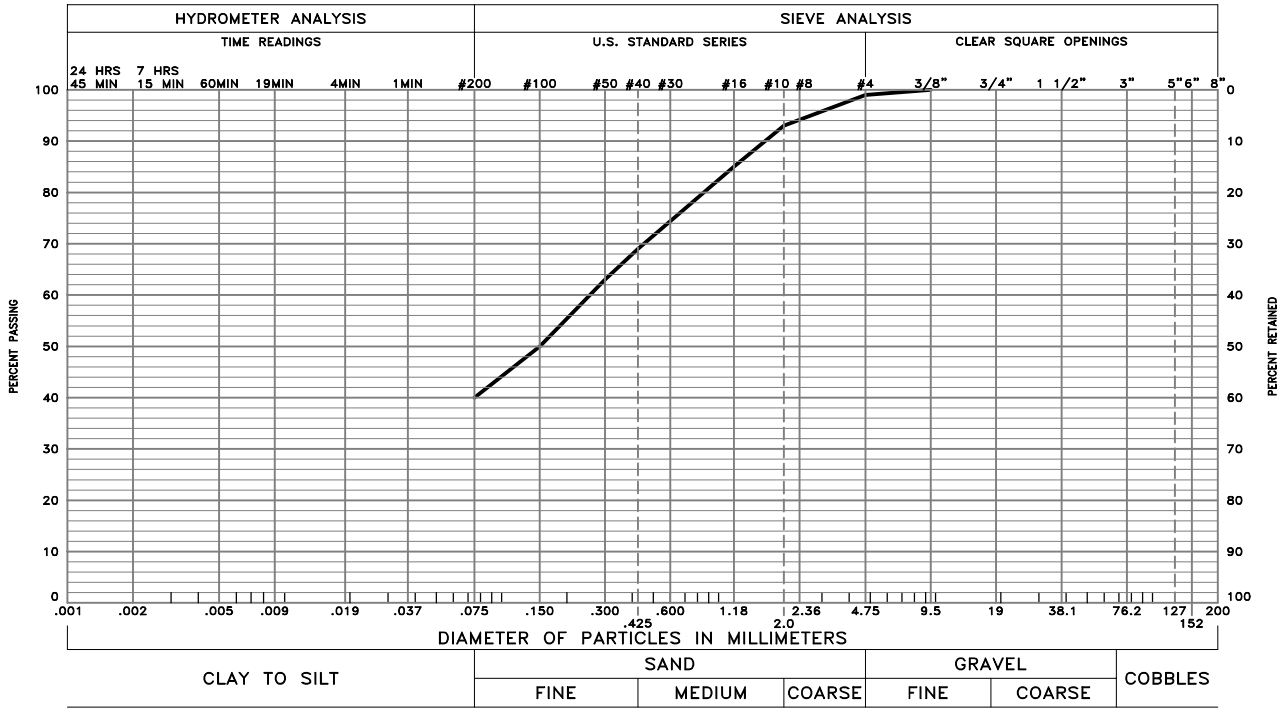
17–2–183A	Kumar & Associates	GRADATION TEST RESULTS	Fig. 41



GRAVEL 2 % SAND 54 % SILT AND CLAY 44 %

LIQUID LIMIT 28 PLASTICITY INDEX 11

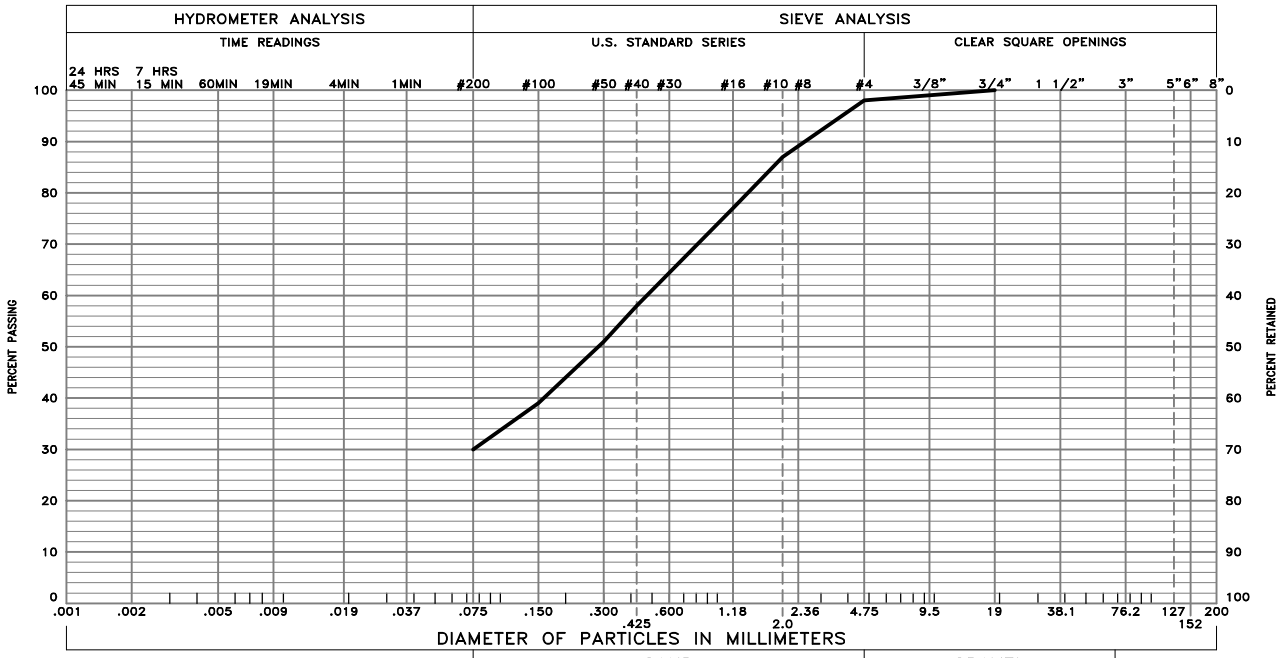
SAMPLE OF: Fill: Clayey Sand (SC) FROM: Boring F3 @ 3"–10'



GRAVEL 1 % SAND 59 % SILT AND CLAY 40 %

LIQUID LIMIT 21 PLASTICITY INDEX 7

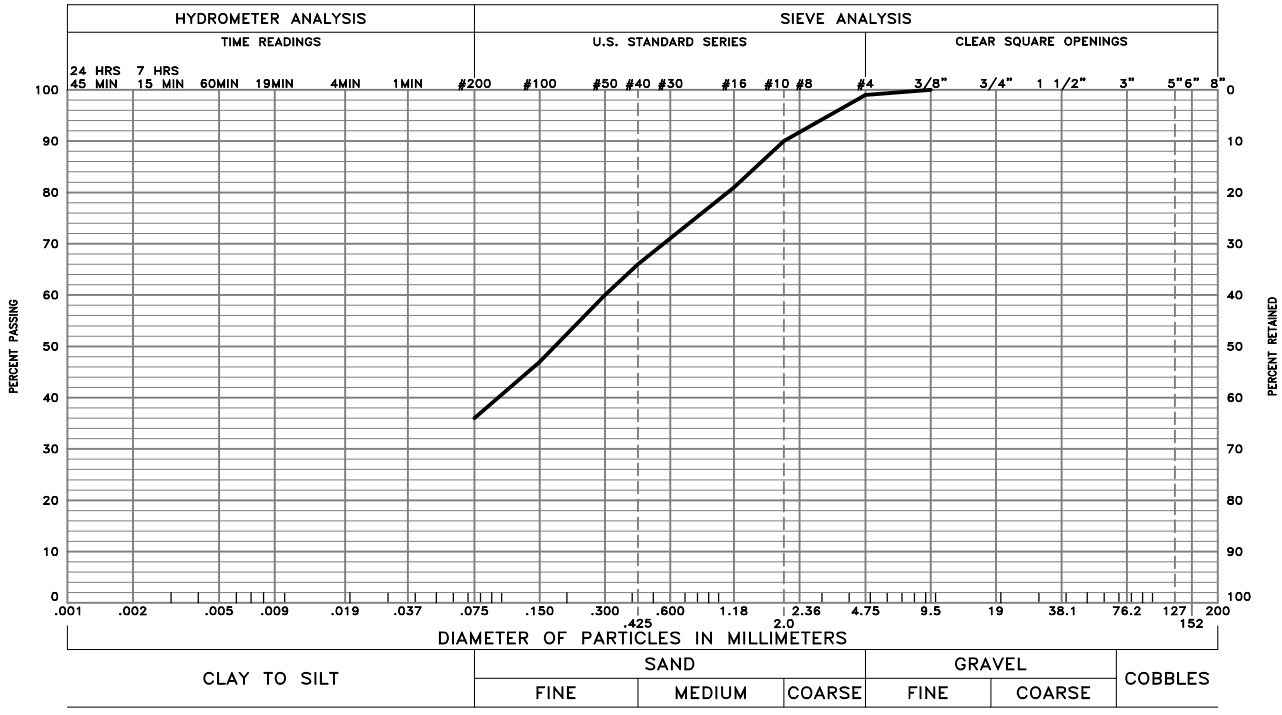
SAMPLE OF: Clayey Sandstone FROM: Boring B1 @ 8"–5'



GRAVEL 2 % SAND 68 % SILT AND CLAY 30 %

LIQUID LIMIT 21 PLASTICITY INDEX 5

SAMPLE OF: Silty Clayey Sand (SC-SM) FROM: Boring B2 @ 10"-5'

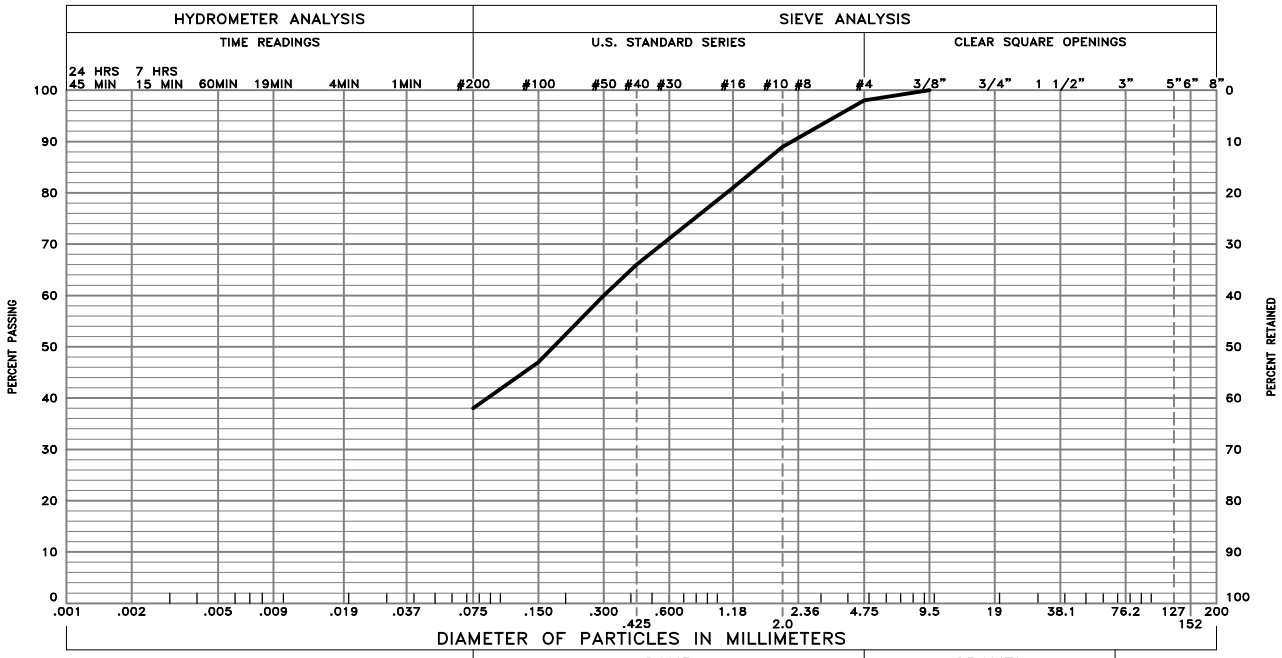


GRAVEL 1 % SAND 63 % SILT AND CLAY 36 %

LIQUID LIMIT 28 PLASTICITY INDEX 10

SAMPLE OF: Clayey Sand (SC) FROM: Boring B3 @ 9"-4'

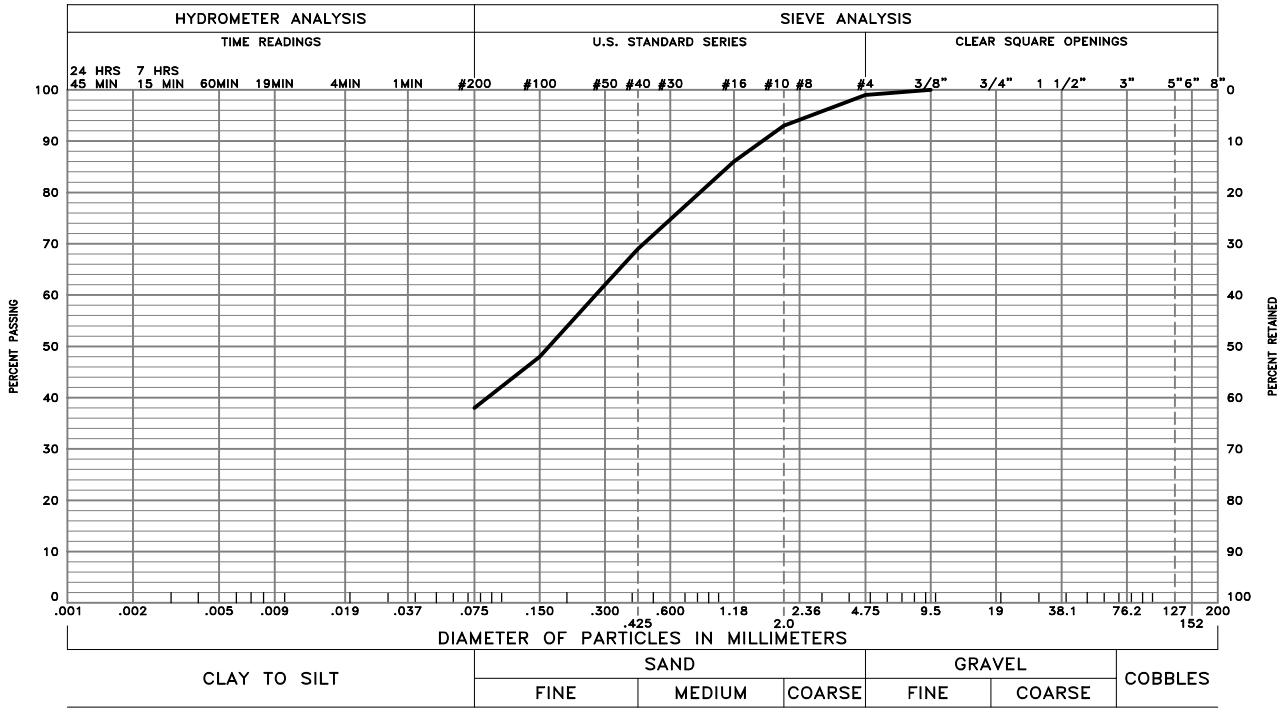
17-2-183A	Kumar & Associates	GRADATION TEST RESULTS	Fig. 43



GRAVEL 2 % SAND 60 % SILT AND CLAY 38 %

LIQUID LIMIT 23 PLASTICITY INDEX 6

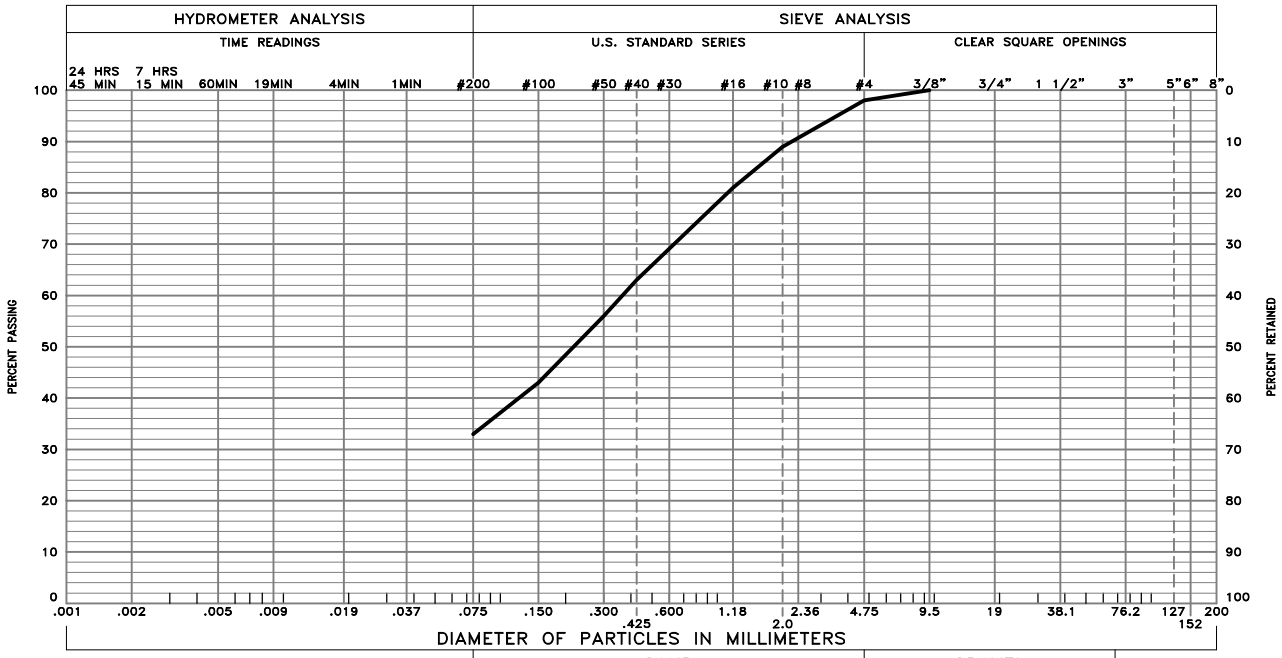
SAMPLE OF: Fill: Silty Clayey Sand (SC-SM) FROM: Boring B4 @ 10.5"-5'



GRAVEL 1 % SAND 61 % SILT AND CLAY 38 %

LIQUID LIMIT 27 PLASTICITY INDEX 9

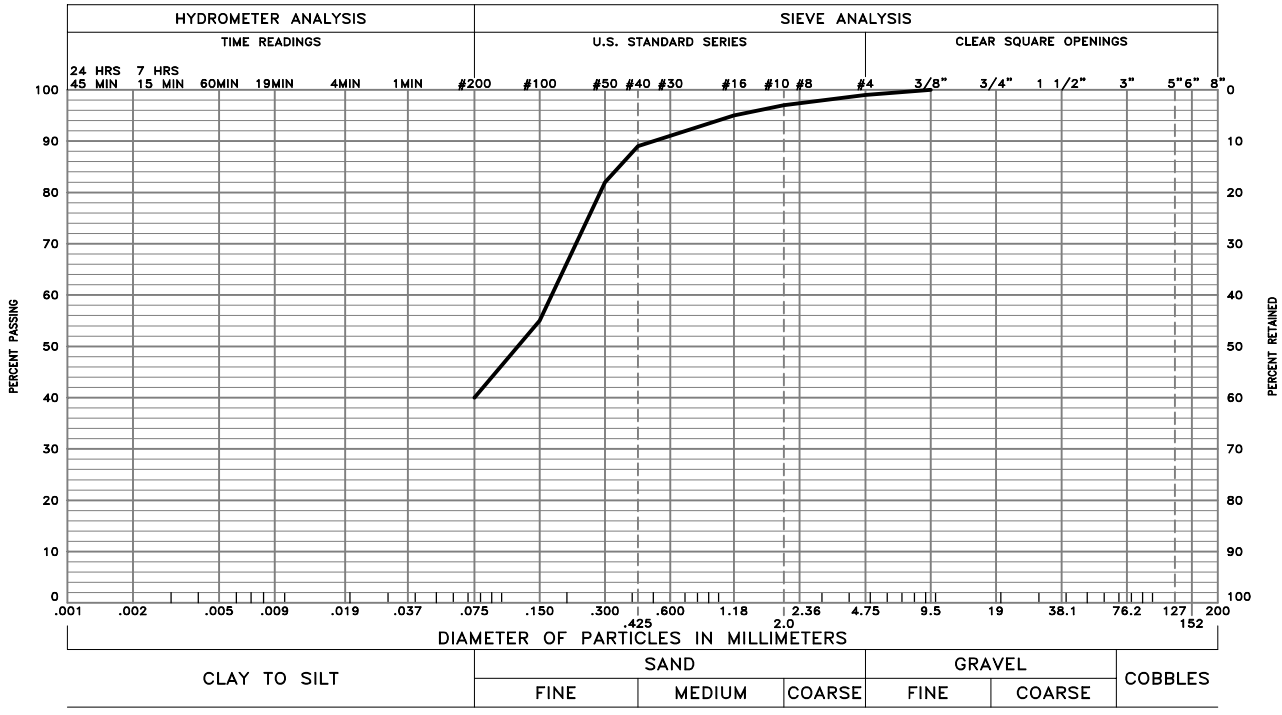
SAMPLE OF: Fill: Clayey Sand (SC) FROM: Boring B5 @ 9.25"-4'



GRAVEL 2 % SAND 65 % SILT AND CLAY 33 %

LIQUID LIMIT 28 PLASTICITY INDEX 11

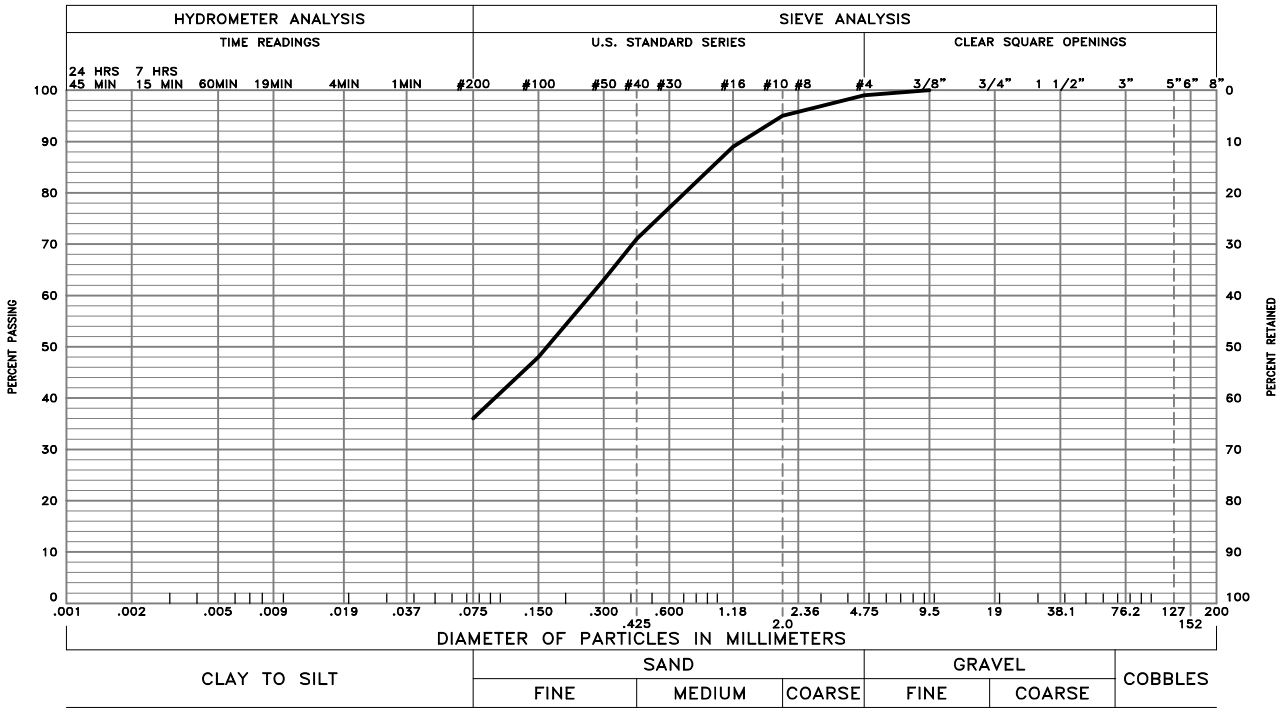
SAMPLE OF: Fill: Clayey Sand (SC) FROM: Boring B6 @ 8.5"–5'



GRAVEL 1 % SAND 59 % SILT AND CLAY 40 %

LIQUID LIMIT 27 PLASTICITY INDEX 9

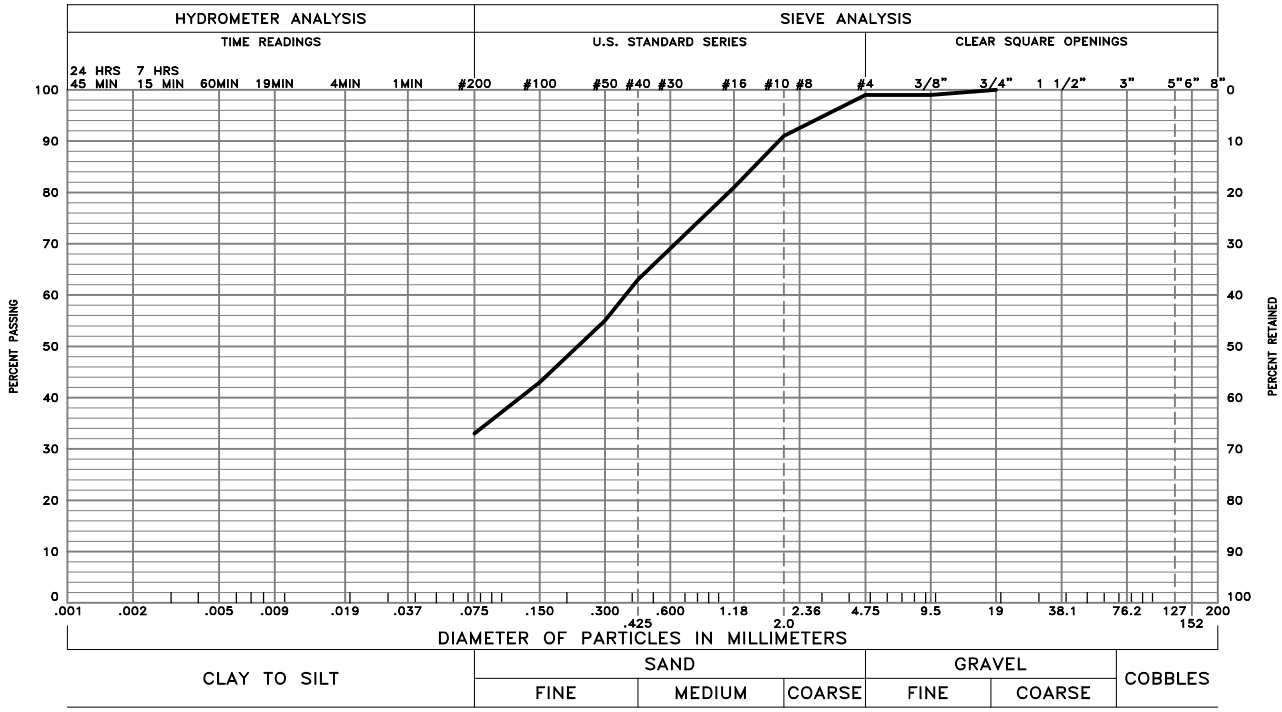
SAMPLE OF: Clayey Sandstone FROM: Boring B7 @ 8"–4'



GRAVEL 1 % SAND 63 % SILT AND CLAY 36 %

LIQUID LIMIT 24 PLASTICITY INDEX 5

SAMPLE OF: Fill: Silty-Clayey Sand (SC-SM) FROM: Boring B9 @ 10"-4'

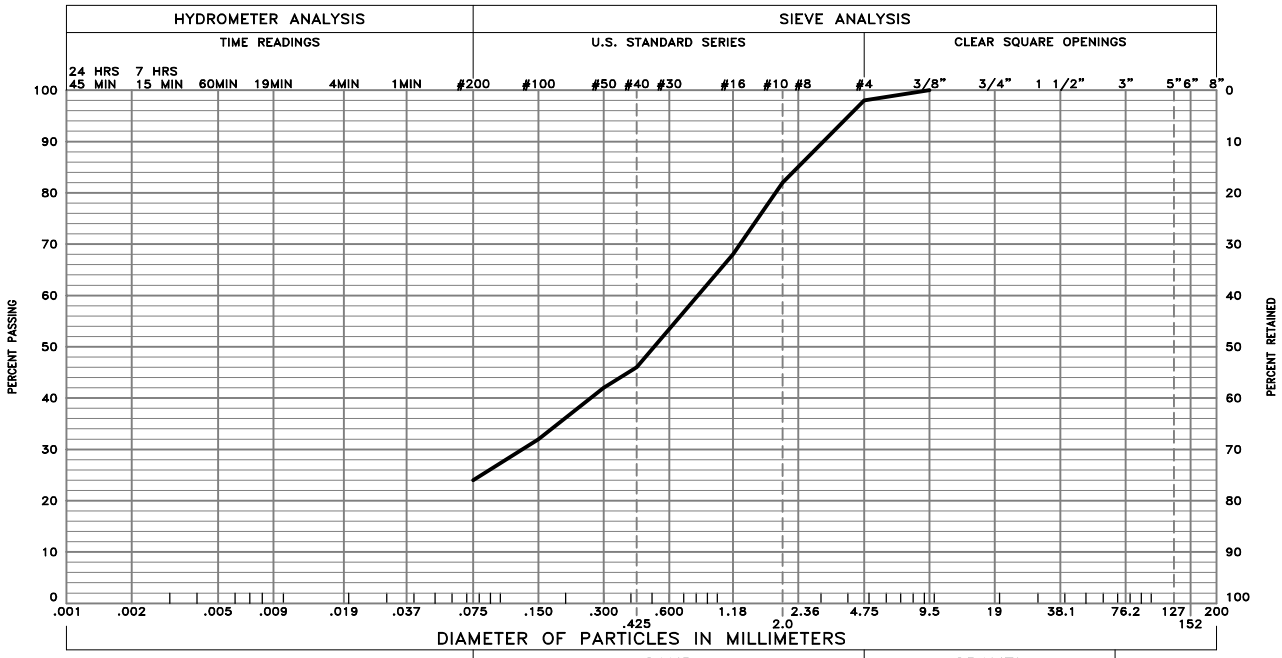


GRAVEL 1 % SAND 66 % SILT AND CLAY 33 %

LIQUID LIMIT 21 PLASTICITY INDEX 5

SAMPLE OF: Silty Clayey Sand (SC-SM) FROM: Boring B10 @ 9"-5'

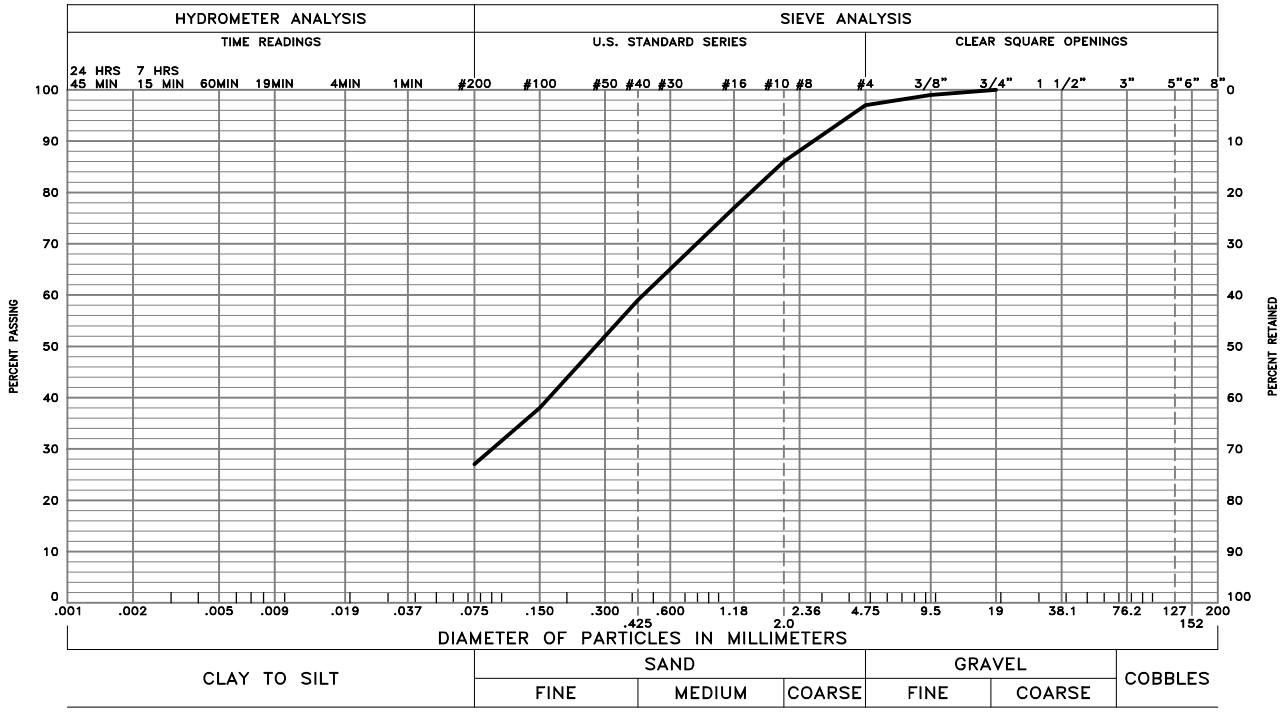
17-2-183A	Kumar & Associates	GRADATION TEST RESULTS	Fig. 46



GRAVEL 2 % SAND 74 % SILT AND CLAY 24 %

LIQUID LIMIT 27 PLASTICITY INDEX 8

SAMPLE OF: Fill: Clayey Sand (SC) FROM: Boring B13 @ 8"–5'

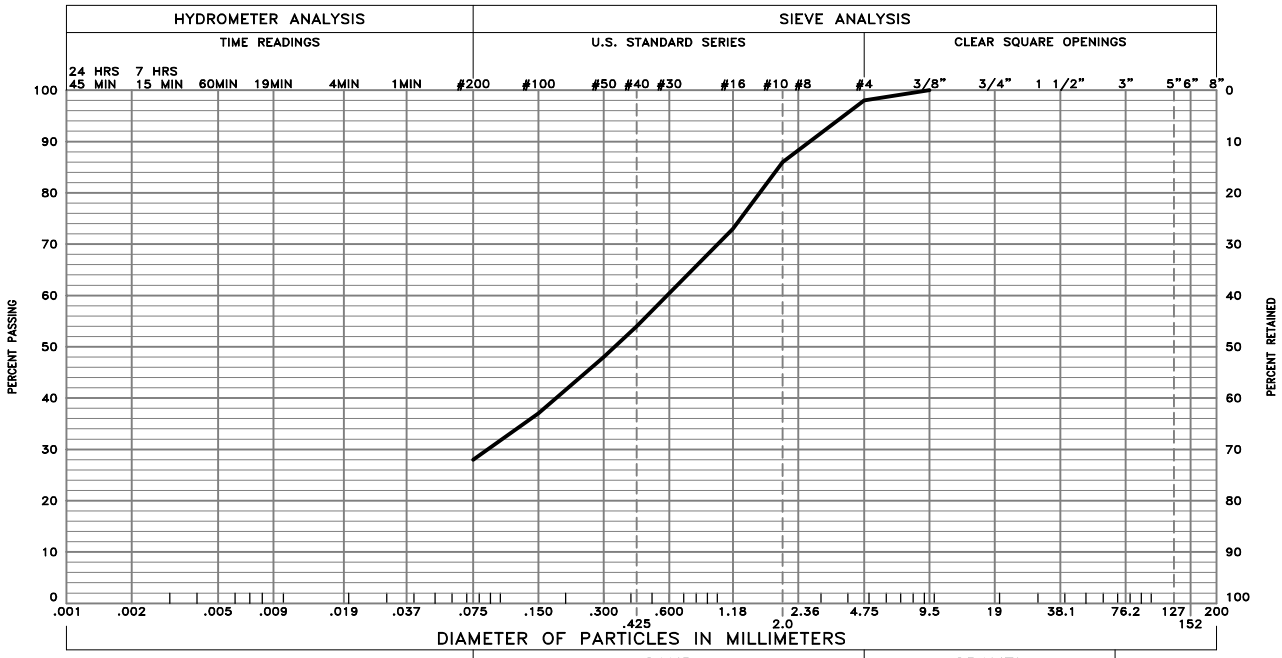


GRAVEL 3 % SAND 70 % SILT AND CLAY 27 %

LIQUID LIMIT 25 PLASTICITY INDEX 8

SAMPLE OF: Clayey Sand (SC) FROM: Boring B14 @ 9"–4'

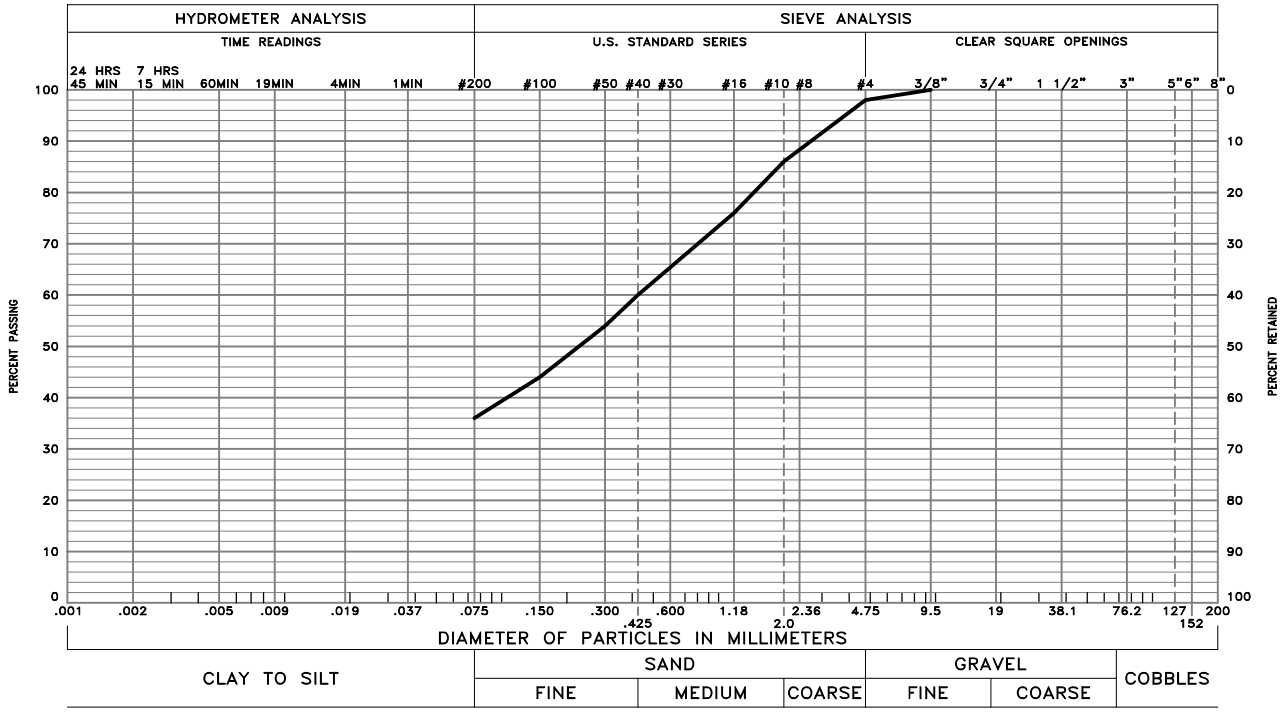
17–2–183A	Kumar & Associates	GRADATION TEST RESULTS	Fig. 47



GRAVEL 2 % SAND 70 % SILT AND CLAY 28 %

LIQUID LIMIT 28 PLASTICITY INDEX 9

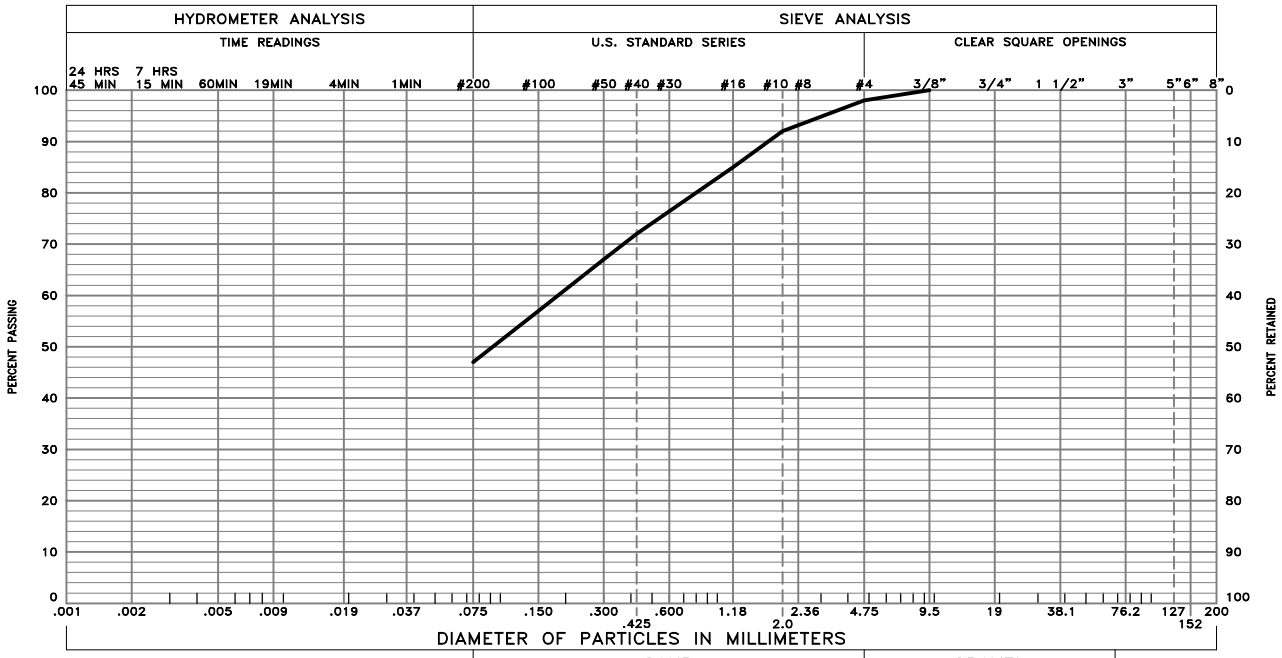
SAMPLE OF: Fill: Clayey Sand (SC) FROM: Boring B15 @ 10"–4'



GRAVEL 2 % SAND 62 % SILT AND CLAY 36 %

LIQUID LIMIT 21 PLASTICITY INDEX 6

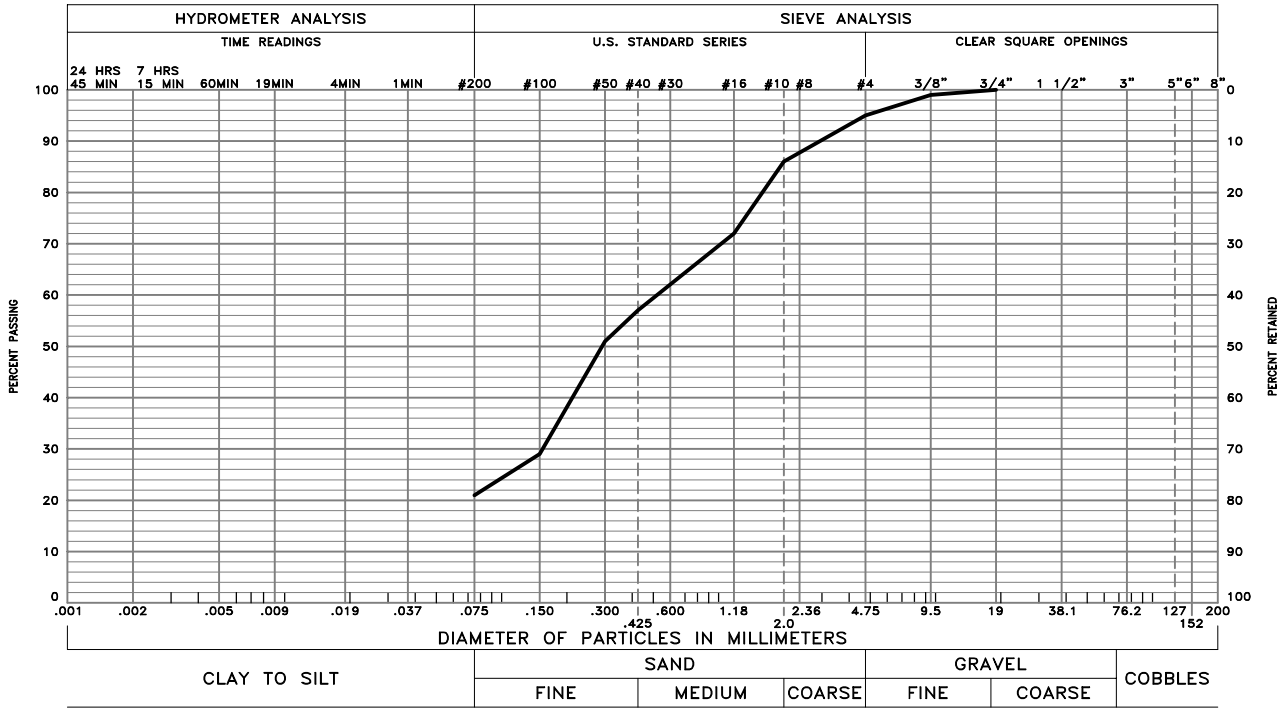
SAMPLE OF: Silty Clayey Sand (SC–SM) FROM: Boring B18 @ 9"–4'



GRAVEL 2 % SAND 51 % SILT AND CLAY 47 %

LIQUID LIMIT 37 PLASTICITY INDEX 18

SAMPLE OF: Fill: Clayey Sand (SC) FROM: Boring B19 @ 1'–4'

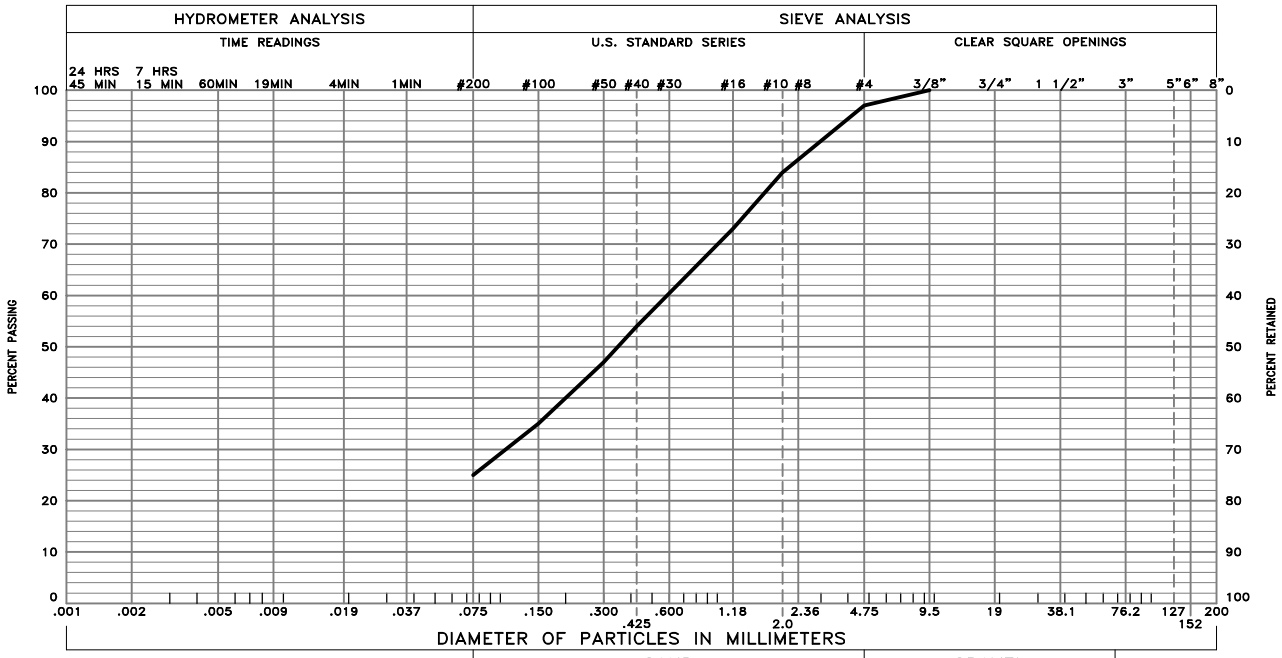


GRAVEL 5 % SAND 74 % SILT AND CLAY 21 %

LIQUID LIMIT 28 PLASTICITY INDEX 8

SAMPLE OF: Fill: Clayey Sand (SC) FROM: Borinb B20 @ 11"–5'

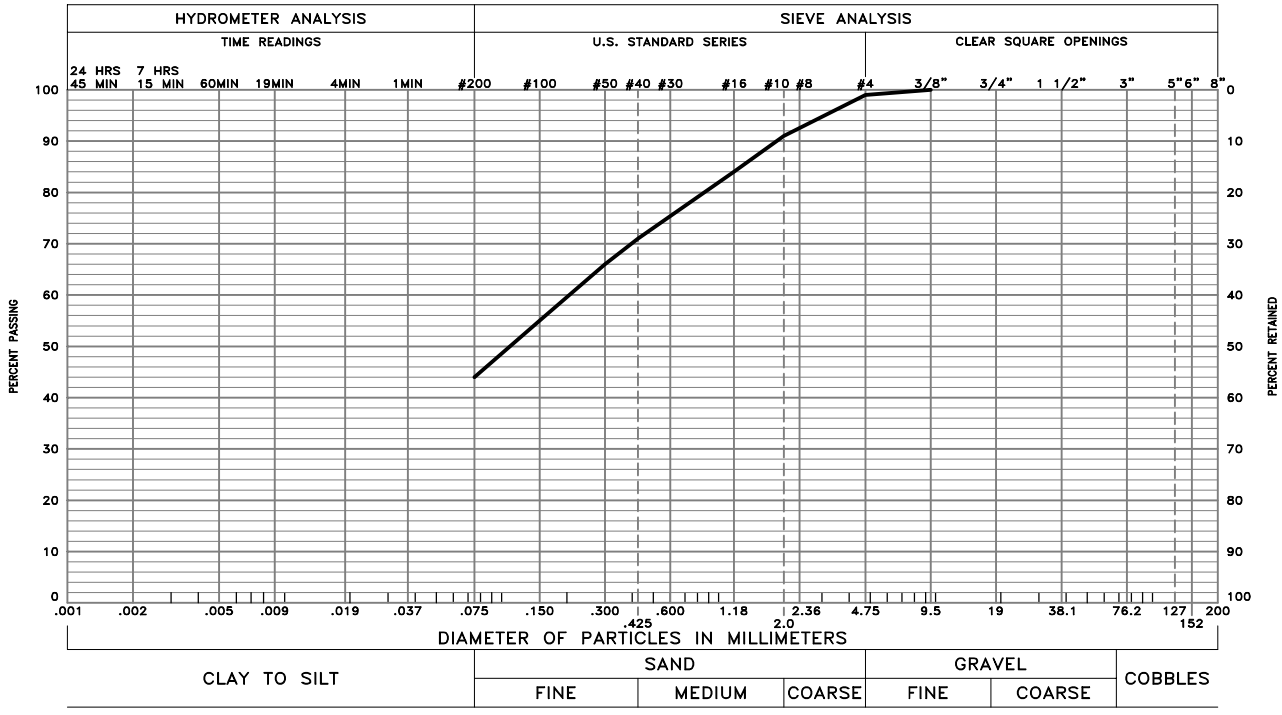
17–2–183A	Kumar & Associates	GRADATION TEST RESULTS	Fig. 49



GRAVEL 3 % SAND 72 % SILT AND CLAY 25 %

LIQUID LIMIT 35 PLASTICITY INDEX 16

SAMPLE OF: Fill: Clayey Sand (SC) FROM: Boring B21 @ 6.25"–5'

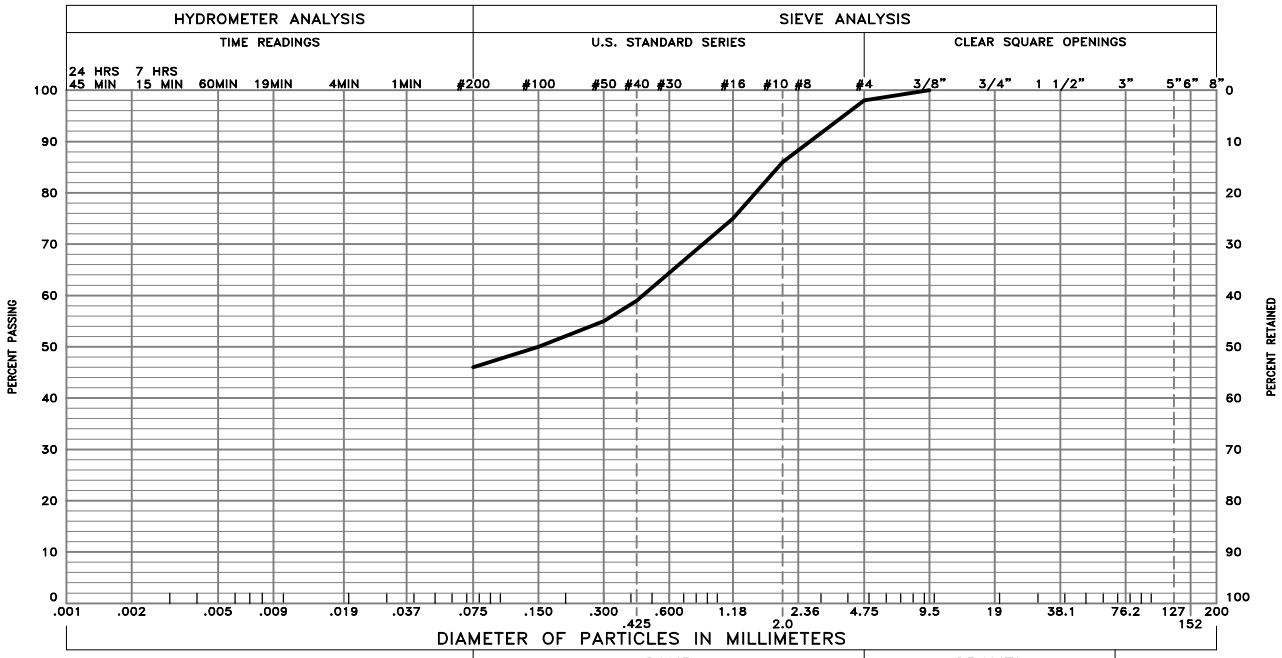


GRAVEL 1 % SAND 55 % SILT AND CLAY 44 %

LIQUID LIMIT 41 PLASTICITY INDEX 15

SAMPLE OF: Clayey Sand (SC) FROM: Boring B22 @ 5"–5'

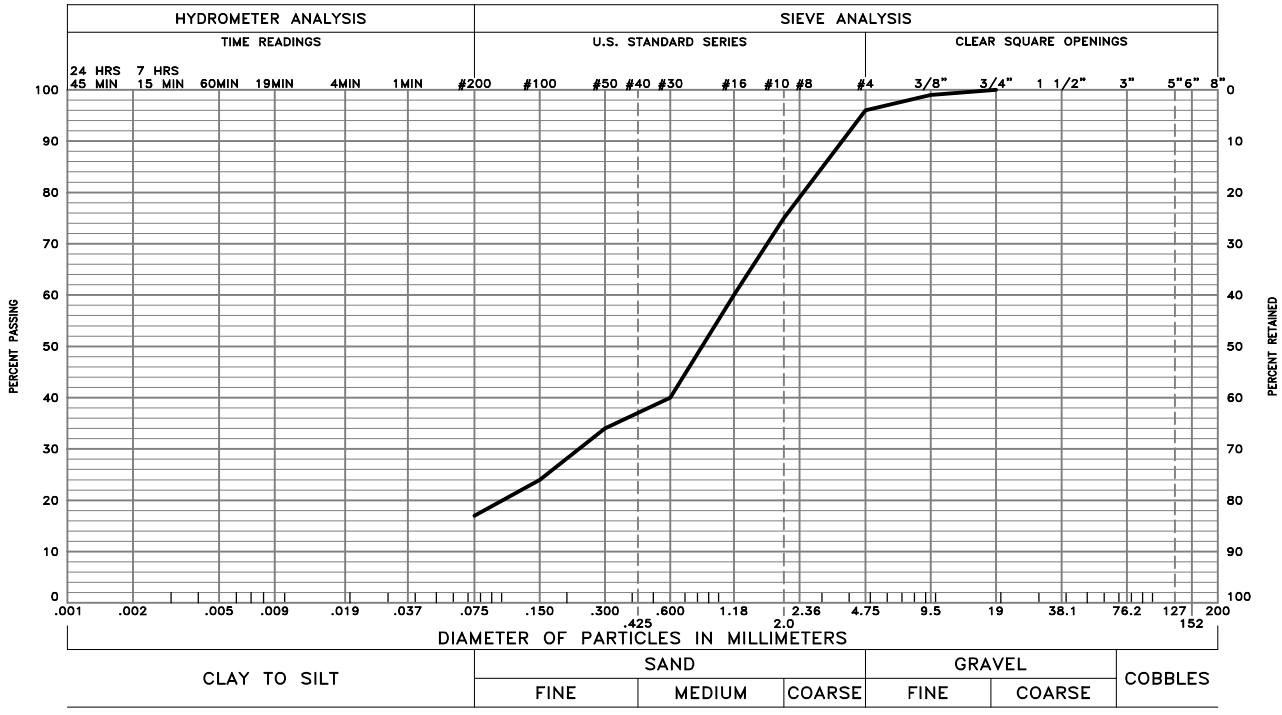
17-2-183A	Kumar & Associates	GRADATION TEST RESULTS	Fig. 50



GRAVEL 2 % SAND 52 % SILT AND CLAY 46 %

LIQUID LIMIT 27 PLASTICITY INDEX 10

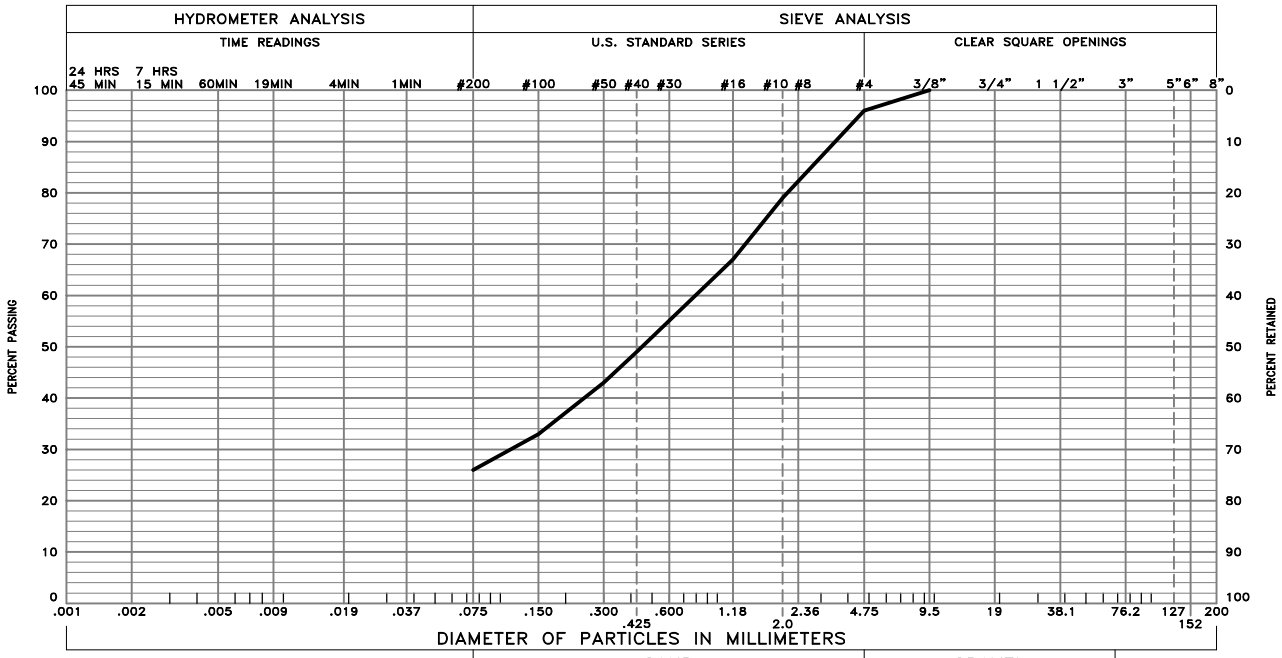
SAMPLE OF: Clayey Sand (SC)/Claystone FROM: Boring B23 @ 7.5"–5'



GRAVEL 4 % SAND 79 % SILT AND CLAY 17 %

LIQUID LIMIT PLASTICITY INDEX NP

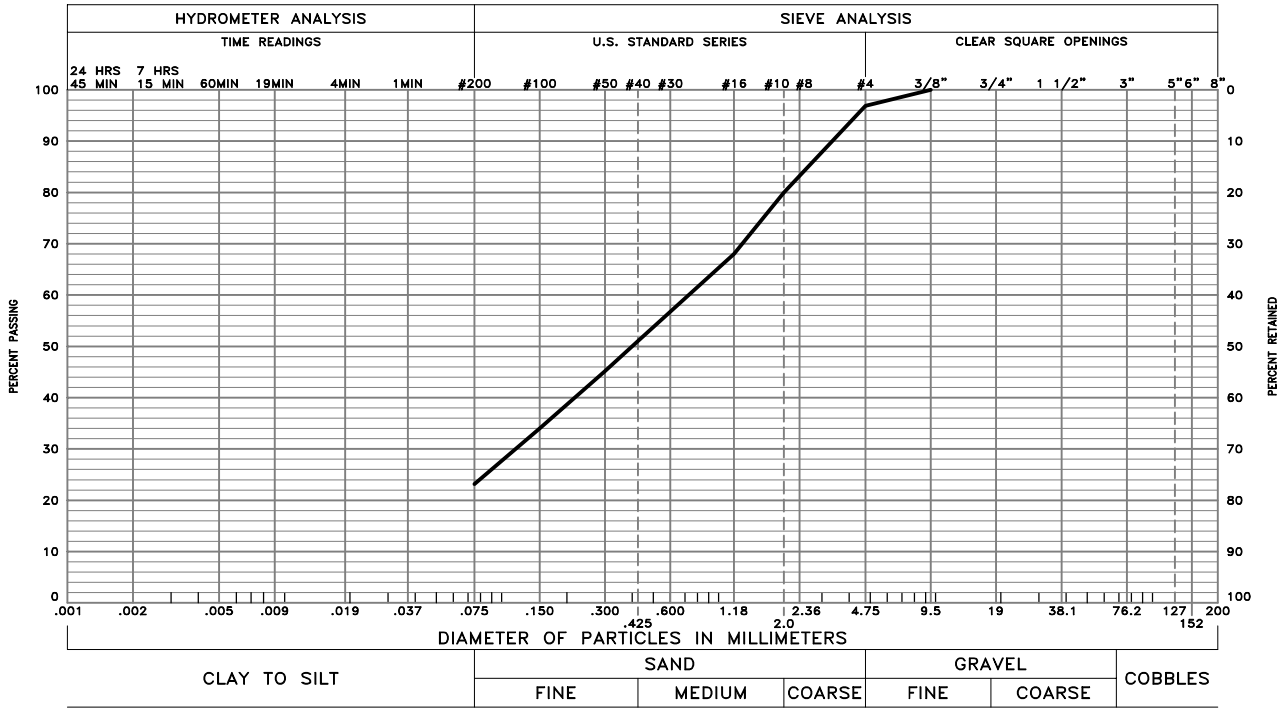
SAMPLE OF: Silty Sand (SM) FROM: Boring B25 @ 2'–5'



GRAVEL 4 % SAND 70 % SILT AND CLAY 26 %

LIQUID LIMIT 25 PLASTICITY INDEX 6

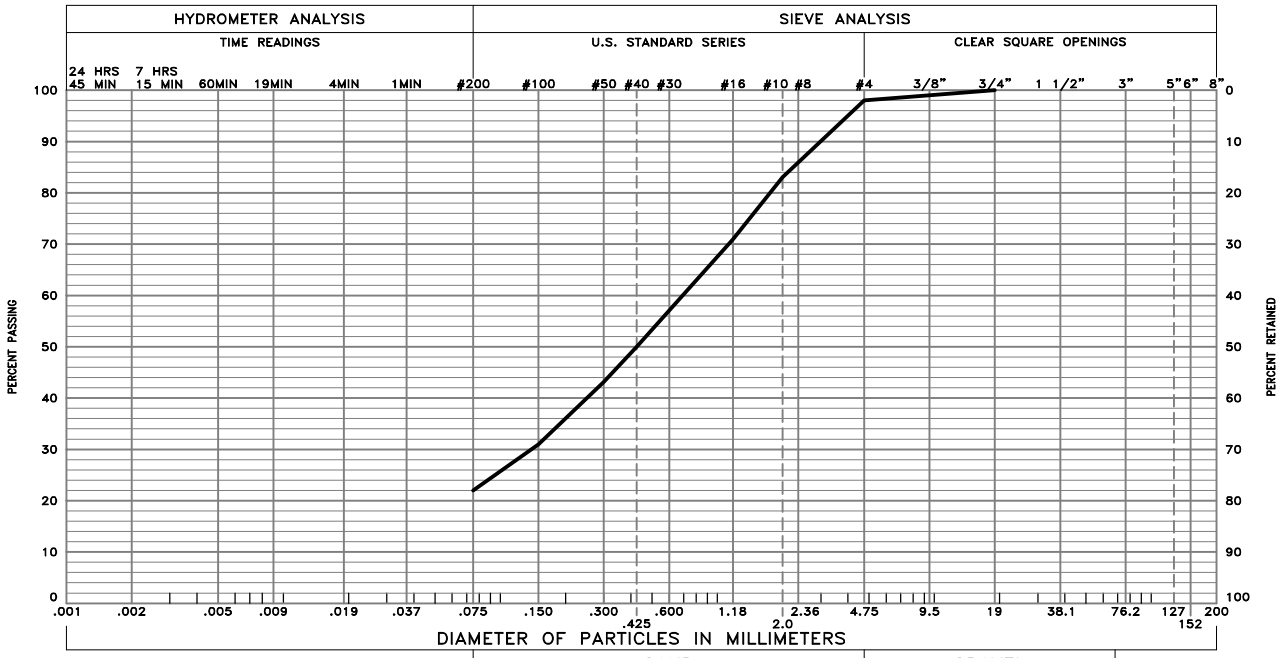
SAMPLE OF: Silty Clayey Sand (SC-SM) FROM: Boring B26 @ 7.5"-4'



GRAVEL 3 % SAND 74 % SILT AND CLAY 23 %

LIQUID LIMIT 26 PLASTICITY INDEX 9

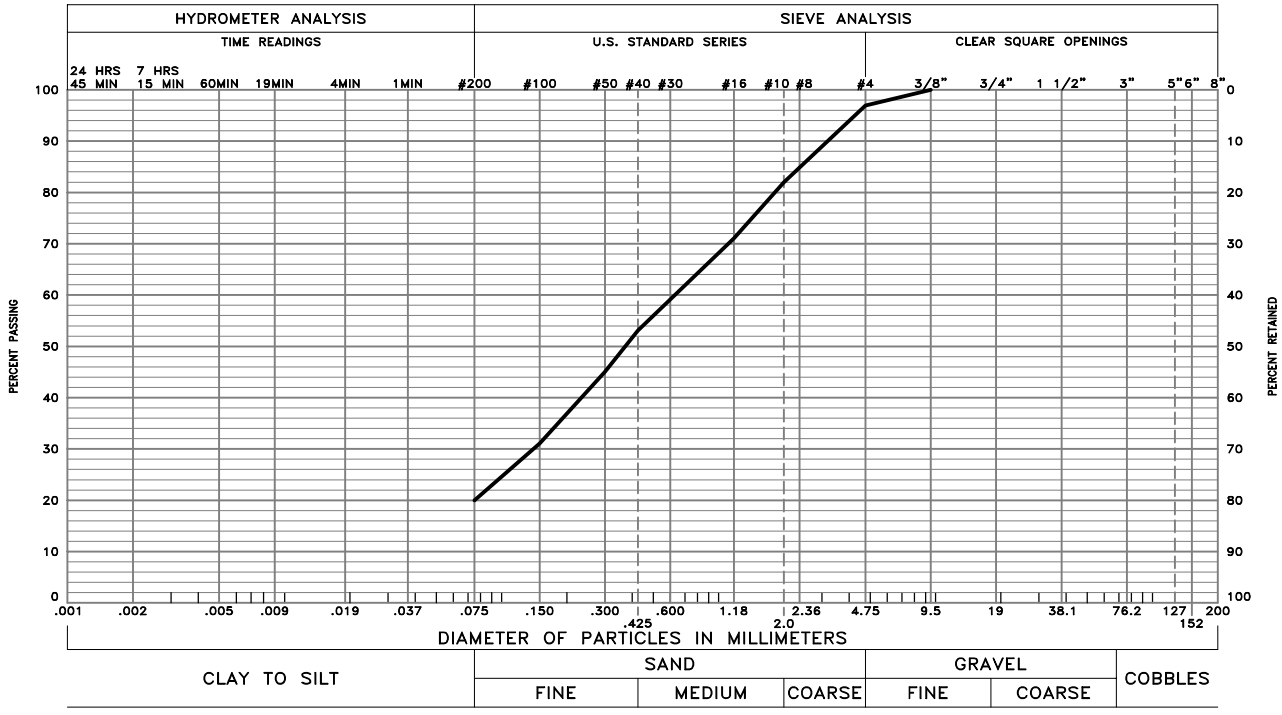
SAMPLE OF: Fill: Clayey Sand (SC) FROM: Boring R1 @ 4"-5



GRAVEL 2 % SAND 76 % SILT AND CLAY 22 %

LIQUID LIMIT 27 PLASTICITY INDEX 10

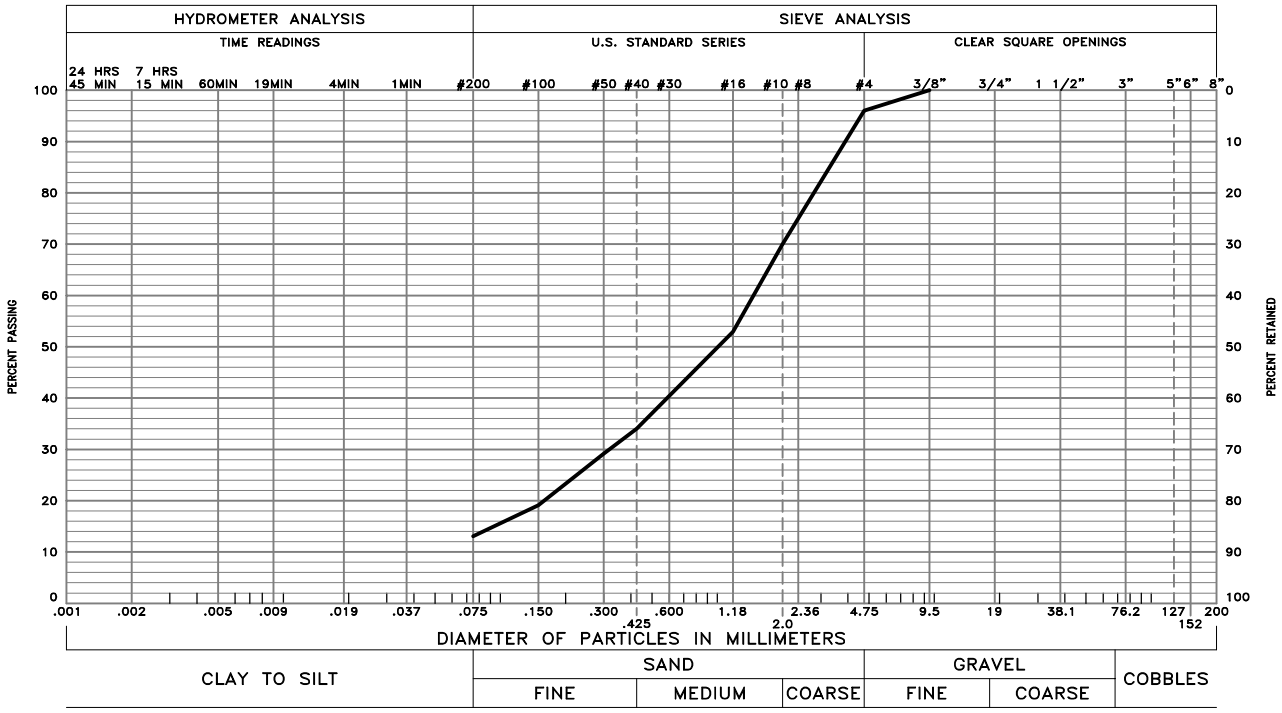
SAMPLE OF: Clayey Sand (SC) FROM: Boring R2 @ 4"–4'



GRAVEL 3 % SAND 77 % SILT AND CLAY 20 %

LIQUID LIMIT 24 PLASTICITY INDEX 6

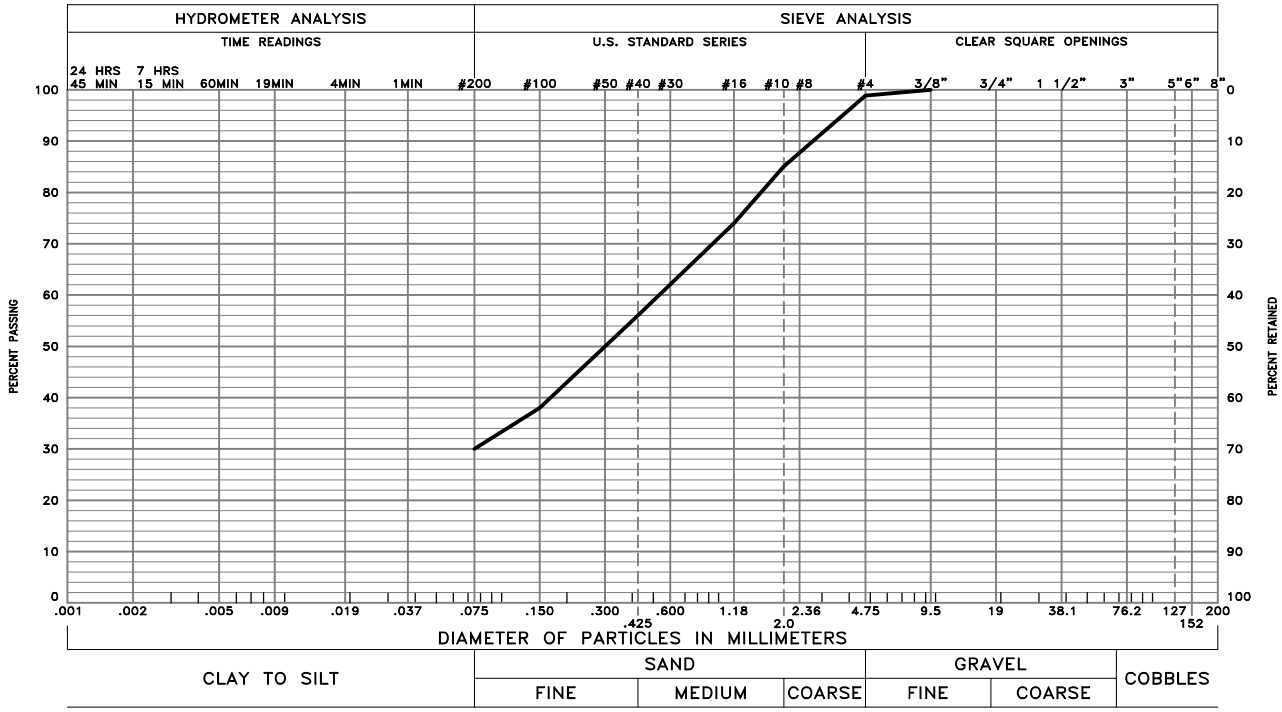
SAMPLE OF: Silty Clayey Sand (SC–SM) FROM: Boring R6 @ 3"–5'



GRAVEL 4 % SAND 83 % SILT AND CLAY 13 %

LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Silty Sand (SM) FROM: Boring R7 @ 2"–5'

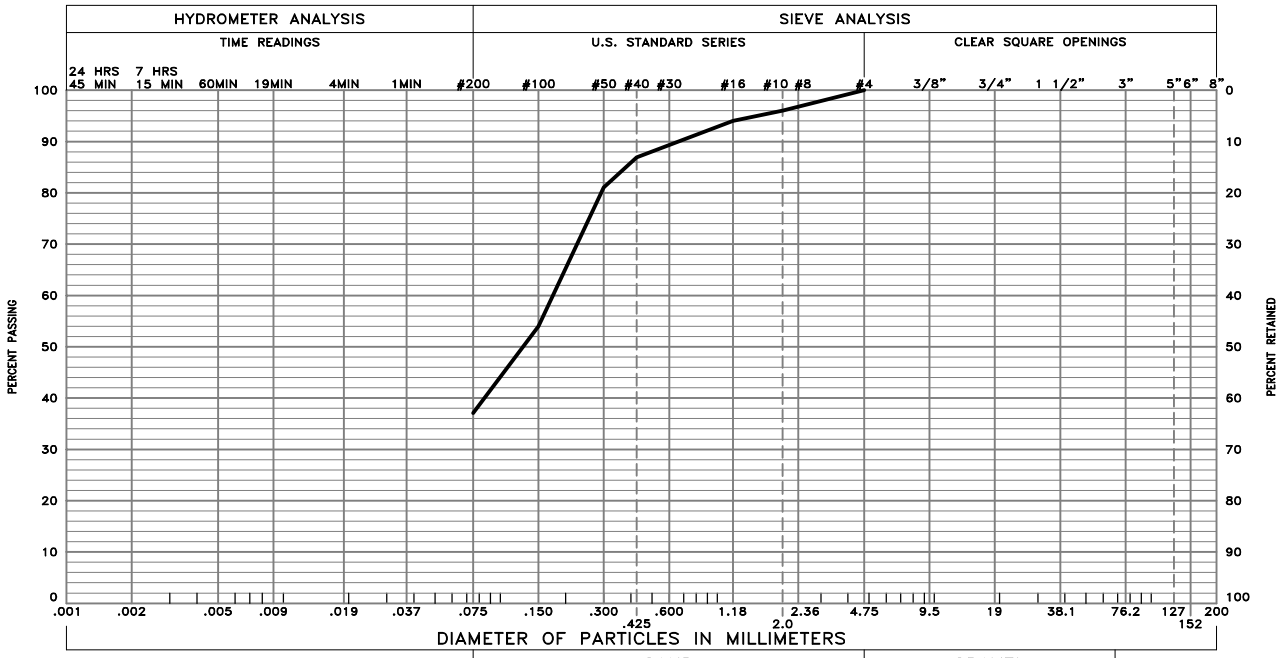


GRAVEL 1 % SAND 69 % SILT AND CLAY 30 %

LIQUID LIMIT 28 PLASTICITY INDEX 13

SAMPLE OF: Fill: Clayey Sand (SC) FROM: Boring R8 @ 4"–5'

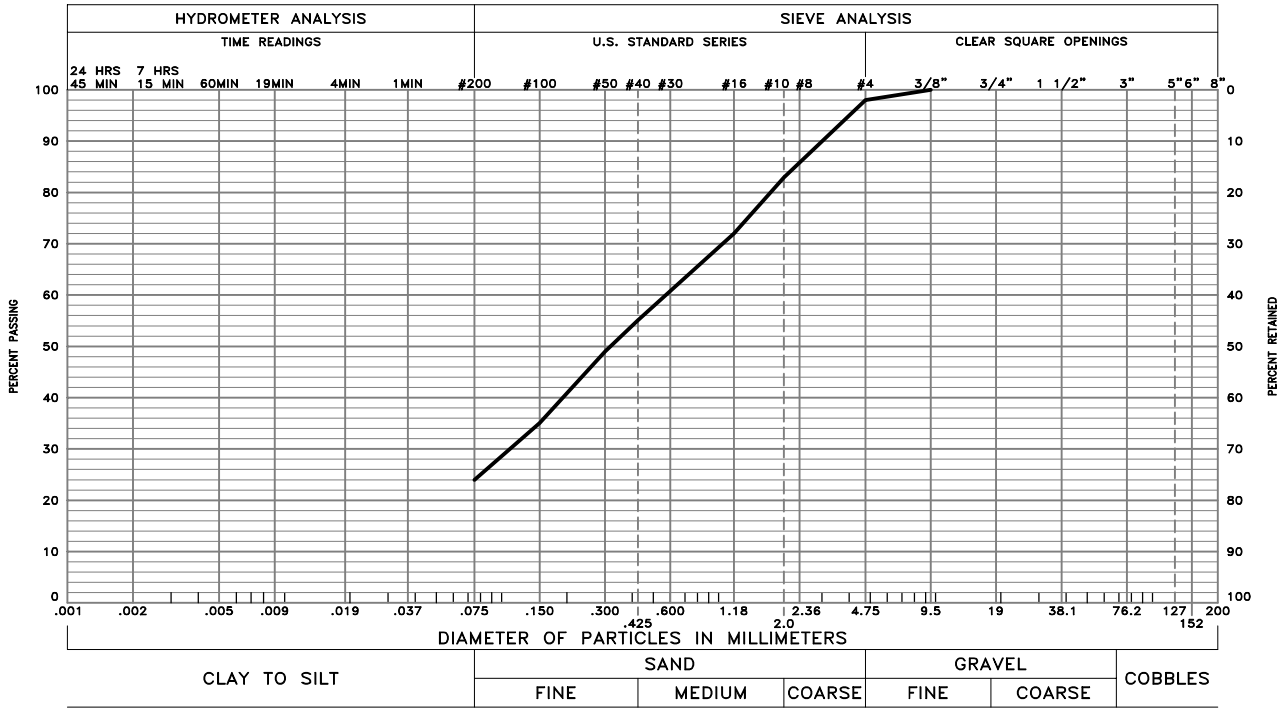
17–2–183A	Kumar & Associates	GRADATION TEST RESULTS	Fig. 54



GRAVEL 0 % SAND 63 % SILT AND CLAY 37 %

LIQUID LIMIT 19 PLASTICITY INDEX 2

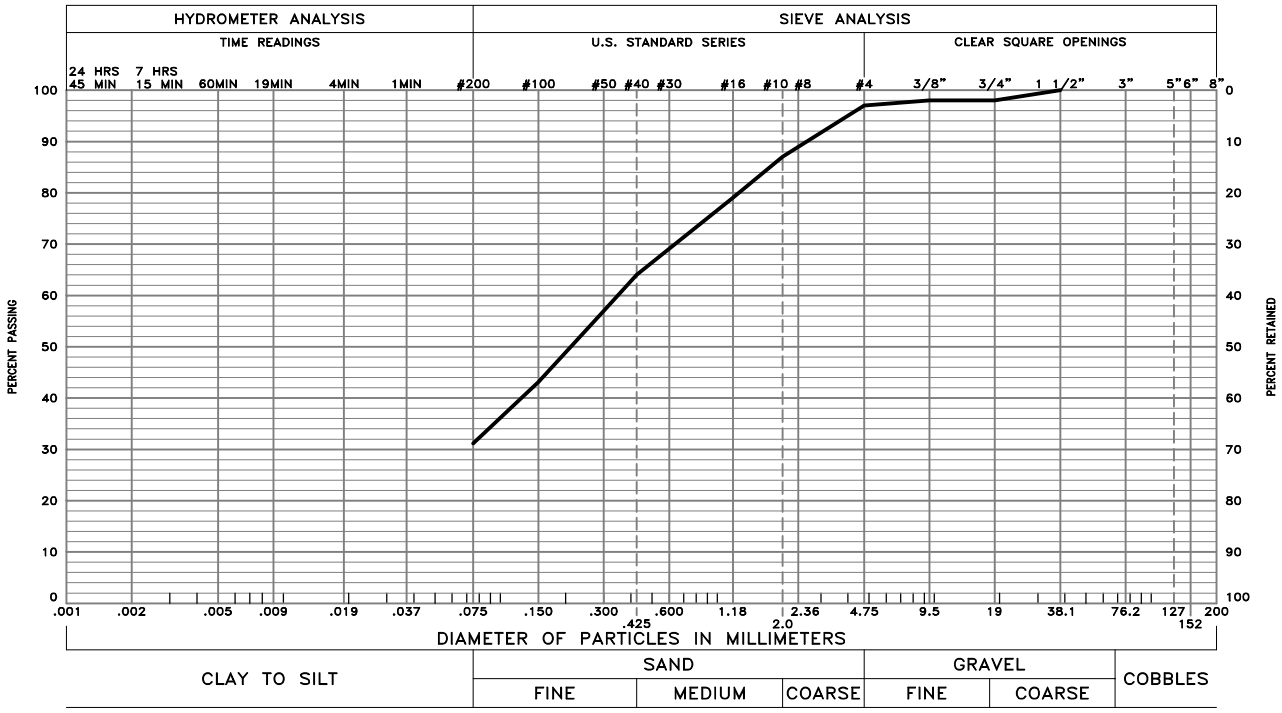
SAMPLE OF: Sandstone FROM: Boring R9 @ 3"–5'



GRAVEL 2 % SAND 74 % SILT AND CLAY 24 %

LIQUID LIMIT 25 PLASTICITY INDEX 8

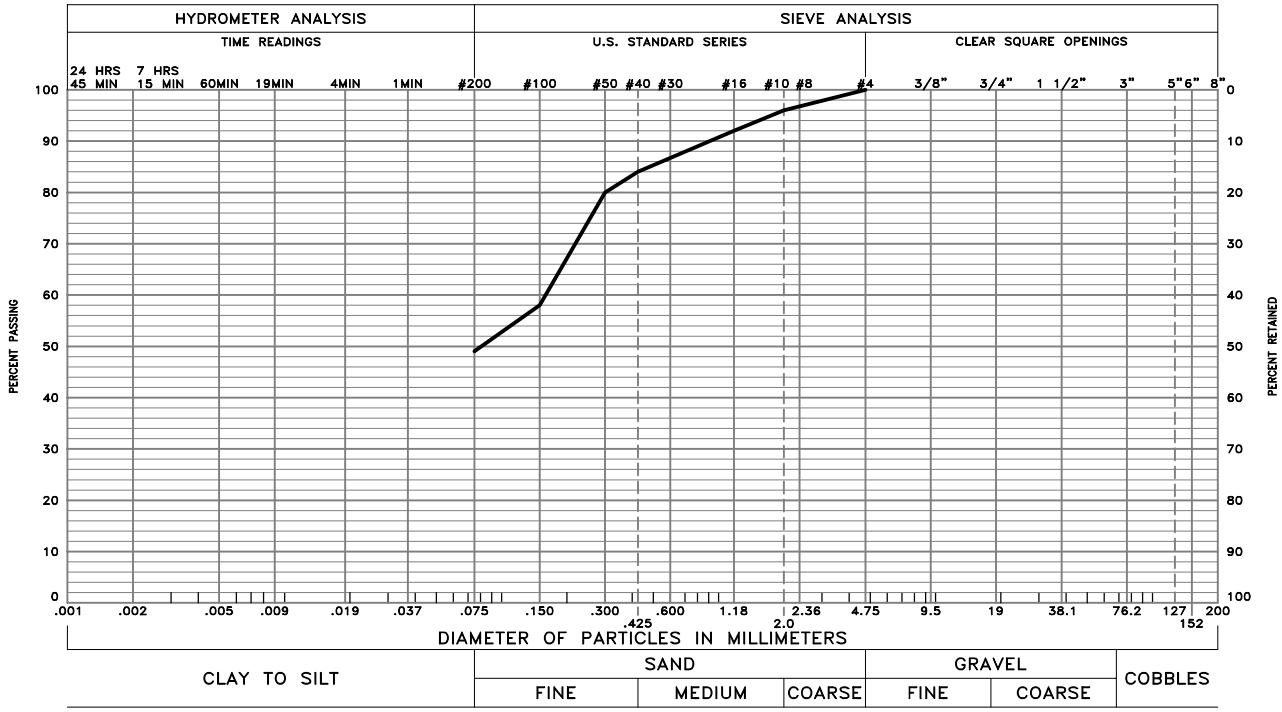
SAMPLE OF: Clayey Sand (SC) FROM: Boring R10 @ 3"–5'



GRAVEL 3 % SAND 66 % SILT AND CLAY 31 %

LIQUID LIMIT 28 PLASTICITY INDEX 10

SAMPLE OF: Fill: Clayey Sand (SC) FROM: Boring R11 @ 5"–6'

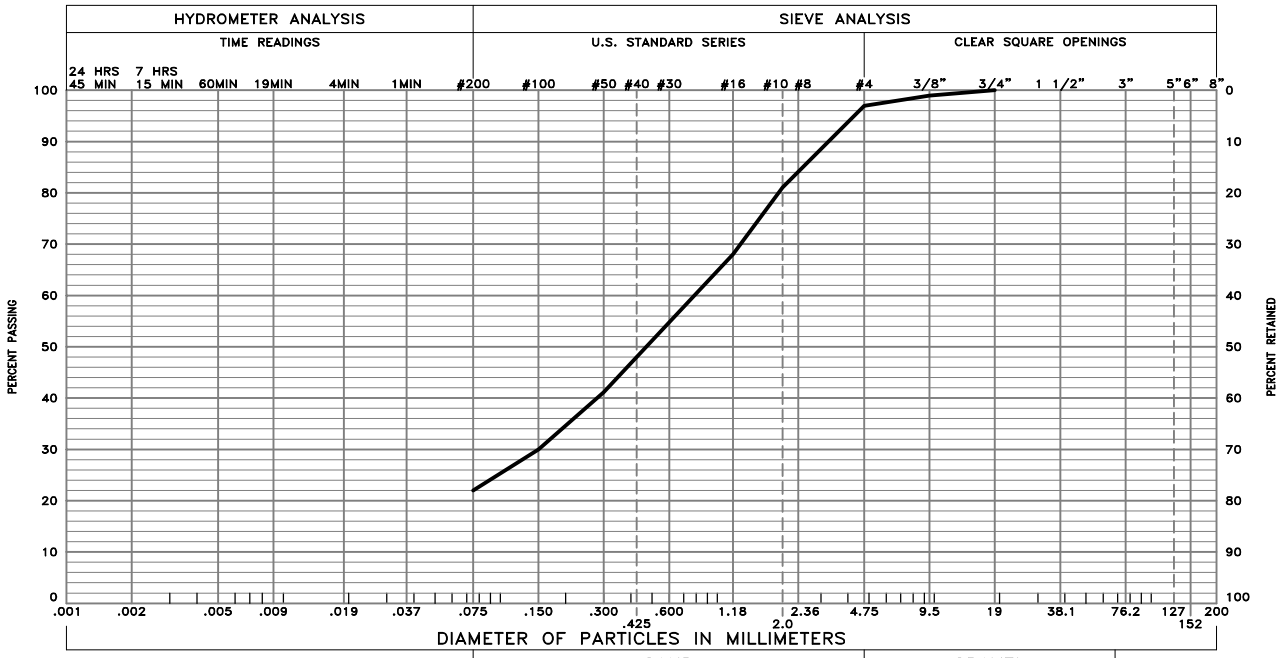


GRAVEL 0 % SAND 51 % SILT AND CLAY 49 %

LIQUID LIMIT 36 PLASTICITY INDEX 19

SAMPLE OF: Fill: Clayey Sand (SC) FROM: Boring R13 @ 3"–6'

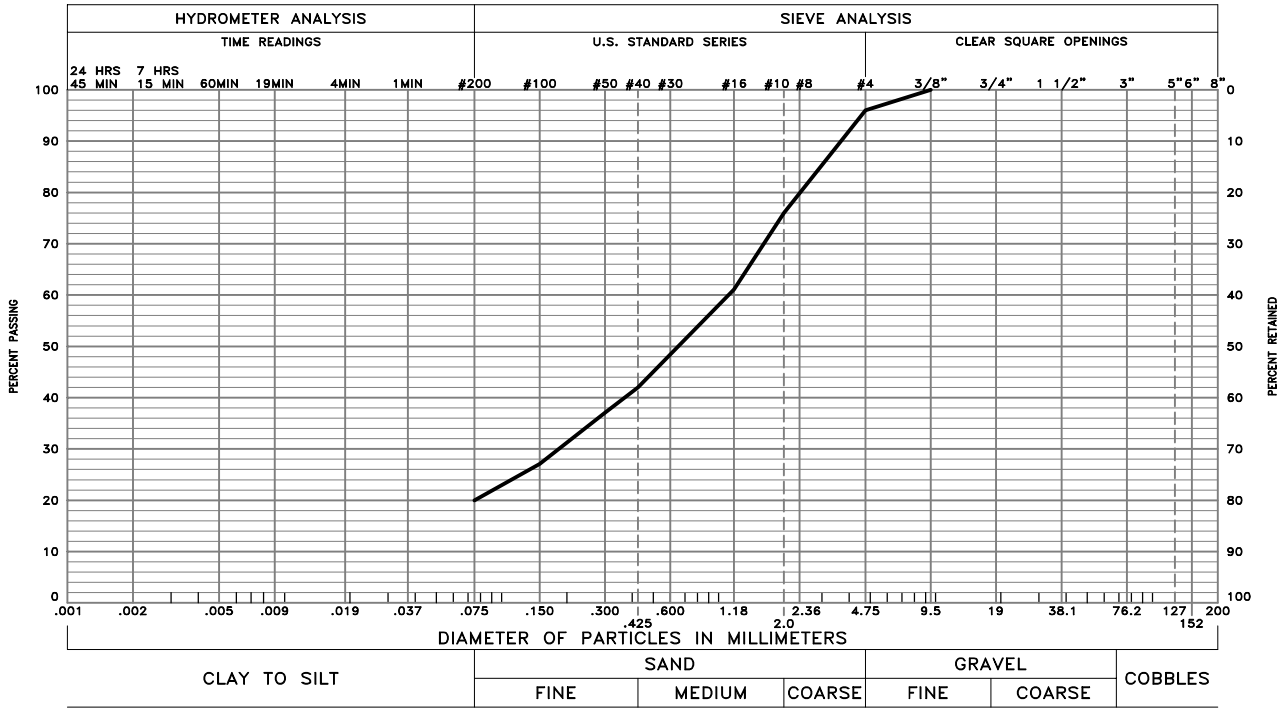
17–2–183A	Kumar & Associates	GRADATION TEST RESULTS	Fig. 56



GRAVEL 3 % SAND 75 % SILT AND CLAY 22 %

LIQUID LIMIT 21 PLASTICITY INDEX 7

SAMPLE OF: Silty Clayey Sand (SC-SM) FROM: Boring R14 @ 2"-5'

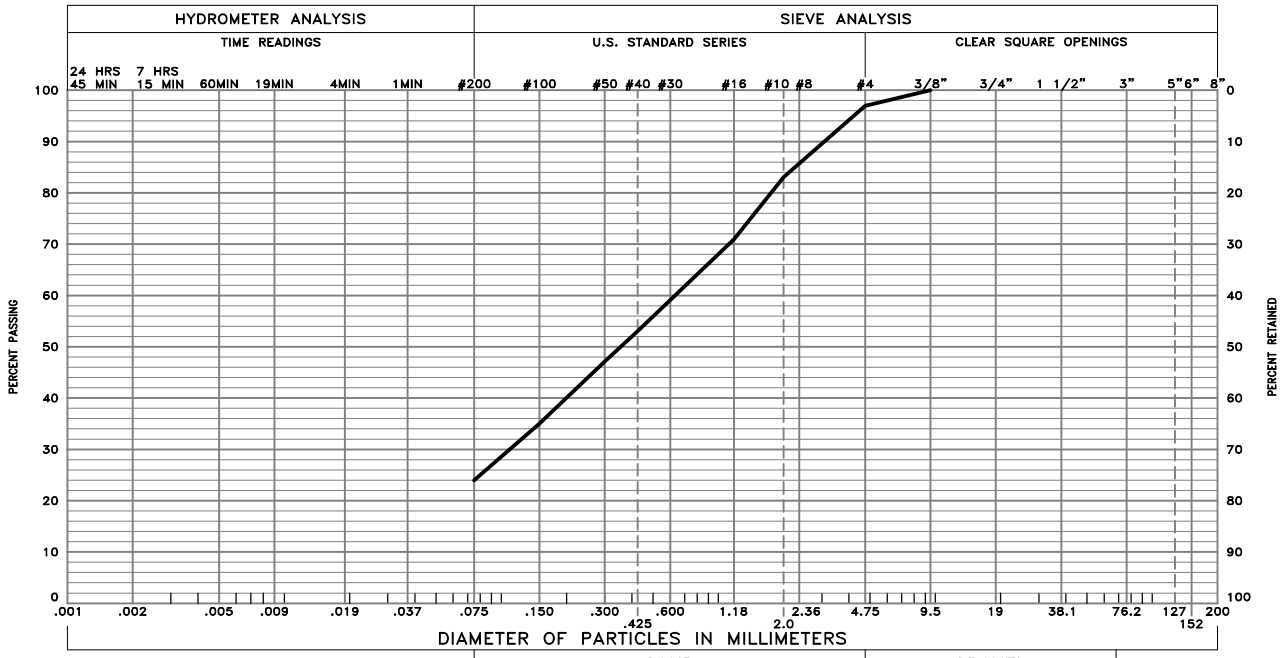


GRAVEL 4 % SAND 76 % SILT AND CLAY 20 %

LIQUID LIMIT 22 PLASTICITY INDEX 7

SAMPLE OF: Silty Clayey Sand (SC-SM) FROM: Boring R15 @ 3"-5'

17-2-183A	Kumar & Associates	GRADATION TEST RESULTS	Fig. 57



GRAVEL 3 % SAND 73 % SILT AND CLAY 24 %

LIQUID LIMIT 27 PLASTICITY INDEX 11

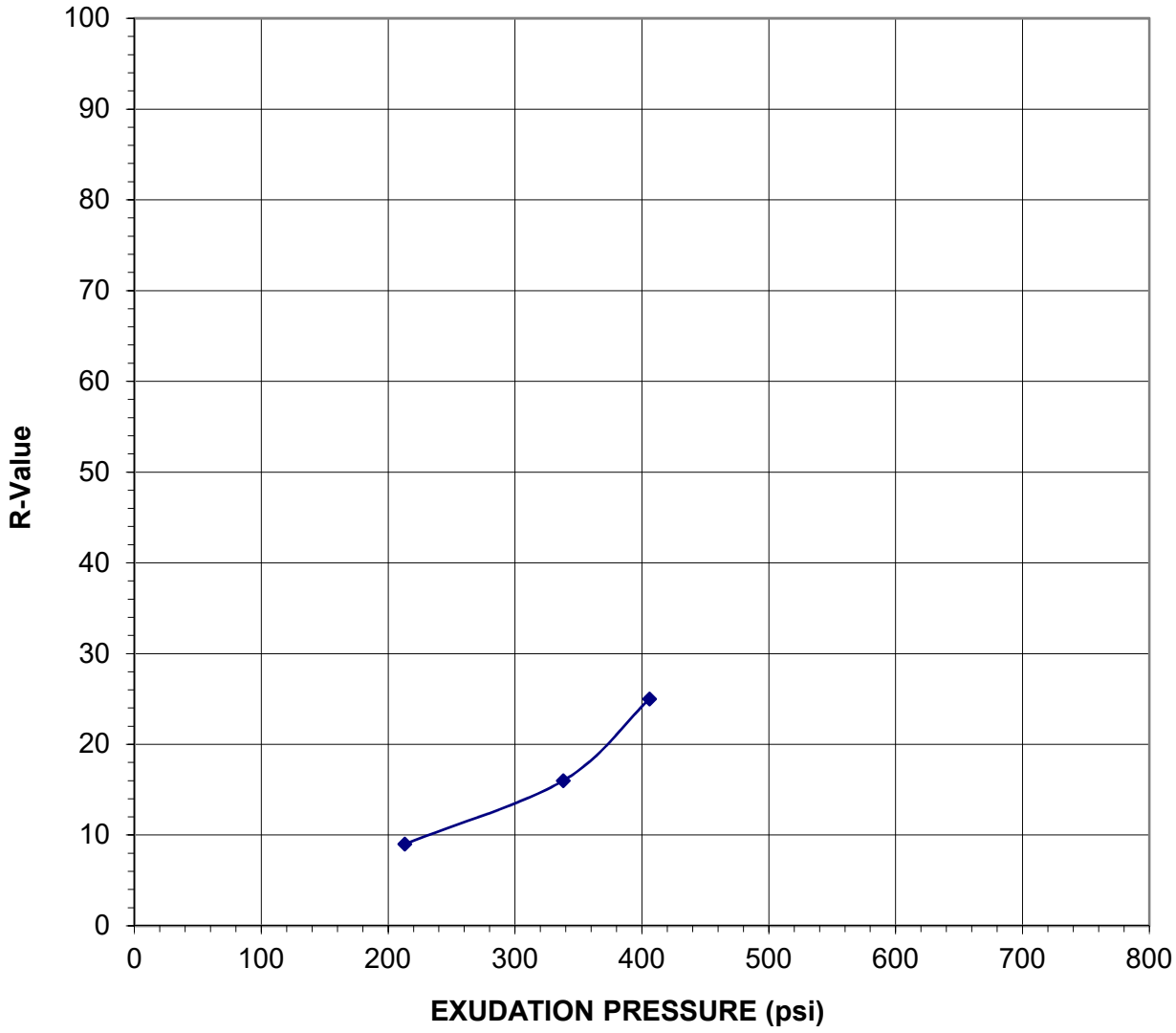
SAMPLE OF: Fill: Clayey Sand (SC) FROM: Boring R16 @ 3"–5'

These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D422, ASTM C136 and/or ASTM D1140.

17–2–183A	Kumar & Associates	GRADATION TEST RESULTS	Fig. 58

R-VALUE

TEST SPECIMEN	1	2	3	4	Rvalue @ 300 psi
MOISTURE CONTENT (%)	13.2	12.3	11.5		
DENSITY (pcf)	118.7	117.8	123.9		
EXPANSION PRESSURE (psi)	0.090	0.150	0.540		
EXUDATION PRESSURE (psi)	213	338	406		
R-VALUE	9	16	25		**14**



SOIL TYPE: **Fill: Clayey Sand (SC) / A-2-6 (0)**

LOCATION: **Powers / Research Interchange F2 @ 3"-20'**

DATE SAMPLED: **10/3/2018** DATE RECEIVED: **10/23/2018** DATE TESTED: **11/5/2018**

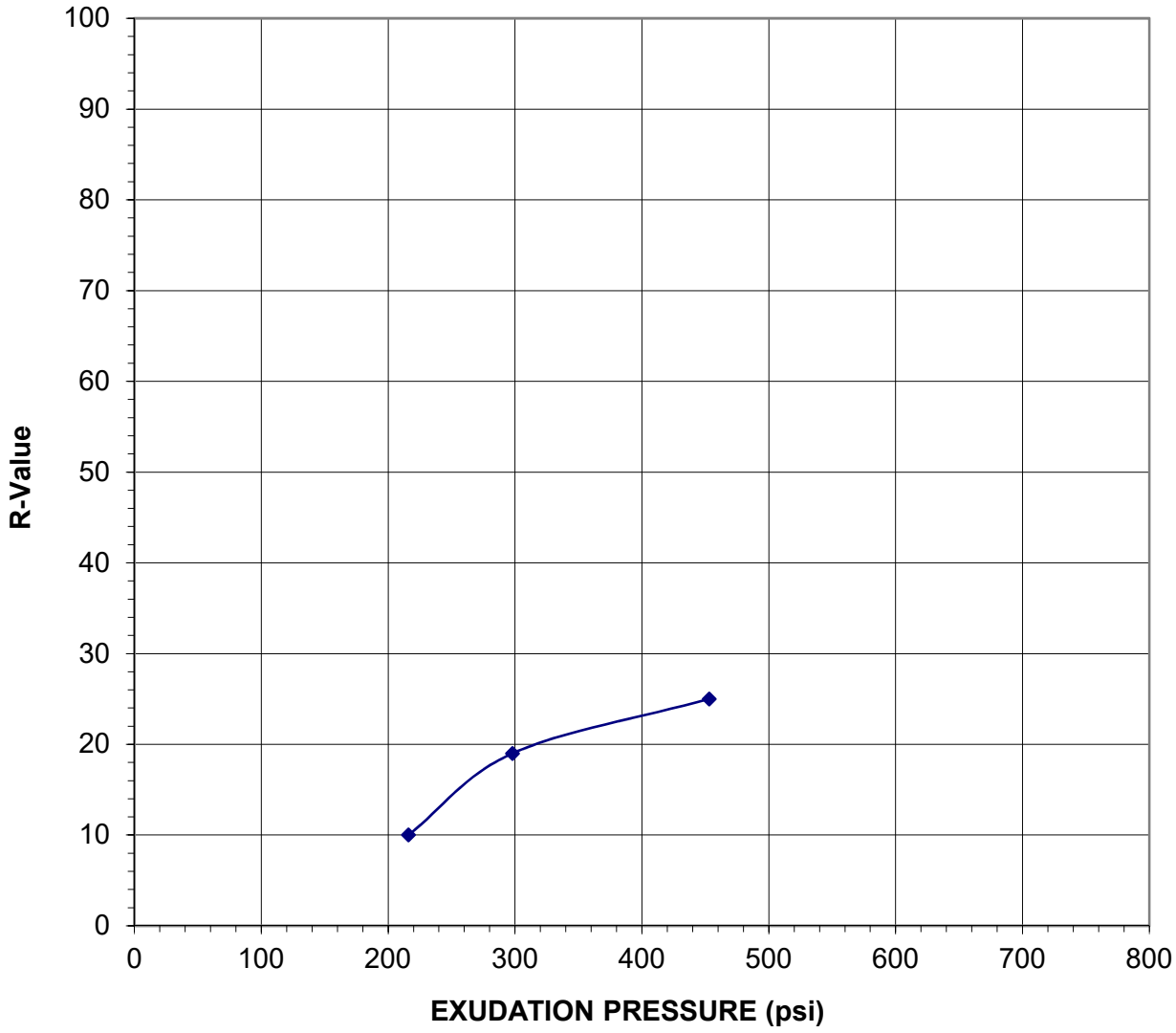
GRAVEL: **2** SAND: **65** SILT AND CLAY: **33**

LIQUID LIMIT: **27** PLASTICITY INDEX: **11**

17-2-183A	KUMAR & ASSOCIATES	HVEEM STABILOMETER TEST RESULTS	Fig. 59

R-VALUE

TEST SPECIMEN	1	2	3	4	Rvalue @ 300 psi
MOISTURE CONTENT (%)	16.7	15.8	14.9		
DENSITY (pcf)	115.3	114.6	116.7		
EXPANSION PRESSURE (psi)	0.150	0.510	0.660		
EXUDATION PRESSURE (psi)	216	298	453		
R-VALUE	10	19	25		**19**



SOIL TYPE: **Fill: Clayey Sand (SC) / A-6 (2)**

LOCATION: **Powers / Research Interchange F3 @ 3"-10'**

DATE SAMPLED: **10/23/2018** DATE RECEIVED: **10/23/2018** DATE TESTED: **11/6/2018**

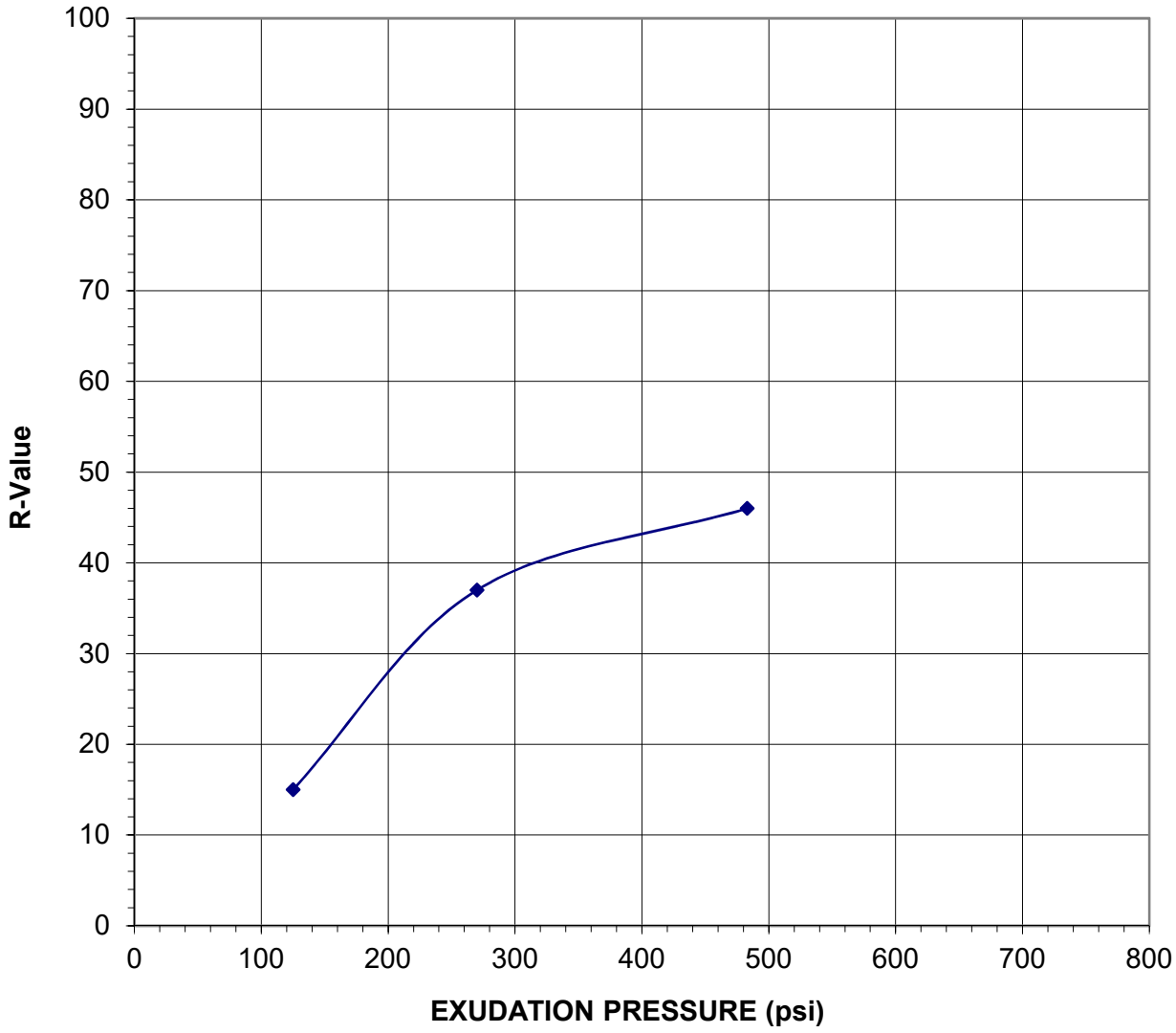
GRAVEL: **2** SAND: **54** SILT AND CLAY: **44**

LIQUID LIMIT: **28** PLASTICITY INDEX: **11**

17-2-183A	KUMAR & ASSOCIATES	HVEEM STABILOMETER TEST RESULTS	Fig. 60

R-VALUE

TEST SPECIMEN	1	2	3	4	Rvalue @ 300 psi
MOISTURE CONTENT (%)	17.4	15.6	13.8		
DENSITY (pcf)	108.2	107.0	101.8		
EXPANSION PRESSURE (psi)	0.000	0.000	0.000		
EXUDATION PRESSURE (psi)	125	270	483		
R-VALUE	15	37	46		**40**



SOIL TYPE: **Clayey Sandstone, A-4 (0)**

LOCATION: **Power Boulevard, Northbound, B7 @ 8"-4'**

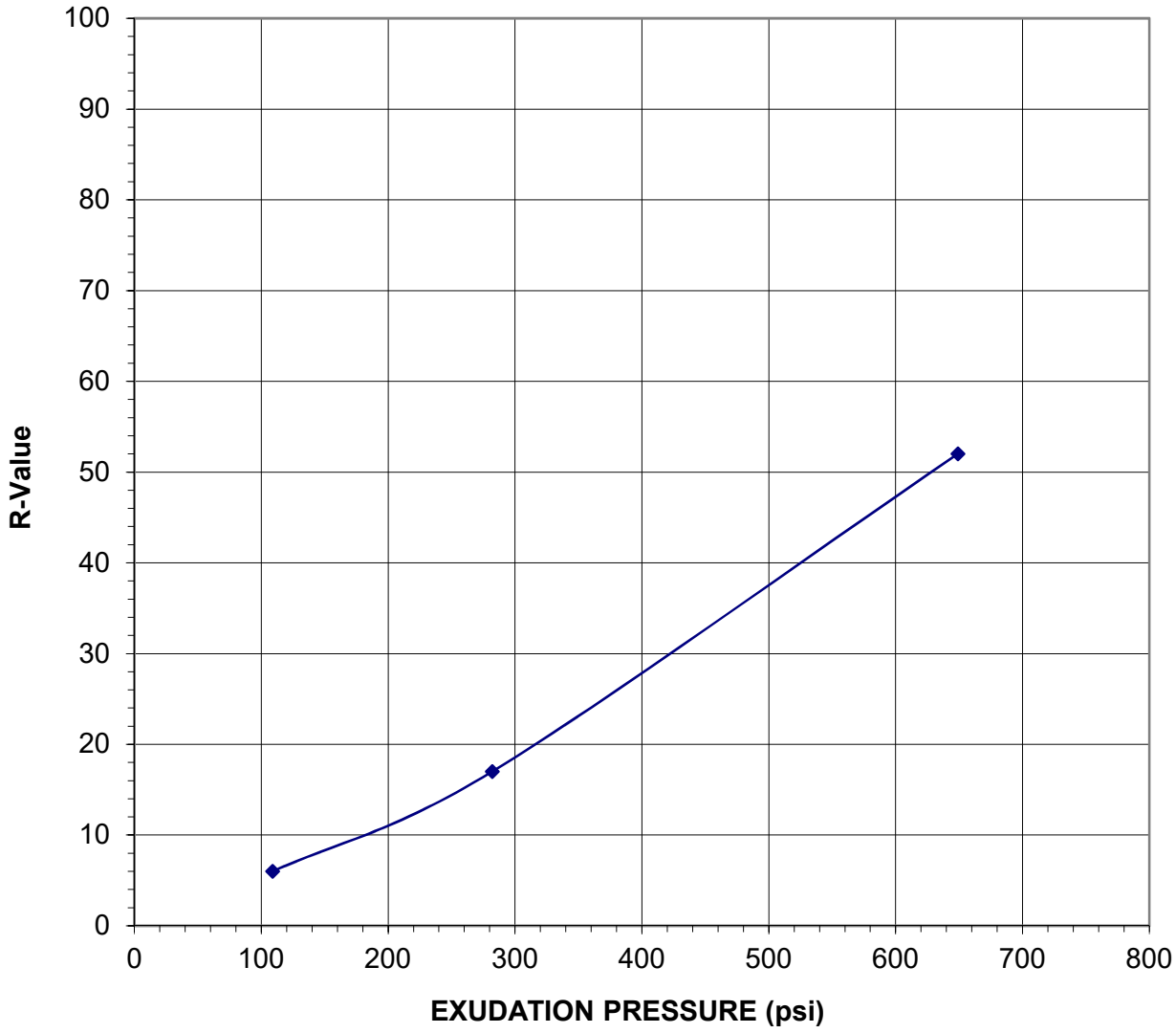
DATE SAMPLED: **10/11/2017** DATE RECEIVED: **11/1/2017** DATE TESTED: **11/7/2017**

GRAVEL: **1** SAND: **59** SILT AND CLAY: **40**

LIQUID LIMIT: **27** PLASTICITY INDEX: **9**

R-VALUE

TEST SPECIMEN	1	2	3	4	Rvalue @ 300 psi
MOISTURE CONTENT (%)	13.8	12.1	10.3		
DENSITY (pcf)	123.1	123.1	116.9		
EXPANSION PRESSURE (psi)	0.000	0.000	0.000		
EXUDATION PRESSURE (psi)	109	282	649		
R-VALUE	6	17	52		**18**



SOIL TYPE: **Silty-Clayey Sand (SC-SM), A-2-4 (0)**

LOCATION: **Powers Blvd., SB, B10 @ 9"-5'**

DATE SAMPLED: **10/13/2017** DATE RECEIVED: **11/1/2017** DATE TESTED: **11/7/2017**

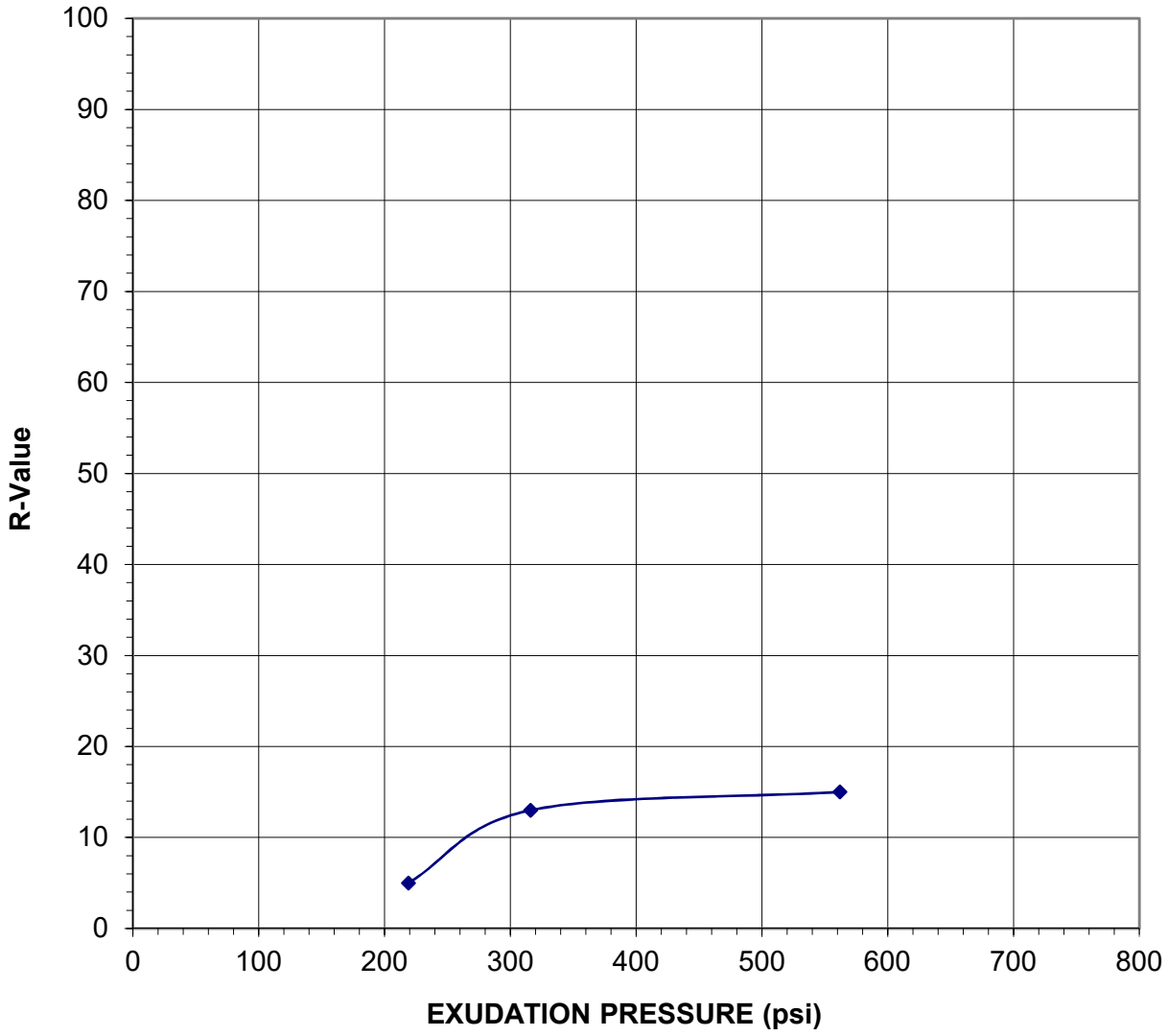
GRAVEL: **1** SAND: **66** SILT AND CLAY: **33**

LIQUID LIMIT: **24** PLASTICITY INDEX: **5**

17-2-183A	KUMAR & ASSOCIATES	HVEEM STABILOMETER TEST RESULTS	Fig. 62

R-VALUE

TEST SPECIMEN	1	2	3	4	Rvalue @ 300 psi
MOISTURE CONTENT (%)	20.3	17.6	16.2		
DENSITY (pcf)	106.8	107.8	110.6		
EXPANSION PRESSURE (psi)	0.000	0.000	0.000		
EXUDATION PRESSURE (psi)	219	316	562		
R-VALUE	5	13	15		**13**



SOIL TYPE: **Fill: Clayey Sand (SC), A-6 (5)**

LOCATION: **Research Parkway, EB, B19 @ 1'-4'**

DATE SAMPLED: **9/19/2017** DATE RECEIVED: **10/4/2017** DATE TESTED: **10/13/2017**

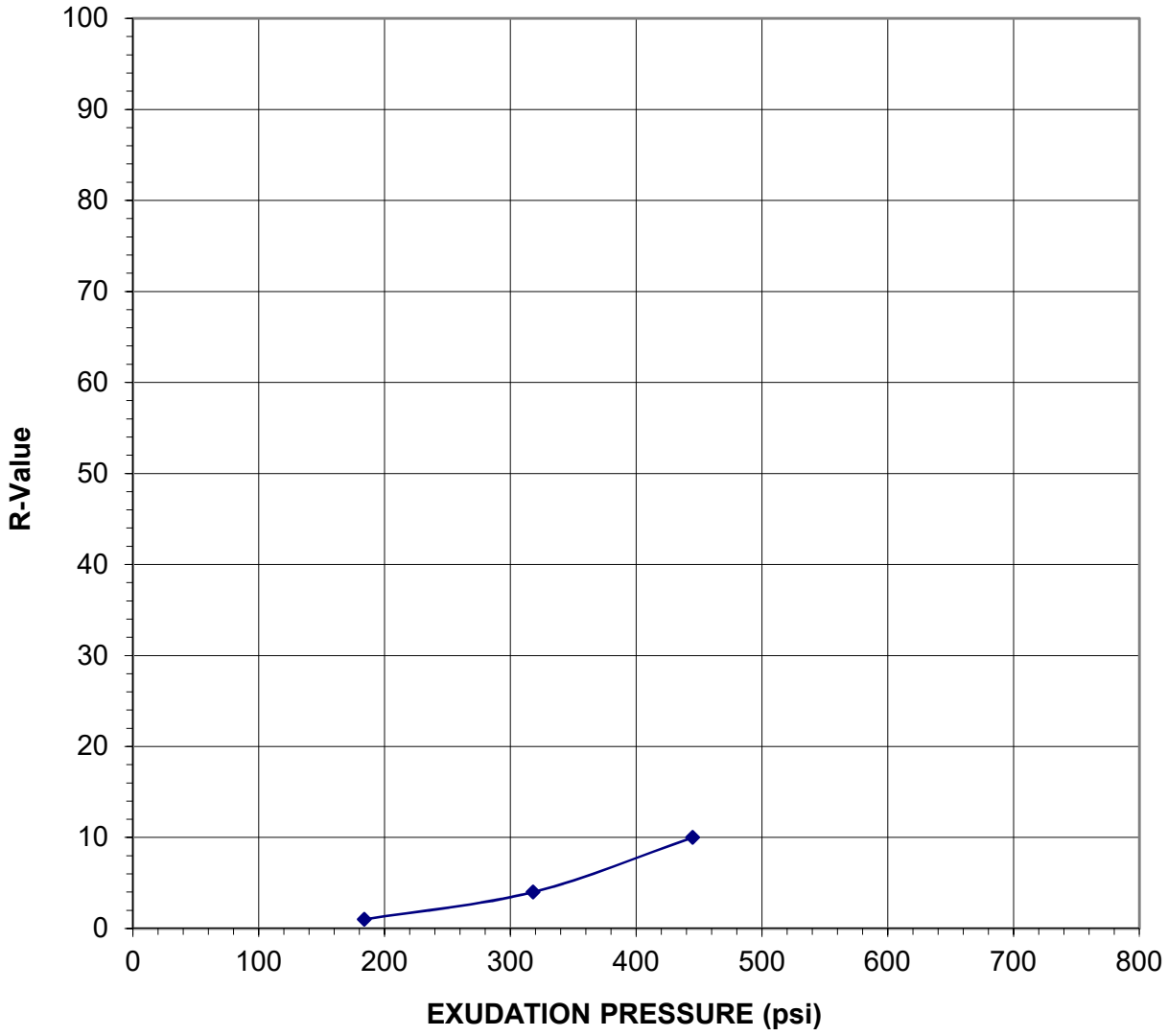
GRAVEL: **2** SAND: **51** SILT AND CLAY: **47**

LIQUID LIMIT: **37** PLASTICITY INDEX: **18**

17-2-183A	KUMAR & ASSOCIATES	HVEEM STABILOMETER TEST RESULTS	Fig. 63

R-VALUE

TEST SPECIMEN	1	2	3	4	Rvalue @ 300 psi
MOISTURE CONTENT (%)	22.0	21.0	20.1		
DENSITY (pcf)	108.8	112.4	110.5		
EXPANSION PRESSURE (psi)	0.000	0.000	0.000		
EXUDATION PRESSURE (psi)	184	318	445		
R-VALUE	1	4	10		**4**



SOIL TYPE: **Fill: Clayey Sand (SC), A-6 (7)**

LOCATION: **Research Parkway, WB, B24 @ 8"-4'**

DATE SAMPLED: **9/19/2017** DATE RECEIVED: **10/4/2017** DATE TESTED: **10/13/2017**

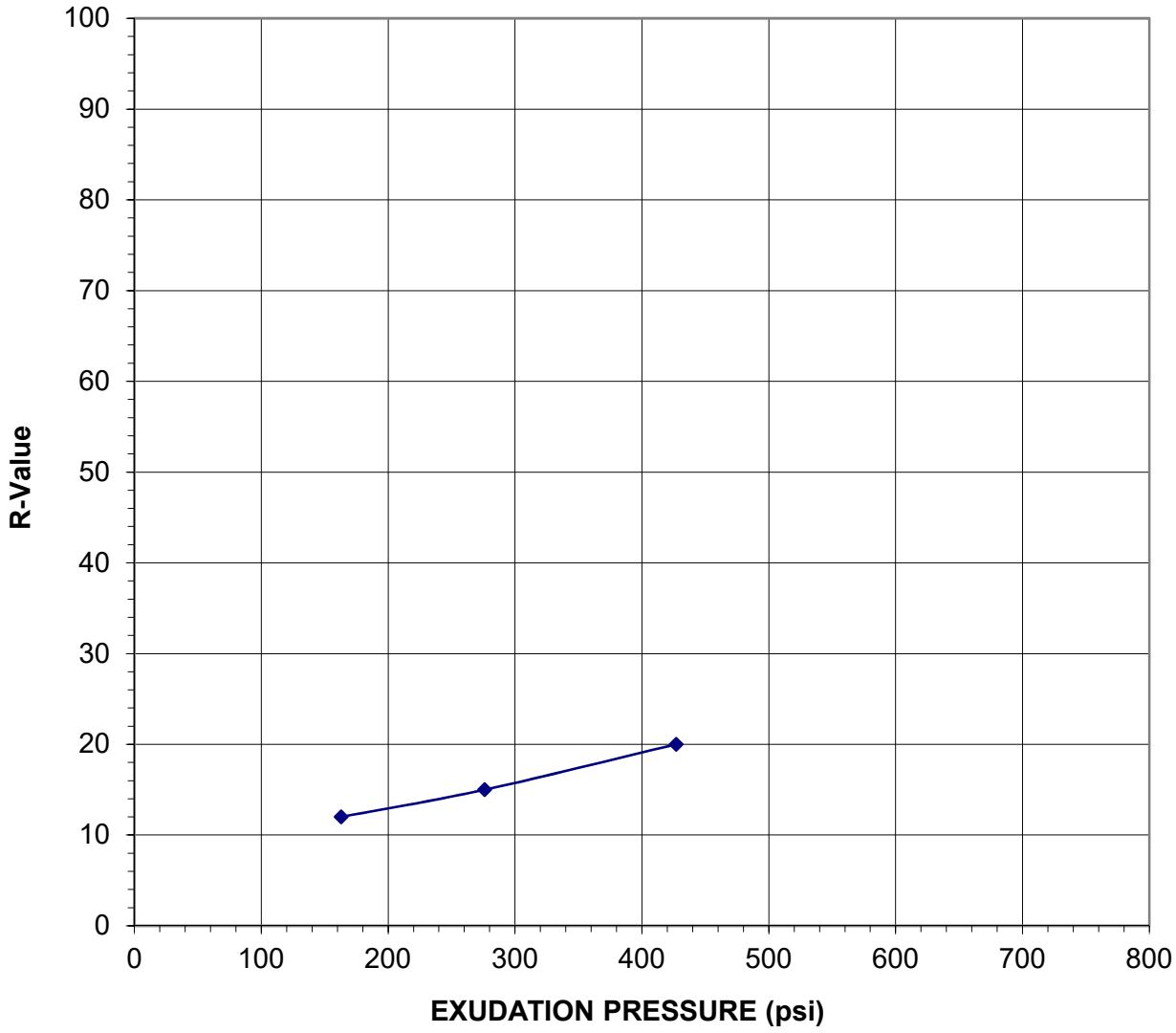
GRAVEL: SAND: SILT AND CLAY: **48**

LIQUID LIMIT: **40** PLASTICITY INDEX: **22**

17-2-183A	KUMAR & ASSOCIATES	HVEEM STABILOMETER TEST RESULTS	Fig. 64

R-VALUE

TEST SPECIMEN	1	2	3	4	Rvalue @ 300 psi
MOISTURE CONTENT (%)	13.0	12.1	10.4		
DENSITY (pcf)	117.9	122.4	124.6		
EXPANSION PRESSURE (psi)	0.000	0.000	0.150		
EXUDATION PRESSURE (psi)	163	276	427		
R-VALUE	12	15	20		**16**



SOIL TYPE: **Fill: Clayey Sand (SC) / A-2-4 (0)**

LOCATION: **Powers / Research Interchange R1 @ 4"-5'**

DATE SAMPLED: **10/4/2018** DATE RECEIVED: **10/23/2018** DATE TESTED: **11/5/2018**

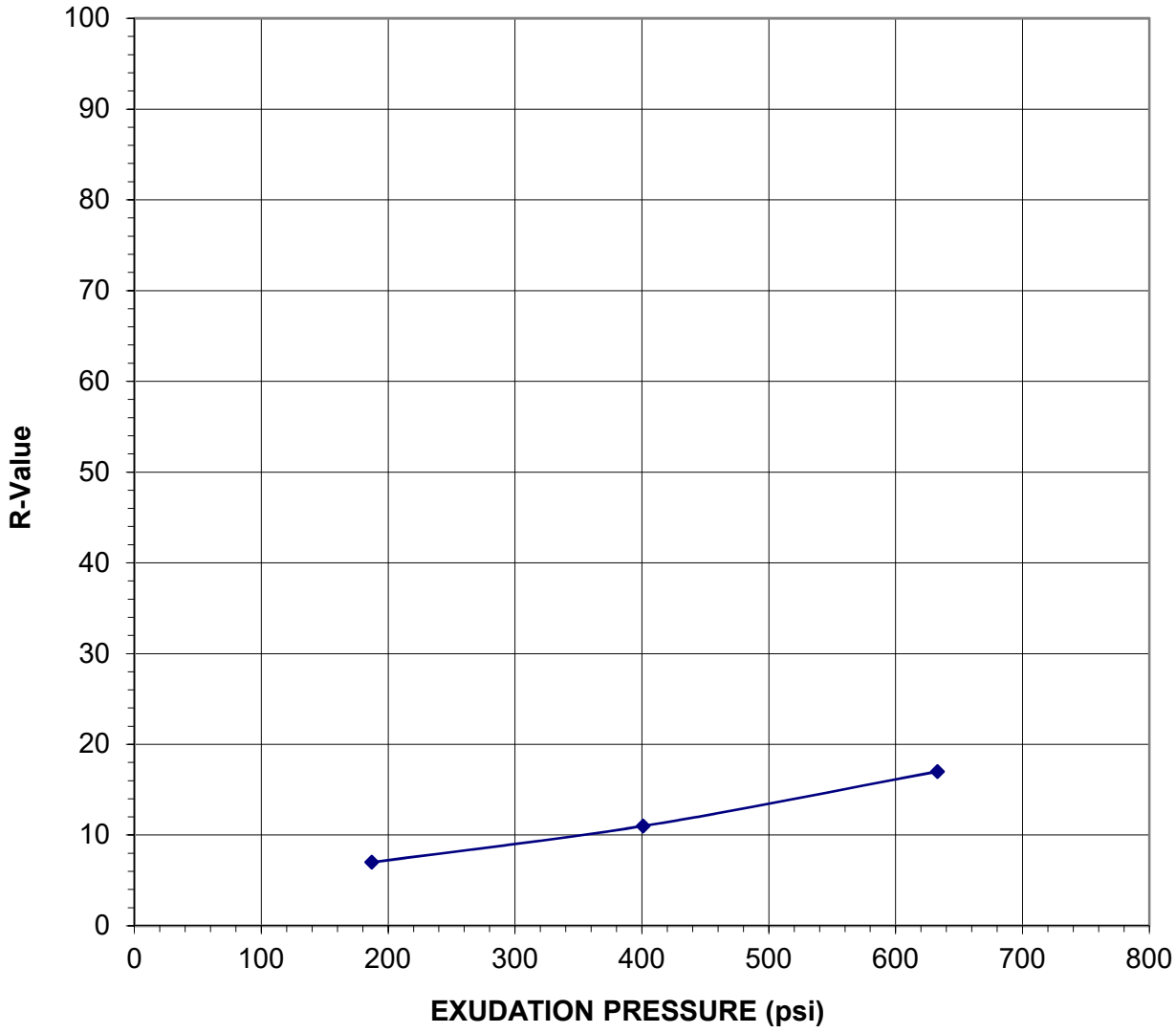
GRAVEL: **3** SAND: **74** SILT AND CLAY: **23**

LIQUID LIMIT: **26** PLASTICITY INDEX: **9**

17-2-183A	KUMAR & ASSOCIATES	HVEEM STABILOMETER TEST RESULTS	Fig. 65

R-VALUE

TEST SPECIMEN	1	2	3	4	Rvalue @ 300 psi
MOISTURE CONTENT (%)	20.9	18.6	16.8		
DENSITY (pcf)	106.5	109.3	113.4		
EXPANSION PRESSURE (psi)	0.210	0.030	0.480		
EXUDATION PRESSURE (psi)	187	401	633		
R-VALUE	7	11	17		**9**



SOIL TYPE: **Clayey Sandstone / A-6 (2)**

LOCATION: **Powers / Research Interchange R3 @ 1.5'-5'**

DATE SAMPLED: **10/3/2018** DATE RECEIVED: **10/23/2018** DATE TESTED: **11/5/2018**

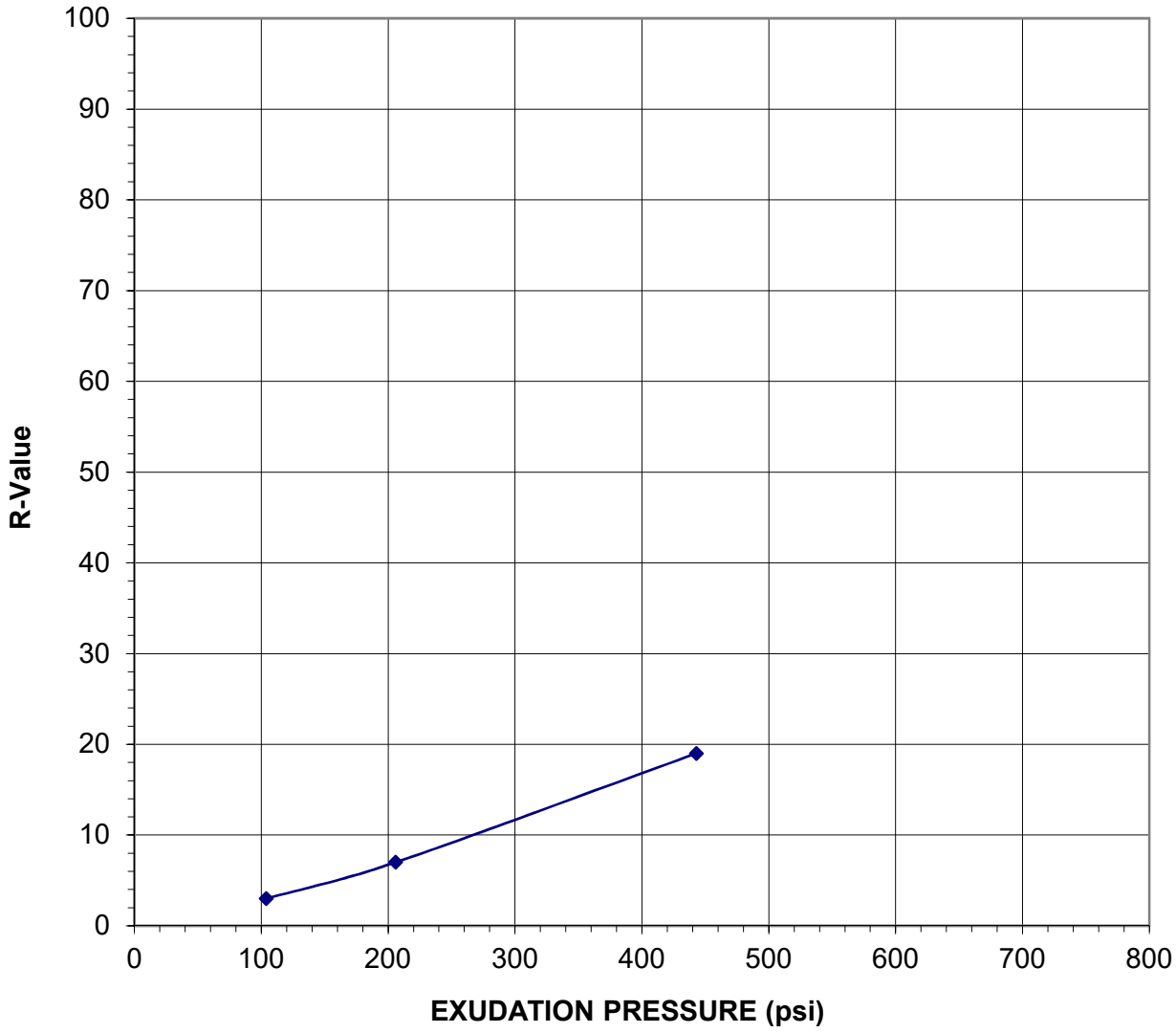
GRAVEL: SAND: SILT AND CLAY: **46**

LIQUID LIMIT: **29** PLASTICITY INDEX: **11**

17-2-183A	KUMAR & ASSOCIATES	HVEEM STABILOMETER TEST RESULTS	Fig. 66

R-VALUE

TEST SPECIMEN	1	2	3	4	Rvalue @ 300 psi
MOISTURE CONTENT (%)	19.2	17.4	15.1		
DENSITY (pcf)	106.5	112.5	110.7		
EXPANSION PRESSURE (psi)	0.210	0.030	0.780		
EXUDATION PRESSURE (psi)	104	206	443		
R-VALUE	3	7	19		**12**



SOIL TYPE: **Sandstone A-4 (0)**

LOCATION: **Powers / Research Interchange R9 @ 3"-5'**

DATE SAMPLED: **10/11/2018** DATE RECEIVED: **10/23/2018** DATE TESTED: **11/6/2018**

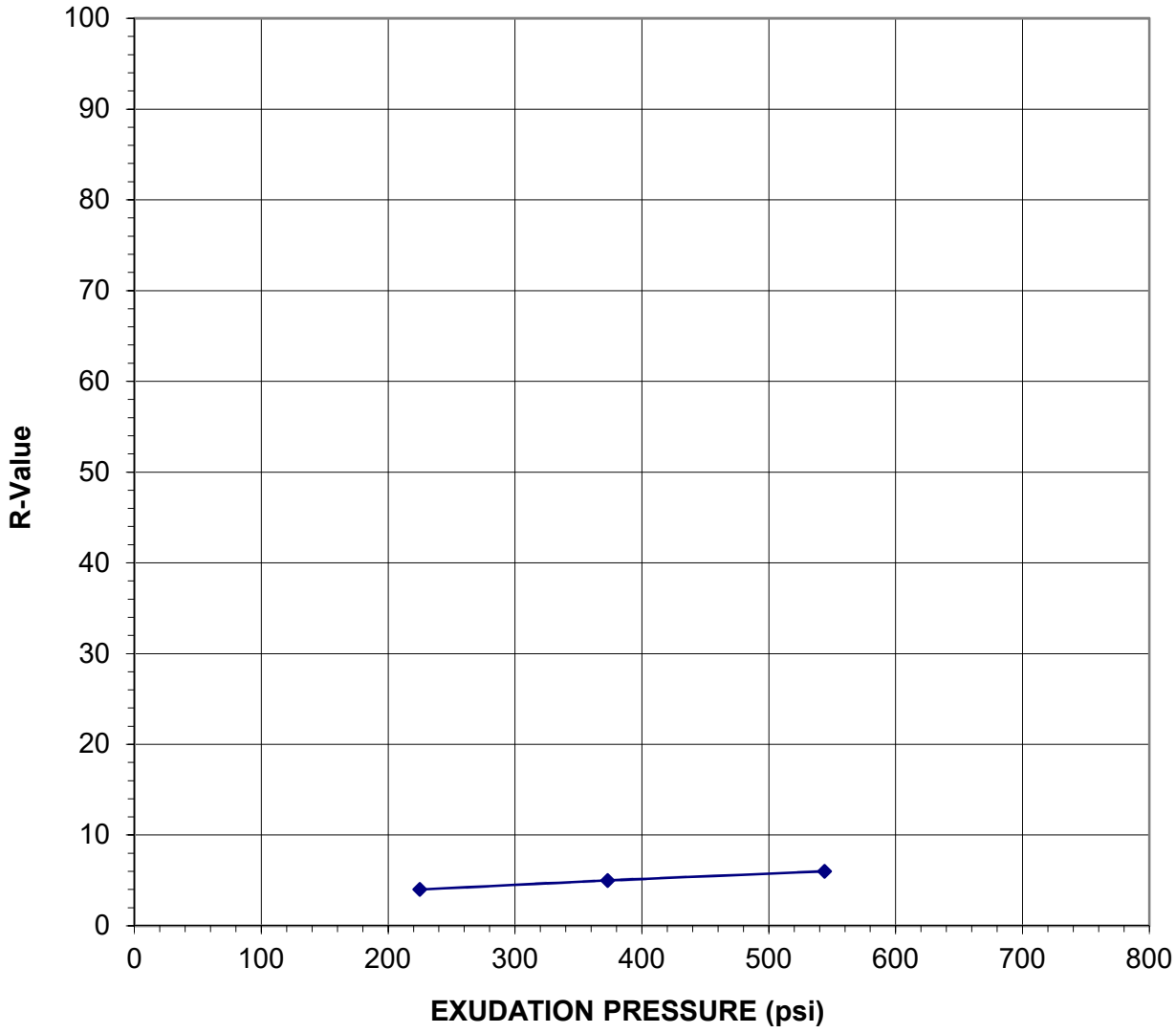
GRAVEL: **0** SAND: **63** SILT AND CLAY: **37**

LIQUID LIMIT: **19** PLASTICITY INDEX: **2**

17-2-183A	KUMAR & ASSOCIATES	HVEEM STABILOMETER TEST RESULTS	Fig. 67

R-VALUE

TEST SPECIMEN	1	2	3	4	Rvalue @ 300 psi
MOISTURE CONTENT (%)	23.3	21.5	19.7		
DENSITY (pcf)	93.7	99.2	109.1		
EXPANSION PRESSURE (psi)	0.210	0.120	0.000		
EXUDATION PRESSURE (psi)	225	373	544		
R-VALUE	4	5	6		**4**



SOIL TYPE: **Claystone / A-6 (7)**

LOCATION: **Powers / Research Interchange R12 @ 3"-5'**

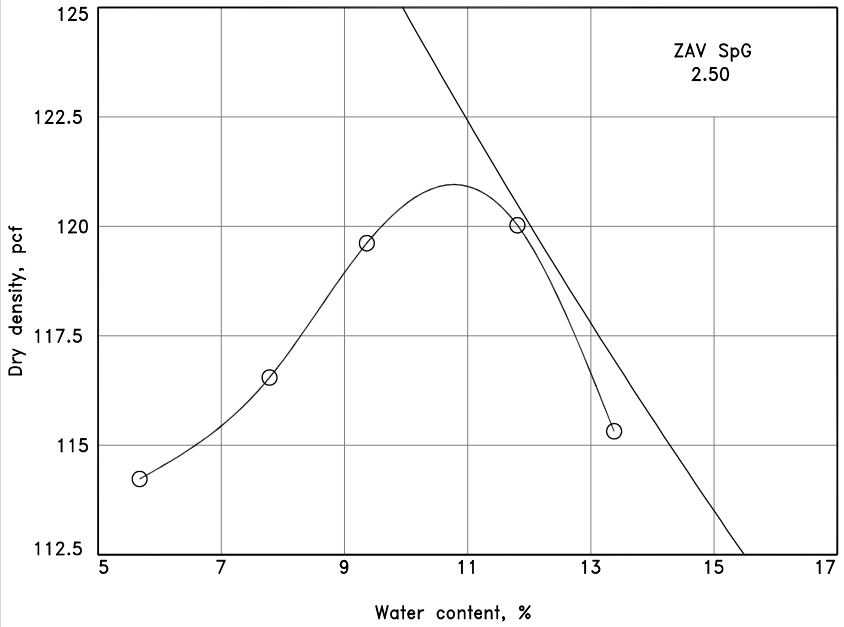
DATE SAMPLED: **10/4/2018** DATE RECEIVED: **10/23/2018** DATE TESTED: **11/5/2018**

GRAVEL: SAND: SILT AND CLAY: **62**

LIQUID LIMIT: **32** PLASTICITY INDEX: **15**

17-2-183A	KUMAR & ASSOCIATES	HVEEM STABILOMETER TEST RESULTS	Fig. 68

COMPACTION TEST REPORT



Preparation Method

Rammer: Wt. 5.5 lb. Drop 12 in.

Type

Layers: No. three Blows per 25

Mold Size 0.03333 cu. ft.

Test Performed on Material

Passing #4 Sieve

%>#4 2 %<No.200 33

Atterberg (D 4318): LL 27 PI 11

NM (D 2216) Sp.G. (D 854) 2.5

USCS (D 2487) SC

AASHTO (M 145) A-2-6(0)

Date: Sampled 10/15/2018

Received 10/15/2018

Tested 10/15/2018

Tested By JEE

COMPACTION TESTING DATA
AASHTO T 99-15 Method A Standard
AASHTO T 224-01 Oversize Correction Applied to Final Results

	1	2	3	4	5	6
WM + WS	6180.0	6254.1	6332.6	6383.7	6331.6	
WM	4356.7	4356.7	4356.7	4356.7	4356.7	
WW + T #1	861.4	755.0	860.1	1137.0	707.1	
WD + T #1	825.6	714.8	805.4	1040.3	646.1	
TARE #1	194.5	198.2	221.1	221.3	190.1	
WW + T #2						
WD + T #2						
TARE #2						
MOIST.	5.7	7.8	9.4	11.8	13.4	
DRY DENS.	114.2	116.5	119.6	120.0	115.3	

SIEVE TEST RESULTS
ASTM D 422 ASTM D 1140

Opening Size	% Passing	Specs.
3/4"	100	
3/8"	100	
#4	98	
#10	88	
#16	79	
#40	61	
#50	54	
#100	42	
#200	33	

ROCK CORRECTED TEST RESULTS

Maximum dry density = 122 pcf

Optimum moisture = 11 %

Material Description

Fill: Clayey Sand (SC)
A-6 (2)

Project No. 17-2-183.A Client: FHU

Project: Powers Boulevard/Research Parkway Interchange; Final Study

○ Depth: 3"-20' Sample Number: F2

Remarks:

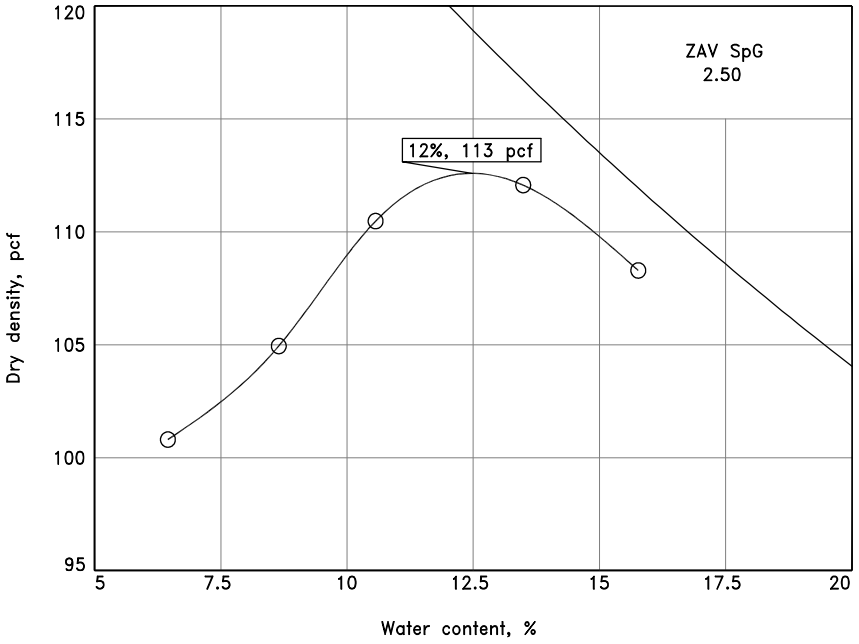
These test results apply only to the samples which were tested. the testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Moisture/density relationships performed in accordance with ASTM D698, D1557. Atterberg limits performed in accordance with ASTM D4318 sieve analysis performed in accordance with ASTM D422, D1140.

Checked by: JE

Title: Lab tech.

17-2-183A	Kumar & Associates	MOISTURE-DENSITY RELATIONSHIPS	Fig. 69

COMPACTION TEST REPORT



Preparation Method

Rammer: Wt. 5.5 lb. Drop 12 in.

Type

Layers: No. three Blows per 25

Mold Size 0.03333 cu. ft.

Test Performed on Material

Passing #4 Sieve

%>#4 2 %<No.200 44

Atterberg (D 4318): LL 28 PI 11

NM (D 2216) Sp.G. (D 854) 2.5

USCS (D 2487) SC

AASHTO (M 145) A-6(2)

Date: Sampled 10/11/2018

Received 10/11/2018

Tested 10/11/2018

Tested By JEE

COMPACTION TESTING DATA
AASHTO T 99-15 Method A Standard
AASHTO T 224-01 Oversize Correction Applied to Final Results

	1	2	3	4	5	6
WM + WS	5977.3	6078.7	6201.5	6277.6	6250.1	
WM	4356.5	4356.5	4356.5	4356.5	4356.5	
WW + T #1	853.2	817.9	965.1	723.3	868.0	
WD + T #1	813.2	767.9	893.9	663.3	776.1	
TARE #1	193.2	189.7	220.0	218.5	193.3	
WW + T #2						
WD + T #2						
TARE #2						
MOIST.	6.5	8.6	10.6	13.5	15.8	
DRY DENS.	100.8	104.9	110.5	112.1	108.3	

SIEVE TEST RESULTS
ASTM D 422 ASTM D 1140

Opening Size	% Passing	Specs.
3/8"	100	
#4	98	
#10	89	
#16	83	
#40	69	
#50	64	
#100	53	
#200	44	

ROCK CORRECTED TEST RESULTS

Maximum dry density = 113 pcf

Optimum moisture = 12 %

Material Description

Fill: Clayey Sand (SC)
A-6 (2)

Remarks:

These test results apply only to the samples which were tested. the testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Moisture/density relationships performed in accordance with ASTM D698, D1557. Atterberg limits performed in accordance with ASTM D4318 sieve analysis performed in accordance with ASTM D422, D1140.

Project No. 17-2-183.A Client: FHU

Project: Powers Boulevard/Research Parkway Interchange; Final Study

○ Depth: 3"-10' Sample Number: F3

Checked by: JE

Title: Lab tech.

17-2-183A	Kumar & Associates	MOISTURE-DENSITY RELATIONSHIPS	Fig. 70

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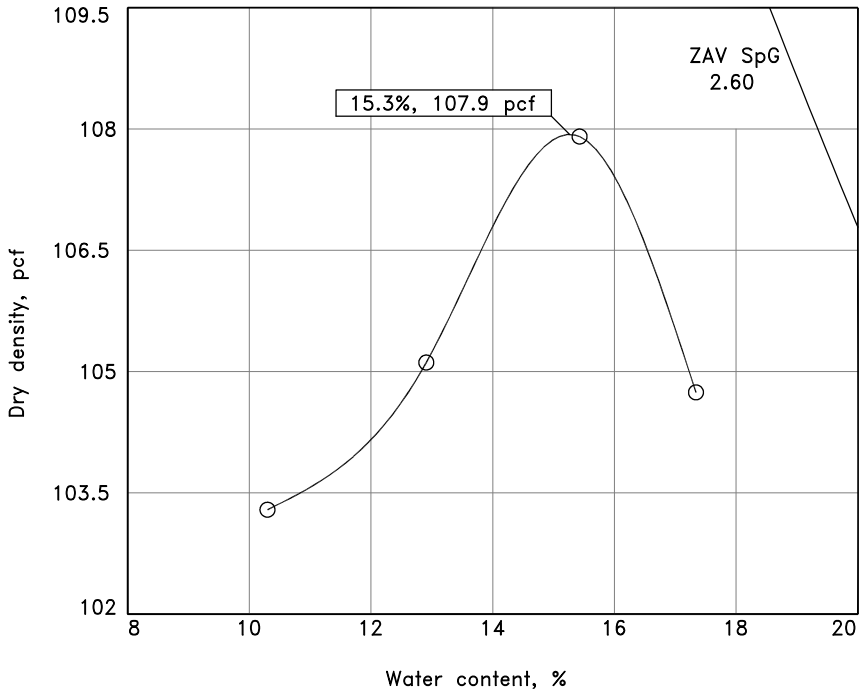
COMPACTION TEST REPORT

Curve No. 8075



Preparation Method

Rammer: Wt. 5.50 lb. Drop 12.00

Type Manual

Layers: No. 3 Blows per 25

Mold Size 0.03333 cu. ft.

Test Performed on Material

Passing #4 Sieve

%>#4 0 %<No.200 47

Atterberg (D 4318): LL 26 PI 10

NM (D 2216) Sp.G. (D 854) 2.6

USCS (D 2487) SC

AASHTO (M 145) A-4(2)

Date: Sampled 11-1-17

Received 11-1-17

Tested 11-2-17

Tested By AS

COMPACTION TESTING DATA
ASTM D 698-12 Method A Standard

	1	2	3	4	5	6
WM + WS	3898.0	3970.0	4059.0	4034.0		
WM	2172.0	2172.0	2172.0	2172.0		
WW + T #1	399.7	396.5	387.4	389.7		
WD + T #1	377.2	368.4	356.5	354.5		
TARE #1	158.7	150.7	156.2	151.5		
WW + T #2						
WD + T #2						
TARE #2						
MOIST.	10.3	12.9	15.4	17.3		
DRY DENS.	103.3	105.1	107.9	104.7		

TEST RESULTS

Maximum dry density = 107.9 pcf

Optimum moisture = 15.3 %

Project No. 17-2-183 Client: FHU

Project: Powers Boulevard

○ Location: B7 Depth: 8"-4' Sample Number: 8075

Material Description

Clayey Sandstone
A-4 (0)

Remarks:

These test results apply only to the samples which were tested. the testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Moisture/density relationships performed in accordance with ASTM D698, D1557. Atterberg limits performed in accordance with ASTM D4318 sieve analysis performed in accordance with ASTM D422, D1140.

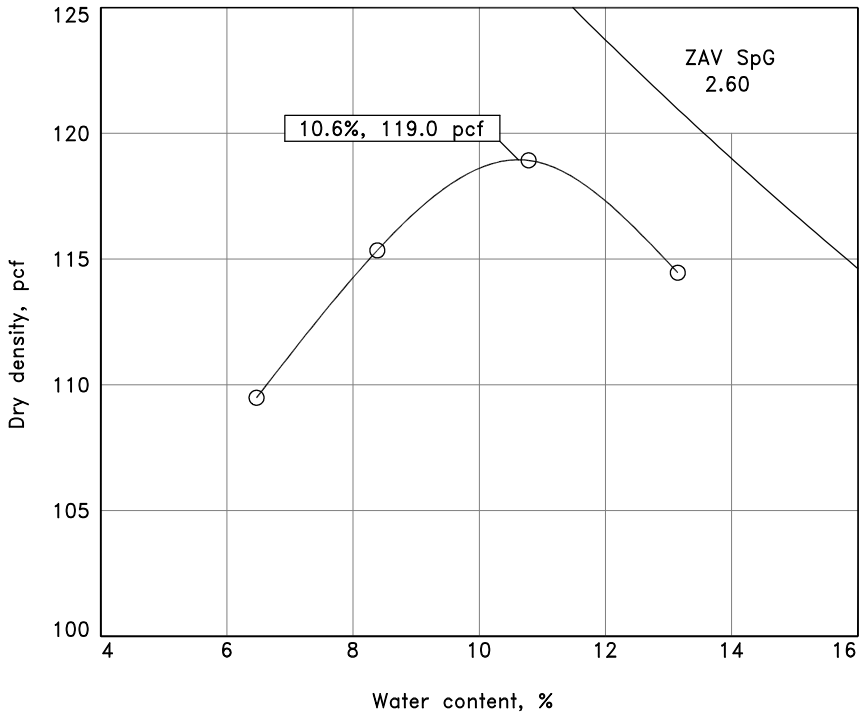
Checked by: DS

Title: Lab Manager

17-2-183A	Kumar & Associates	MOISTURE-DENSITY RELATIONSHIPS	Fig. 71

COMPACTION TEST REPORT

Curve No. 8074



Preparation Method

Rammer: Wt. 5.50 lb. Drop 12.00

Type Manual

Layers: No. 3 Blows per 25

Mold Size 0.03333 cu. ft.

Test Performed on Material

Passing #4 Sieve

%>#4 1 %<No.200 33

Atterberg (D 4318): LL 21 PI 5

NM (D 2216) Sp.G. (D 854) 2.6

USCS (D 2487) SC-SM

AASHTO (M 145)

Date: Sampled 11-1-17

Received 11-1-17

Tested 11-3-17

Tested By AS

COMPACTION TESTING DATA
ASTM D 698-12 Method A Standard

	1	2	3	4	5	6
WM + WS	3938.0	4066.0	4168.0	4134.0		
WM	2172.0	2172.0	2172.0	2172.0		
WW + T #1	404.7	463.7	404.3	477.7		
WD + T #1	389.6	440.1	379.6	439.8		
TARE #1	156.2	158.6	150.5	151.5		
WW + T #2						
WD + T #2						
TARE #2						
MOIST.	6.5	8.4	10.8	13.1		
DRY DENS.	109.5	115.3	118.9	114.5		

TEST RESULTS

Maximum dry density = 119.0 pcf

Optimum moisture = 10.6 %

Project No. 17-2-183 Client: FHU

Project: Powers and Research Interchange

○ Location: B10 Depth: 9"-5' Sample Number: 8074

Material Description

Silty-Clayey Sand (SC-SM)
A-2-4 (0)

Remarks:

These test results apply only to the samples which were tested. the testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Moisture/density relationships performed in accordance with ASTM D698, D1557. Atterberg limits performed in accordance with ASTM D4318 sieve analysis performed in accordance with ASTM D422, D1140.

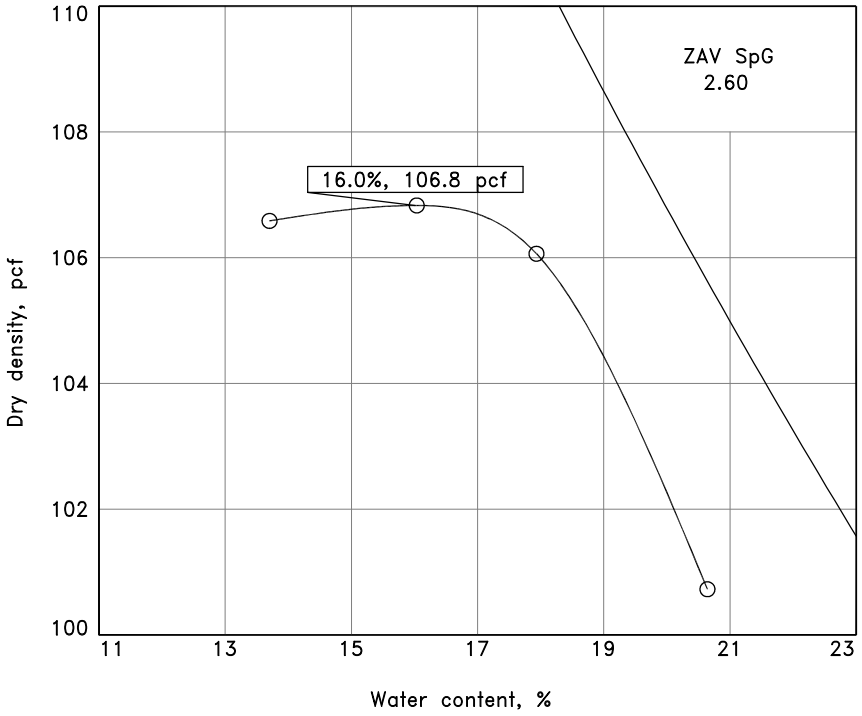
Checked by: DS

Title: Lab Manager

17-2-183A	Kumar & Associates	MOISTURE-DENSITY RELATIONSHIPS	Fig. 72

COMPACTION TEST REPORT

Curve No. 8073



Preparation Method

Rammer: Wt. 5.50 lb. Drop 12.00

Type Manual

Layers: No. 3 Blows per 25

Mold Size 0.03333 cu. ft.

Test Performed on Material

Passing #4 Sieve

%>#4 2 %<No.200 47

Atterberg (D 4318): LL 37 PI 18

NM (D 2216) Sp.G. (D 854) 2.6

USCS (D 2487) SC

AASHTO (M 145)

Date: Sampled 11-1-17

Received 11-1-17

Tested 11-3-17

Tested By AS

COMPACTION TESTING DATA
ASTM D 698-12 Method A Standard

	1	2	3	4	5	6
WM + WS	4008.0	4050.0	4067.0	4013.0		
WM	2172.0	2172.0	2172.0	2172.0		
WW + T #1	408.2	432.6	441.8	445.0		
WD + T #1	378.0	392.8	399.1	395.6		
TARE #1	157.6	144.6	161.0	156.3		
WW + T #2						
WD + T #2						
TARE #2						
MOIST.	13.7	16.0	17.9	20.6		
DRY DENS.	106.6	106.8	106.1	100.7		

TEST RESULTS

Maximum dry density = 106.8 pcf

Optimum moisture = 16.0 %

Project No. 17-2-183 Client: FHU

Project: Research Parkway

○ Location: B19 Depth: 1'-4' Sample Number: 8073

Material Description

Fill: Clayey Sand (SC)
A-6 (5)

Remarks:

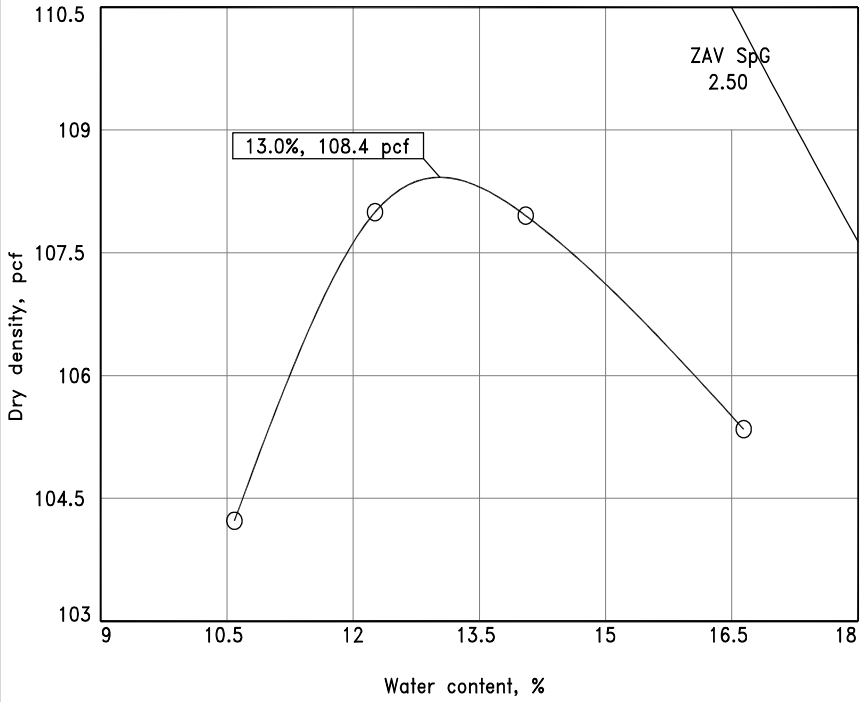
These test results apply only to the samples which were tested. the testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Moisture/density relationships performed in accordance with ASTM D698, D1557. Atterberg limits performed in accordance with ASTM D4318 sieve analysis performed in accordance with ASTM D422, D1140.

Checked by: DS

Title: Lab Manager

17-2-183A	Kumar & Associates	MOISTURE-DENSITY RELATIONSHIPS	Fig. 73

COMPACTION TEST REPORT



Preparation Method _____

Rammer: Wt. 5.5 lb. Drop 12 in

Type _____

Layers: No. 3 Blows per 25

Mold Size 0.03333 cu. ft.

Test Performed on Material

Passing #4 Sieve

%>#4 _____ %<No.200 _____

Atterberg (D 4318): LL _____ PI _____

NM (D 2216) _____ Sp.G. (D 854) 2.5

USCS (D 2487) _____

AASHTO (M 145) _____

Date: Sampled 9/19/2017

Received 9/19/2017

Tested 9/19/2017

Tested By JEE

COMPACTION TESTING DATA
ASTM D 698-12 Method A Standard

	1	2	3	4	5	6
WM + WS	6133.4	6223.6	6252.1	6248.4		
WM	4392.4	4392.4	4392.4	4392.4		
WW + T #1	678.5	613.1	759.2	733.0		
WD + T #1	634.8	570.5	693.5	655.7		
TARE #1	222.1	223.0	225.9	191.2		
WW + T #2						
WD + T #2						
TARE #2						
MOIST.	10.6	12.3	14.1	16.6		
DRY DENS.	104.2	108.0	108.0	105.3		

TEST RESULTS

Maximum dry density = 108.4 pcf

Optimum moisture = 13.0 %

Project No. 17-2-183 Client: FHU

Project: Research Parkway

○ Depth: 8"-4' Sample Number: Boring B24

Material Description

Fill: Clayey Sand (SC)
A-6 (7)

Remarks:

These test results apply only to the samples which were tested. the testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Moisture/density relationships performed in accordance with ASTM D698, D1557. Atterberg limits performed in accordance with ASTM D4318 sieve analysis performed in accordance with ASTM D422, D1140.

Checked by: JE

Title: Lab tech.

17-2-183A	Kumar & Associates	MOISTURE-DENSITY RELATIONSHIPS	Fig. 74

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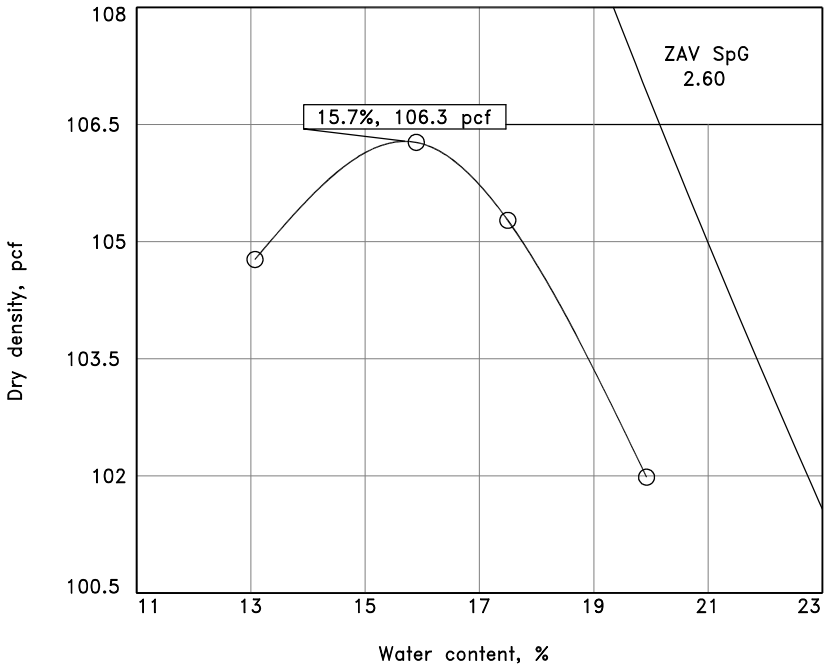
COMPACTION TEST REPORT

Curve No. 9012



Preparation Method

Rammer: Wt. 5.5 lb. Drop 12 in.

Type Manual

Layers: No. 3 Blows per 25

Mold Size 0.03333 cu. ft.

Test Performed on Material

Passing #4 Sieve

%>#4 0 %<No.200 46

Atterberg (D 4318): LL 29 PI 11

NM (D 2216) Sp.G. (D 854) 2.6

USCS (D 2487) SC

AASHTO (M 145) A-6 (2)

Date: Sampled 10-23-18

Received 10-23-18

Tested 10-26-18

Tested By AS

COMPACTION TESTING DATA
ASTM D 698-12 Method A Standard

	1	2	3	4	5	6
WM + WS	3955.0	4026.0	4034.0	4013.0		
WM	2164.0	2164.0	2164.0	2164.0		
WW + T #1	449.5	440.3	460.3	527.8		
WD + T #1	414.9	399.5	413.2	464.8		
TARE #1	150.2	142.8	144.0	148.6		
WW + T #2						
WD + T #2						
TARE #2						
MOIST.	13.1	15.9	17.5	19.9		
DRY DENS.	104.8	106.3	105.3	102.0		

TEST RESULTS

Maximum dry density = 106.3 pcf

Optimum moisture = 15.7 %

Project No. 17-2-183A Client: FHU

Project: Powers and Research Interchange

○ Location: R3 Depth: 1.5'-5' Sample Number: 9012

Material Description

Clayey Sandstone
A-6 (2)

Remarks:

These test results apply only to the samples which were tested. the testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Moisture/density relationships performed in accordance with ASTM D698, D1557. Atterberg limits performed in accordance with ASTM D4318 sieve analysis performed in accordance with ASTM D422, D1140.

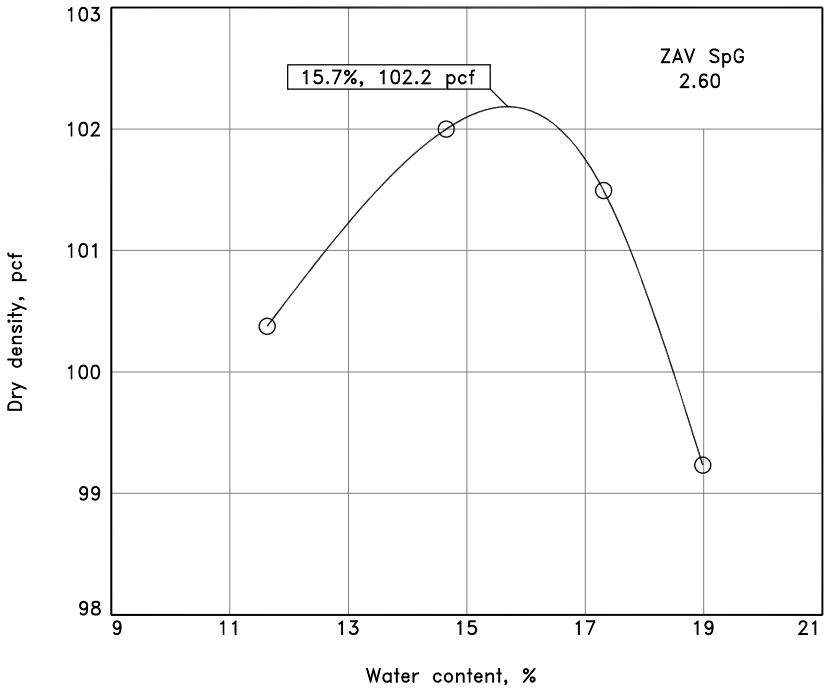
Checked by: DS

Title: Lab Manager

17-2-183A	Kumar & Associates	MOISTURE-DENSITY RELATIONSHIPS	Fig. 75

COMPACTION TEST REPORT

Curve No. 9015



Preparation Method

Rammer: Wt. 5.5 lb. Drop 12 in.

Type Manual

Layers: No. 3 Blows per 25

Mold Size 0.03333 cu. ft.

Test Performed on Material

Passing #4 Sieve

%>#4 0 %<No.200 50

Atterberg (D 4318): LL 33 PI 14

NM (D 2216) Sp.G. (D 854) 2.6

USCS (D 2487)

AASHTO (M 145) A-6 (4)

Date: Sampled 10-23-18

Received 10-23-18

Tested 10-26-18

Tested By AS

COMPACTION TESTING DATA
ASTM D 698-12 Method A Standard

	1	2	3	4	5	6
WM + WS	3858.0	3932.0	3964.0	3949.0		
WM	2164.0	2164.0	2164.0	2164.0		
WW + T #1	430.5	445.2	496.4	485.6		
WD + T #1	401.9	407.5	447.9	432.6		
TARE #1	156.0	150.2	167.7	153.4		
WW + T #2						
WD + T #2						
TARE #2						
MOIST.	11.6	14.7	17.3	19.0		
DRY DENS.	100.4	102.0	101.5	99.2		

TEST RESULTS

Maximum dry density = 102.2 pcf

Optimum moisture = 15.7 %

Project No. 17-2-183A Client: FHU

Project: Powers and Research Interchange

○ Location: R5 Depth: 2"-5' Sample Number: 9015

Material Description

Fill: Sandy Lean Clay (CL)
A-6 (4)

Remarks:

These test results apply only to the samples which were tested. the testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Moisture/density relationships performed in accordance with ASTM D698, D1557. Atterberg limits performed in accordance with ASTM D4318 sieve analysis performed in accordance with ASTM D422, D1140.

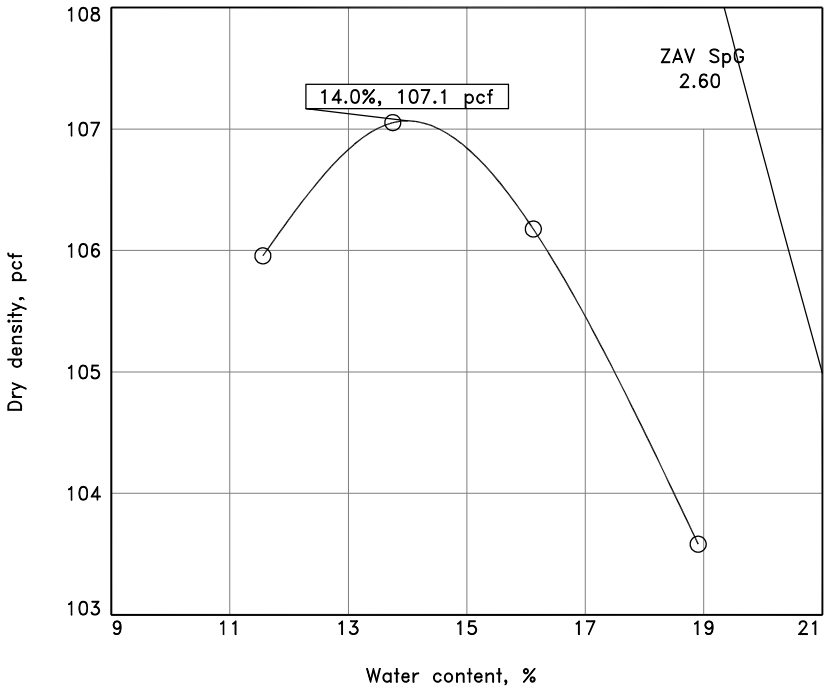
Checked by: DS

Title: Lab Manager

17-2-183A	Kumar & Associates	MOISTURE-DENSITY RELATIONSHIPS	Fig. 76

COMPACTION TEST REPORT

Curve No. 9014



Preparation Method

Rammer: Wt. 5.5 lb. Drop 12 in.

Type Manual

Layers: No. 3 Blows per 25

Mold Size 0.03333 cu. ft.

Test Performed on Material

Passing #4 Sieve

%>#4 0 %<No.200 62

Atterberg (D 4318): LL 32 PI 15

NM (D 2216) Sp.G. (D 854) 2.6

USCS (D 2487)

AASHTO (M 145) A-6 (7)

Date: Sampled 10-23-18

Received 10-23-18

Tested 10-26-18

Tested By AS

COMPACTION TESTING DATA
ASTM D 698-12 Method A Standard

	1	2	3	4	5	6
WM + WS	3951.0	4005.0	4028.0	4026.0		
WM	2164.0	2164.0	2164.0	2164.0		
WW + T #1	507.8	431.0	453.8	501.0		
WD + T #1	477.3	398.7	415.3	447.5		
TARE #1	213.4	163.8	176.5	164.5		
WW + T #2						
WD + T #2						
TARE #2						
MOIST.	11.6	13.8	16.1	18.9		
DRY DENS.	106.0	107.1	106.2	103.6		

TEST RESULTS

Maximum dry density = 107.1 pcf

Optimum moisture = 14.0 %

Project No. 17-2-183A Client: FHU

Project: Powers and Research Interchange

○ Location: R12 Depth: 3"-5' Sample Number: 9014

Material Description

Claystone
A-6 (7)

Remarks:

These test results apply only to the samples which were tested. the testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Moisture/density relationships performed in accordance with ASTM D698, D1557. Atterberg limits performed in accordance with ASTM D4318 sieve analysis performed in accordance with ASTM D422, D1140.

Checked by: DS

Title: Lab Manager

17-2-183A	Kumar & Associates	MOISTURE-DENSITY RELATIONSHIPS	Fig. 77

LEGEND:

ANTICIPATED OVEREXCAVATION AREAS

100 0 100 200

APPROXIMATE SCALE–FEET

July 18, 2019 – 03:06pm
V:\Projects\2017\17-2-183.A Powers Boulevard-Research Parkway Interchange; Final Study\Drafting\172183A-78.dwg

17–2–183A	Kumar & Associates		POTENTIAL AREAS REQUIRING OVEREXCAVATION	Fig. 78

Kumar & Associates, Inc.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Project No.: 17-2-183A
Project Name: Research Parkway/Powers Boulevard Interchange
Date Sampled: 9/19-10/13/2017; 9/19/2018- 10/15/2018
Date Received: 9/19-10/13/2017; 9/19/2018- 10/15/2018

SAMPLE LOCATION		DATE TESTED	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		WATER SOLUBLE SULFATES (%)	UNCONFINED COMPRSSSIVE STRENGTH (psf)	R-VALUE	STANDARD PROCTOR		AASHTO CLASSIFICATION (group index)	SOIL OR BEDROCK TYPE (Unified Soil Classification)
BORING	DEPTH				GRAVEL (%)	SAND (%)		LIQUID LIMIT	PLASTICITY INDEX				MAX DRY DENSITY (pcf)	OPTIMUM MOISTURE CONTENT (%)		
S1	2'	10/13/17	3.3	102.2	1	82	17	26	7						A-2-4 (0)	Fill: Silty Clayey Sand (SC-SM)
S1	19'	10/13/17	14.8	112.5							10,678					Claystone
S1	24'	10/13/17	17.3	109.6	0	93	7		NP						A-1-b (0)	Sandstone
S2	4'	10/13/17	21.7	94.9	4	62	34		NP						A-2-4 (0)	Silt Sand (SM)
S2	34'	10/13/17	15.2	115.9			46	35	9						A-4 (2)	Clayey Sandstone
S2	39'	10/13/17	16.1	113.4												Claystone
S3	14'	10/13/17	24.5	100.0							9,631					Claystone
S3	19'	10/13/17					61	42	11						A-7-5 (6)	Sandy Claystone
S4	4'	10/13/17	12.6	115.9	2	61	37	32	16						A-6 (2)	Fill: Clayey Sand (SC)
S4	24'	10/13/17	16.9	109.4			49		NP		1,548				A-4 (0)	Sandstone
S1A	9'	10/18/18	22.3	103.1			72	49	20	0.03					A-7-6 (15)	Sandy Claystone
S1A	29'	10/18/18	16.1	115.0			38	38	14		6,887				A-6 (1)	Clayey Sandstone
S2A	14'	10/18/18	20.7	101.7	0	81	19		NP	0.02					A-2-4 (0)	Sandstone
S2A	24'	10/18/18	16.0	109.6												Sandstone
W1	4'	10/18/18	7.4	110.5	1	85	14		NP	0.01					A-2-4 (0)	Silty Sand (SM)
W1	14'	10/18/18	19.1	107.2							18,392					Claystone
W2	2'	10/18/18	10.6	120.7	0	93	7		NP						A-1-b (0)	Well Graded Sand with Silt (SW-SM)
W2	9'	10/18/18	16.8	112.9			70	41	16						A-7-6 (10)	Sandy Claystone
W3	4'	10/18/18	11.2	119.4	6	65	29	33	16	0.07					A-2-6 (1)	Fill: Clayey Sand (SC)

Kumar & Associates, Inc.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Project No.: 17-2-183A
Project Name: Research Parkway/Powers Boulevard Interchange
Date Sampled: 9/19-10/13/2017; 9/19/2018- 10/15/2018
Date Received: 9/19-10/13/2017; 9/19/2018- 10/15/2018

SAMPLE LOCATION		DATE TESTED	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		WATER SOLUBLE SULFATES (%)	UNCONFINED COMPRSSSIVE STRENGTH (psf)	R-VALUE	STANDARD PROCTOR		AASHTO CLASSIFICATION (group index)	SOIL OR BEDROCK TYPE (Unified Soil Classification)
BORING	DEPTH				GRAVEL (%)	SAND (%)		LIQUID LIMIT	PLASTICITY INDEX				MAX DRY DENSITY (pcf)	OPTIMUM MOISTURE CONTENT (%)		
W4	9'	10/18/18	6.5	126.5	6	82	12	26	6						A-1-b (0)	Sandstone
W4	14'	10/18/18	15.3	115.0			88	47	28	<0.01					A-7-6 (26)	Claystone
SW1	4'	10/18/18	5.5	129.0	1	72	27	28	9	0.02					A-2-4 (0)	Clayey Sand (SC)
SW1	14'	10/18/18	22.8	101.2												Claystone
SW2	19'	10/18/18	14.2	114.6	0	87	13		NP						A-2-4 (0)	Sandstone
SW4	9'	10/18/18	11.6	118.2			45	28	9	0.02					A-4 (1)	Clayey Sandstone
SW5	4'	10/18/18	4.1	119.1	0	78	22		NP						A-2-4 (0)	Silty Sand (SM)
SW7	2'	10/18/18	22.5	101.1			90	56	34						A-7-6 (33)	Fill: Fat Clay (CH)
SW7	9'	10/18/18	19.8	109.8												Claystone
SW7	14'	10/18/18					79	33	16		26,704				A-6 (11)	Claystone
SW8	4'	10/23/18	13.3	118.8			70	33	16	0.02					A-6 (9)	Claystone
SW9	9'	10/23/18	19.1	107.9			94	53	30						A-7-6 (31)	Claystone
SW11	4'	10/23/18	15.5	113.2	2	50	48	34	17						A-6 (5)	Fill: Clayey Sand (SC)
SW13	9'	10/23/18	11.3	119.9	8	87	5		NP						A-1-b (0)	Well Graded Sand with Silt (SW-SM)
SW13	19'	10/23/18	22.3	104.0			68	46	19						A-7-6 (12)	Claystone
SW14	9'	10/23/18	8.9	115.2	2	83	15	18	2						A-1-b (0)	Silty Sand (SM)

Kumar & Associates, Inc.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Project No.: 17-2-183A
Project Name: Research Parkway/Powers Boulevard Interchange
Date Sampled: 9/19-10/13/2017; 9/19/2018- 10/15/2018
Date Received: 9/19-10/13/2017; 9/19/2018- 10/15/2018

SAMPLE LOCATION		DATE TESTED	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		WATER SOLUBLE SULFATES (%)	UNCONFINED COMPRSSSIVE STRENGTH (psf)	R-VALUE	STANDARD PROCTOR		AASHTO CLASSIFICATION (group index)	SOIL OR BEDROCK TYPE (Unified Soil Classification)
BORING	DEPTH				GRAVEL (%)	SAND (%)		LIQUID LIMIT	PLASTICITY INDEX				MAX DRY DENSITY (pcf)	OPTIMUM MOISTURE CONTENT (%)		
SW15	14'	10/23/18	9.1	125.8	7	81	12	26	11						A-2-6 (0)	Well Graded Sand with Clay (SW-SC)
SW16	4'	10/23/18	7.5	120.2			28	34	19	0.02					A-2-6 (1)	Clayey Sand (SC)
SW18	14'	10/23/18	8.9	126.0			53	28	13		22,159				A-6 (4)	Sandy Claystone
SW19	4'	10/3/18	16.8	108.4	5	62	33	41	20	0.03					A-2-7 (2)	Fill: Clayey Sand (SC)
SW20	19'	10/3/18	25.6	95.9			98	63	33						A-7-5 (39)	Claystone
SW21	14'	10/3/18	7.8	103.3	3	85	12	25	5						A-1-b (0)	Well Graded Sand with Silty Clay (SW-SC)
SW22	9'	10/3/18	14.2	117.3			38	34	15						A-6 (2)	Clayey Sandstone
SW23	14'	10/3/18	7.7	113.6												Poorly Graded Sand with Silt (SP-SM)
SW23	24'	10/3/18	25.6	96.8			93	56	30						A-7-6 (32)	Claystone
SW23	29'	10/3/18	25.9	96.5						<0.01	11,491					Claystone
SW24	2'	10/3/18	8.6	105.6	2	78	20	23	4						A-2-4 (0)	Fill: Silty Clayey Sand (SC-SM)
D1	4'	10/17/18	2.7	117.9	3	89	8		NP						A-1-b (0)	Well Graded Sand with Silt (SW-SM)
D1	14'	10/17/18	15.5	110.3	0	91	9	32	6	0.01					A-1-b (0)	Sandstone
D2	14'	10/17/18	13.2	133.7			49	28	7						A-4 (1)	Clayey Sandstone

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TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Project No.: 17-2-183A
Project Name: Research Parkway/Powers Boulevard Interchange
Date Sampled: 9/19-10/13/2017; 9/19/2018- 10/15/2018
Date Received: 9/19-10/13/2017; 9/19/2018- 10/15/2018

SAMPLE LOCATION		DATE TESTED	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		WATER SOLUBLE SULFATES (%)	UNCONFINED COMPRSSSIVE STRENGTH (psf)	R-VALUE	STANDARD PROCTOR		AASHTO CLASSIFICATION (group index)	SOIL OR BEDROCK TYPE (Unified Soil Classification)
BORING	DEPTH				GRAVEL (%)	SAND (%)		LIQUID LIMIT	PLASTICITY INDEX				MAX DRY DENSITY (pcf)	OPTIMUM MOISTURE CONTENT (%)		
F1	3"-8'	10/17/18			2	60	38	31	14						A-6 (1)	Fill: Clayey Sand (SC)
F1	4'	10/17/18	6.3	121.0												Fill: Clayey Sand (SC)
F1	9'	10/17/18	18.8	106.2												Fill: Clayey Sand (SC)
F1	14'	10/17/18	9.1	118.8												Fill: Clayey Sand (SC)
F1	34'	10/17/18	14.5	113.2	0	84	16		NP						A-2-4 (0)	Sandstone
F2	3"-20'	10/17/18			2	65	33	27	11			14	122.0	11.0	A-2-6 (0)	Fill: Clayey Sand (SC)
F2	2'	10/17/18	16.3	109.1												Fill: Clayey Sand (SC)
F2	9'	10/17/18	20.3	101.5												Fill: Clayey Sand (SC)
F2	14'	10/17/18	19.4	106.1												Fill: Clayey Sand (SC)
F2	29'	10/17/18	15.6	114.0			60	35	11						A-6 (5)	Claystone
F3	3"-10'	10/17/18			2	54	44	28	11			19	113.0	12.0	A-6 (2)	Fill: Clayey Sand (SC)
F3	2'	10/17/18	13.7	114.6												Fill: Clayey Sand (SC)
F3	9'	10/17/18	10.1	117.4												Fill: Clayey Sand (SC)
B1	2'	10/26/17	6.5	106.4						0.01						Clayey Sandstone
B1	8"-5'	10/26/17			1	59	40	21	7						A-4 (0)	Clayey Sandstone
B2	4'	10/26/17	6.9	115.3												Silty Clayey Sand (SC-SM)
B2	10"-5'	10/26/17			2	68	30	21	5						A-2-4 (0)	Silty Clayey Sand (SC-SM)
B3	2'	10/26/17	11.3	118.5												Clayey Sand (SC)
B3	9"-4'	10/26/17			1	63	36	28	10						A-4 (0)	Clayey Sand (SC)
B4	2'	10/26/17	10.9	117.9												Fill: Silty Clayey Sand (SC-SM)
B4	10.5"-5'	10/26/17			2	60	38	23	6						A-4 (0)	Fill: Silty Clayey Sand (SC-SM)

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TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Project No.: 17-2-183A
Project Name: Research Parkway/Powers Boulevard Interchange
Date Sampled: 9/19-10/13/2017; 9/19/2018- 10/15/2018
Date Received: 9/19-10/13/2017; 9/19/2018- 10/15/2018

SAMPLE LOCATION		DATE TESTED	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		WATER SOLUBLE SULFATES (%)	UNCONFINED COMPRSSSIVE STRENGTH (psf)	R-VALUE	STANDARD PROCTOR		AASHTO CLASSIFICATION (group index)	SOIL OR BEDROCK TYPE (Unified Soil Classification)
BORING	DEPTH				GRAVEL (%)	SAND (%)		LIQUID LIMIT	PLASTICITY INDEX				MAX DRY DENSITY (pcf)	OPTIMUM MOISTURE CONTENT (%)		
B5	4'	10/26/17	13.2	115.8												Fill: Clayey Sand (SC)
B5	9.25"-4'	10/26/17			1	61	38	27	9						A-4 (0)	Fill: Clayey Sand (SC)
B6	2'	10/26/17	15.9	107.6						0.11						Fill: Clayey Sand (SC)
B6	8.5"-5'	10/26/17			2	65	33	28	11						A-2-6 (0)	Fill: Clayey Sand (SC)
B7	2'	10/26/17	15.1	112.0												Clayey Sandstone
B7	8"-4'	10/26/17			1	59	40	27	9			40	107.9	15.3	A-4 (0)	Clayey Sandstone
B8	2'	10/26/17	23.5	98.2												Silty Clayey Sand (SC-SM)
B8	9"-3'	10/26/17					40	25	6						A-4 (0)	Silty Clayey Sand (SC-SM)
B9	2'	10/26/17	8.4	124.5												Fill: Silty-Clayey Sand (SC-SM)
B9	10"-4'	10/26/17			1	63	36	24	5						A-4 (0)	Fill: Silty-Clayey Sand (SC-SM)
B10	4'	10/26/17	5.1	109.8												Silty Clayey Sand (SC-SM)
B10	9"-5'	10/26/17			1	66	33	21	5			18	119.0	10.6	A-2-4 (0)	Silty Clayey Sand (SC-SM)
B11	2'	10/26/17	12.7	112.9						0.02						Clayey Sand (SC)
B11	1.5'-5'	10/26/17					48	33	13						A-6 (3)	Clayey Sand (SC)
B12	2'	10/26/17	14.4	110.9						0.26						Clayey Sand (SC)
B12	8"-5'	10/26/17					48	31	12						A-6 (3)	Clayey Sand (SC)
B13	4'	10/26/17	8.9	115.2												Fill: Clayey Sand (SC)
B13	8"-5'	10/26/17			2	74	24	27	8						A-2-4 (0)	Fill: Clayey Sand (SC)

Kumar & Associates, Inc.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Project No.: 17-2-183A
Project Name: Research Parkway/Powers Boulevard Interchange
Date Sampled: 9/19-10/13/2017; 9/19/2018- 10/15/2018
Date Received: 9/19-10/13/2017; 9/19/2018- 10/15/2018

SAMPLE LOCATION		DATE TESTED	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		WATER SOLUBLE SULFATES (%)	UNCONFINED COMPRSSSIVE STRENGTH (psf)	R-VALUE	STANDARD PROCTOR		AASHTO CLASSIFICATION (group index)	SOIL OR BEDROCK TYPE (Unified Soil Classification)
BORING	DEPTH				GRAVEL (%)	SAND (%)		LIQUID LIMIT	PLASTICITY INDEX				MAX DRY DENSITY (pcf)	OPTIMUM MOISTURE CONTENT (%)		
B14	2'	10/26/17	12.3	110.9												Clayey Sand (SC)
B14	9"-4'	10/26/17			3	70	27	25	8						A-2-4 (0)	Clayey Sand (SC)
B15	2'	10/26/17	9.2	127.2												Fill: Clayey Sand (SC)
B15	10"-4'	10/26/17			2	70	28	28	9						A-2-4 (0)	Fill: Clayey Sand (SC)
B16	2'	10/26/17	14.8	110.1												Fill: Sandy Lean Clay (CL)
B16	9"-5'	10/26/17					50	33	13						A-6 (4)	Fill: Sandy Lean Clay (CL)
B17	4'	10/26/17	12.8	114.7												Sandy Lean Clay (CL)
B17	3'-9'	10/26/17					53	33	17						A-6 (6)	Sandy Lean Clay (CL)
B18	4'	10/26/17	19.2	103.0												Silty Clayey Sand (SC-SM)
B18	9"-4'	10/26/17			2	62	36	21	6						A-4 (0)	Silty Clayey Sand (SC-SM)
B19	2'	9/26/17	18.3	108.0												Fill: Clayey Sand (SC)
B19	1'-4'	9/26/17			2	51	47	37	18	0.07		13	106.8	16.0	A-6 (5)	Fill: Clayey Sand (SC)
B20	2'	9/26/17	11.3	116.8												Fill: Clayey Sand (SC)
B20	11"-5'	9/26/17			5	74	21	28	8						A-2-4 (0)	Fill: Clayey Sand (SC)
B21	4'	9/26/17	11.8	121.7												Fill: Clayey Sand (SC)
B21	6.25"-5'	9/26/17			3	72	25	35	16						A-2-6 (0)	Fill: Clayey Sand (SC)
B22	2'	9/26/17	11.1	115.8												Clayey Sand (SC)
B22	5"-5'	9/26/17			1	55	44	41	15						A-7-6 (3)	Clayey Sand (SC)

Kumar & Associates, Inc.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Project No.: 17-2-183A
Project Name: Research Parkway/Powers Boulevard Interchange
Date Sampled: 9/19-10/13/2017; 9/19/2018- 10/15/2018
Date Received: 9/19-10/13/2017; 9/19/2018- 10/15/2018

SAMPLE LOCATION		DATE TESTED	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		WATER SOLUBLE SULFATES (%)	UNCONFINED COMPRSSSIVE STRENGTH (psf)	R-VALUE	STANDARD PROCTOR		AASHTO CLASSIFICATION (group index)	SOIL OR BEDROCK TYPE (Unified Soil Classification)
BORING	DEPTH				GRAVEL (%)	SAND (%)		LIQUID LIMIT	PLASTICITY INDEX				MAX DRY DENSITY (pcf)	OPTIMUM MOISTURE CONTENT (%)		
B23	4'	9/26/17	16.5	112.4												Claystone
B23	7.5"-5'	9/26/17			2	52	46	27	10						A-4 (1)	Clayey Sand (SC)/Claystone
B24	2'	9/26/17	19.3	103.5												Fill: Clayey Sand (SC)
B24	8"-4'	9/26/17					48	40	22	0.02		4	108.4	13.0	A-6 (7)	Fill: Clayey Sand (SC)
B25	2'	9/26/17	6.6	117.1												Silty Sand (SM)
B25	2'-5'	9/26/17			4	79	17		NP						A-1-b (0)	Silty Sand (SM)
B26	2'	9/26/17	8.3	106.5												Silty Clayey Sand (SC-SM)
B26	7.5"-4'	9/26/17			4	70	26	25	6						A-2-4(0)	Silty Clayey Sand (SC-SM)
R1	2'	10/18/18	7.6	123.7												Fill: Clayey Sand (SC)
R1	4"-5'	10/18/18			3	74	23	26	9	<0.01		16			A-2-4 (0)	Fill: Clayey Sand (SC)
R2	4'	10/18/18	2.9	111.5												Clayey Sand (SC)
R2	4"-4'	10/18/18			2	76	22	27	10						A-2-4 (0)	Clayey Sand (SC)
R3	4'	10/18/18	16.9	113.5												Clayey Sandstone
R3	1.5'-5'	10/18/18					46	29	11			9	106.3	15.7	A-6 (2)	Clayey Sandstone
R4	2'	10/18/18	20.5	105.8												Claystone
R4	2'-5'	10/18/18					56	38	20						A-6 (8)	Claystone
R5	4'	10/18/18	20.4	103.2												Fill: Sandy Lean Clay (CL)
R5	2"-5'	10/18/18					50	33	14	0.05			102.2	15.7	A-6 (4)	Fill: Sandy Lean Clay (CL)

Kumar & Associates, Inc.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Project No.: 17-2-183A
Project Name: Research Parkway/Powers Boulevard Interchange
Date Sampled: 9/19-10/13/2017; 9/19/2018- 10/15/2018
Date Received: 9/19-10/13/2017; 9/19/2018- 10/15/2018

SAMPLE LOCATION		DATE TESTED	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		WATER SOLUBLE SULFATES (%)	UNCONFINED COMPRSSSIVE STRENGTH (psf)	R-VALUE	STANDARD PROCTOR		AASHTO CLASSIFICATION (group index)	SOIL OR BEDROCK TYPE (Unified Soil Classification)
BORING	DEPTH				GRAVEL (%)	SAND (%)		LIQUID LIMIT	PLASTICITY INDEX				MAX DRY DENSITY (pcf)	OPTIMUM MOISTURE CONTENT (%)		
R6	2'	10/18/18	8.9	108.0												Silty Clayey Sand (SC-SM)
R6	3"-5'	10/18/18			3	77	20	24	6						A-2-4 (0)	Silty Clayey Sand (SC-SM)
R7	4'	10/18/18	8.2	112.9												Silty Sand (SM)
R7	2"-5'	10/18/18			4	83	13		NP						A-1-b (0)	Silty Sand (SM)
R8	2'	10/18/18	9.9	122.8						0.02						Fill: Clayey Sand (SC)
R8	4"-5'	10/18/18			1	69	30	28	13						A-2-6 (0)	Fill: Clayey Sand (SC)
R9	2'	10/18/18	16.0	107.7												Sandstone
R9	3"-5'	10/18/18			0	63	37	19	2			12			A-4 (0)	Sandstone
R10	2'	10/18/18	2.4	113.0												Clayey Sand (SC)
R10	3"-5'	10/18/18			2	74	24	25	8						A-2-4 (0)	Clayey Sand (SC)
R11	4'	10/18/18	5.5	117.3												Fill: Clayey Sand (SC)
R11	5"-6'	10/18/18			3	66	31	28	10						A-2-4 (0)	Fill: Clayey Sand (SC)
R12	2'	10/18/18	13.9	119.0												Claystone
R12	3"-5'	10/18/18					62	32	15	<0.01		4	107.1	14.0	A-6 (7)	Claystone
R13	4'	10/18/18	10.7	121.3												Fill: Clayey Sand (SC)
R13	3"-6'	10/18/18			0	51	49	36	19						A-6 (6)	Fill: Clayey Sand (SC)
R14	2'	10/18/18	8.8	123.2												Silty Clayey Sand (SC-SM)
R14	2"-5'	10/18/18			3	75	22	21	7						A-2-4 (0)	Silty Clayey Sand (SC-SM)

Kumar & Associates, Inc.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Project No.: 17-2-183A
Project Name: Research Parkway/Powers Boulevard Interchange
Date Sampled: 9/19-10/13/2017; 9/19/2018- 10/15/2018
Date Received: 9/19-10/13/2017; 9/19/2018- 10/15/2018

SAMPLE LOCATION		DATE TESTED	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		WATER SOLUBLE SULFATES (%)	UNCONFINED COMPRSSSIVE STRENGTH (psf)	R-VALUE	STANDARD PROCTOR		AASHTO CLASSIFICATION (group index)	SOIL OR BEDROCK TYPE (Unified Soil Classification)
BORING	DEPTH				GRAVEL (%)	SAND (%)		LIQUID LIMIT	PLASTICITY INDEX				MAX DRY DENSITY (pcf)	OPTIMUM MOISTURE CONTENT (%)		
R15	4'	10/18/18	10.0	112.8												Silty Clayey Sand (SC-SM)
R15	3"-5'	10/18/18			4	76	20	22	7						A-2-4 (0)	Silty Clayey Sand (SC-SM)
R16	4'	10/18/18	11.7	123.5												Fill: Clayey Sand (SC)
R16	3"-5'	10/18/18			3	73	24	27	11						A-2-6 (0)	Fill: Clayey Sand (SC)

Kumar and Associates, Inc.

TABLE IA

SUMMARY OF LABORATORY TEST RESULTS - SUPPLEMENTAL CORROSION TESTING

Project No.: 17-2-183.A
Project Name : Powers/Research
Date Sampled: 9/19/2017- 10/13/2017, 9/19/2018 -10/15/2018
Date Received: 9/19/2017- 10/13/2017, 9/19/2018 -10/15/2018

SAMPLE LOCATION		DATE TESTED	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	MINIMUM ELECTRICAL RESISTIVITY (ohm-cm)	CHLORIDE CONTENT IN SOIL (%)	pH	SOIL OR BEDROCK TYPE (Unified Soil Classification)
BORING	DEPTH (ft)							
S1A	2	9/30/19	0.6	119.8	4400		7.4	Silty Sand (SM)
S2A	4	10/2/19	1.4	111.9		0.01		Silty Sand (SM)
S2A	9	10/2/19	15.9	110.7	424	0.01	5.9	Claystone
R5	2	10/2/19	15.2	110.9	589	0.02	6.0	Fill: Clayey Sand (SC)
R14	4	9/30/19	1.7	125.2	800		7.4	Clayey Sand (SC)
SW16	14	9/30/19	3.5	128.5	4400		7.1	Sandstone
SW17	4	10/2/19	3.2	134.5		0.01		Sandstone
F3	4	9/30/19	13.1	107.4	3320		7.2	Fill: Clayey Sand (SC)

Kumar & Associates, Inc.

TABLE II

SUMMARY OF EXISTING PAVEMENT SECTIONS

Project No. 17-2-183.A

Boring	Roadway	Location	Asphalt Thickness (in.)
B1	Powers Blvd	Northbound, Outer Lane	8
B2	Powers Blvd	Southbound, Outer Lane	10
B3	Powers Blvd	Northbound, Outer Lane	9
B4	Powers Blvd	Southbound, Outer Lane	10.5
B5	Powers Blvd	Northbound, Outer Lane	9.25
B6	Powers Blvd	Southbound, Outer Lane	8.5
B7	Powers Blvd	Northbound, Merge Lane	8
B8	Powers Blvd	Southbound, Turn Lane	9
B9	Powers Blvd	Northbound, Turn Lane	10
B10	Powers Blvd	Southbound, Merge Lane	9
B11	Powers Blvd	Northbound, Outer Lane	7
B12	Powers Blvd	Southbound, Outer Lane	8
B13	Powers Blvd	Northbound, Outer Lane	7.5
B14	Powers Blvd	Southbound, Outer Lane	9
B15	Powers Blvd	Northbound, Outer Lane	10
B16	Powers Blvd	Southbound, Outer Lane	9
B17	Powers Blvd	Northbound, Outer Lane	12
B18	Powers Blvd	Southbound, Outer Lane	9
			Avg. = 9.0
B19	Research Parkway	Eastbound, Outer Lane	12
B20	Research Parkway	Westbound, Outer Lane	11
B21	Research Parkway	Eastbound, Outer Lane	6.25
B22	Research Parkway	Westbound, Outer Lane	5
B23	Research Parkway	Eastbound, Merge Lane	7.5
B24	Research Parkway	Westbound, Outer Lane	8
B25	Research Parkway	Eastbound, Turn Lane	8
B26	Research Parkway	Westbound, Outer Lane	7.5
SW21	Research Parkway	Eastbound, Outer lane	13.25
SW22	Research Parkway	Eastbound, Outer lane	12.0
			Avg. = 9.1

APPENDIX A

AASHTOWare M-E Pavement Design Output
For Powers Boulevard & Ramps

Powers N AC composite(76-28 SMA over 64-22 sx75)

File Name: C:\Users\darwinME\Desktop\AFK\Powers and Research\HMA\Powers N AC composite(76-28 SMA over 64-22 sx75).dgpx

Design Inputs

Design Life: 20 years
Design Type: FLEXIBLE

Base construction: May, 2020
Pavement construction: June, 2020
Traffic opening: September, 2020

Climate Data Sources (Lat/Lon): 38.812, -104.711

Design Structure

Layer type	Material Type	Thickness (in)
Flexible	R2 Level 1 SMA	2.0
Flexible	R2 Level 1 SX(75) PG 64-22	5.5 (Optimized)
NonStabilized	Class 6 ABC	10.0
Subgrade	Clayey Sand	24.0
Subgrade	A-6	Semi-infinite

Volumetric at Construction:	
Effective binder content (%)	12.2
Air voids (%)	4.7

Traffic

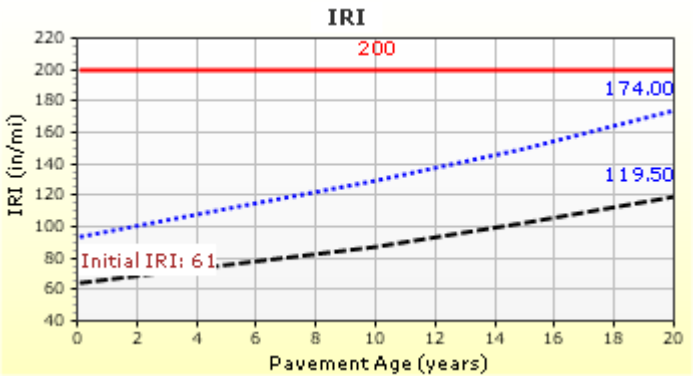
Age (year)	Heavy Trucks (cumulative)
2020 (initial)	2,179
2030 (10 years)	2,733,380
2040 (20 years)	6,396,130

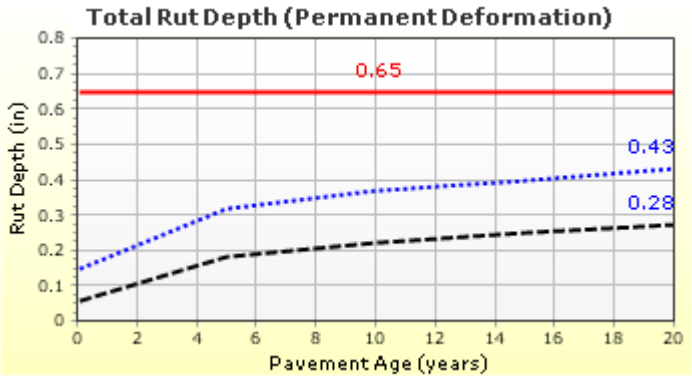
Design Outputs

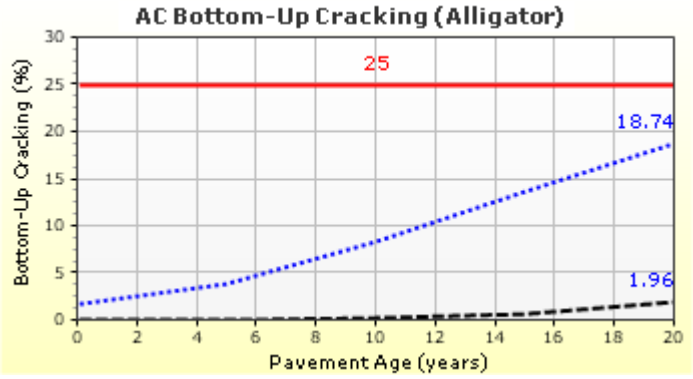
Distress Prediction Summary

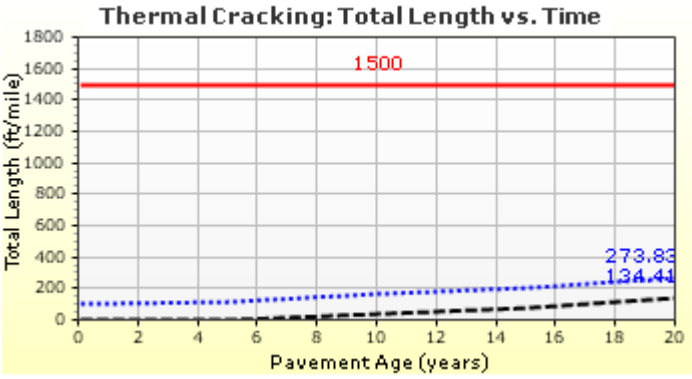
Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	200.00	173.98	95.00	99.25	Pass
Permanent deformation - total pavement (in)	0.65	0.43	95.00	100.00	Pass
AC bottom-up fatigue cracking (% lane area)	25.00	18.74	95.00	98.81	Pass
AC thermal cracking (ft/mile)	1500.00	273.83	95.00	100.00	Pass
AC top-down fatigue cracking (ft/mile)	2500.00	349.88	95.00	100.00	Pass
Permanent deformation - AC only (in)	0.50	0.32	95.00	99.98	Pass

Distress Charts





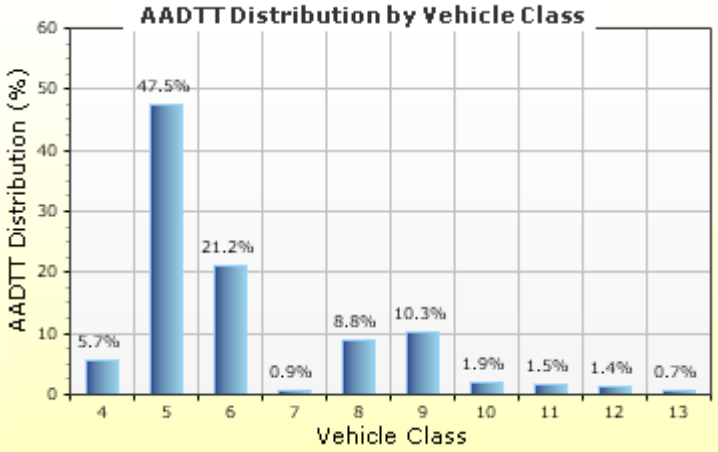


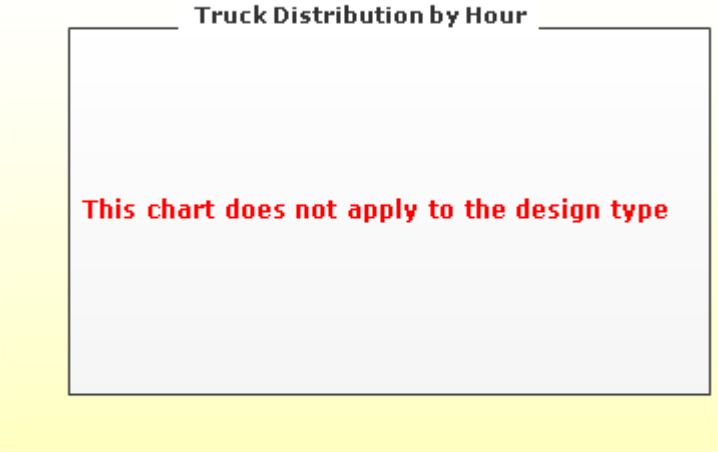


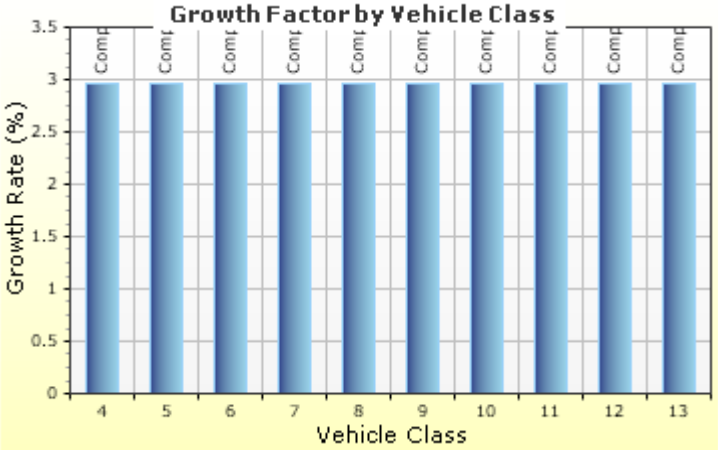
Traffic Inputs

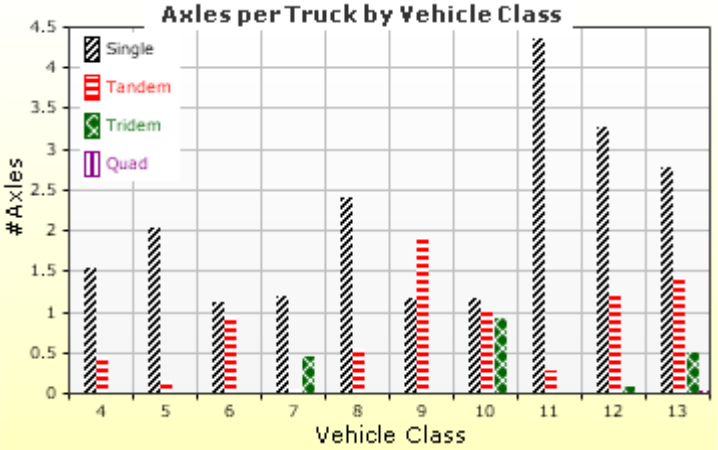
Graphical Representation of Traffic Inputs

Initial two-way AADTT:	2,179	Percent of trucks in design direction (%):	50.0
Number of lanes in design direction:	3	Percent of trucks in design lane (%):	60.0
		Operational speed (mph)	70.0

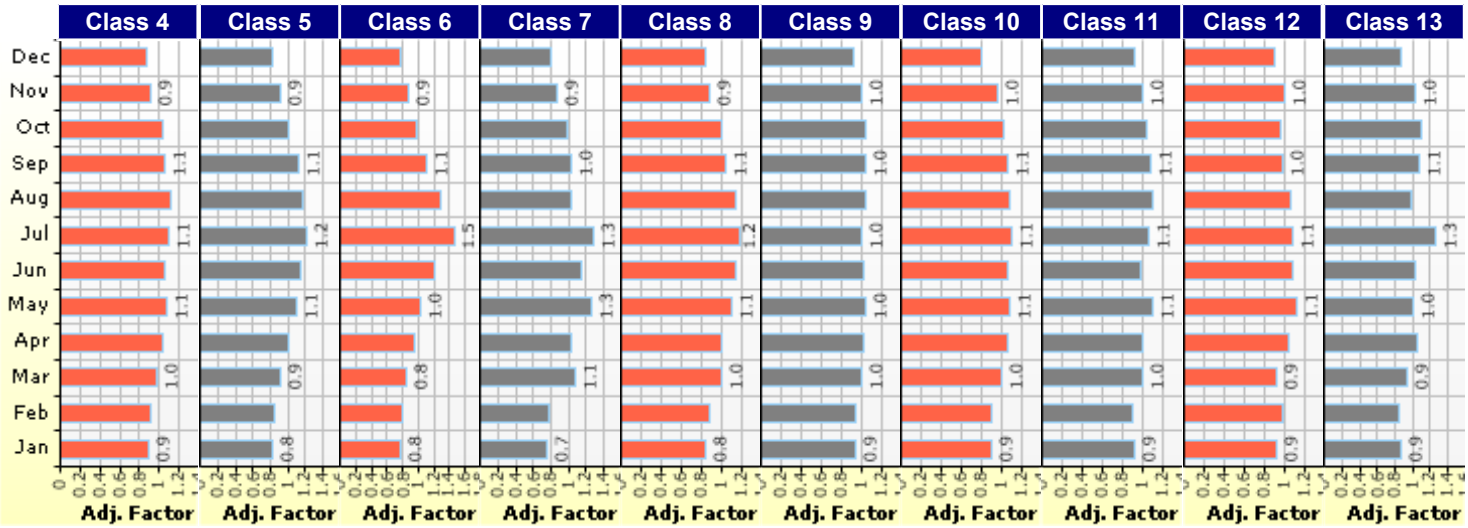








Traffic Volume Monthly Adjustment Factors



Tabular Representation of Traffic Inputs

Volume Monthly Adjustment Factors

Level 3: Default MAF

Month	Vehicle Class									
	4	5	6	7	8	9	10	11	12	13
January	0.9	0.8	0.8	0.7	0.8	0.9	0.9	0.9	0.9	0.9
February	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.8
March	1.0	0.9	0.8	1.1	1.0	1.0	1.0	1.0	0.9	0.9
April	1.0	1.0	0.9	1.0	1.0	1.0	1.1	1.0	1.0	1.1
May	1.1	1.1	1.0	1.3	1.1	1.0	1.1	1.1	1.1	1.0
June	1.1	1.1	1.2	1.1	1.1	1.0	1.1	1.0	1.1	1.0
July	1.1	1.2	1.5	1.3	1.2	1.0	1.1	1.1	1.1	1.3
August	1.1	1.2	1.3	1.0	1.1	1.0	1.1	1.1	1.1	1.0
September	1.1	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1
October	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.1
November	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0
December	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.9	0.9

Distributions by Vehicle Class

Truck Distribution by Hour does not apply

Vehicle Class	AADTT Distribution (%) (Level 3)	Growth Factor	
		Rate (%)	Function
Class 4	5.74%	2.97%	Compound
Class 5	47.46%	2.97%	Compound
Class 6	21.21%	2.97%	Compound
Class 7	0.94%	2.97%	Compound
Class 8	8.84%	2.97%	Compound
Class 9	10.31%	2.97%	Compound
Class 10	1.9%	2.97%	Compound
Class 11	1.51%	2.97%	Compound
Class 12	1.4%	2.97%	Compound
Class 13	0.69%	2.97%	Compound

Axle Configuration

Traffic Wander	
Mean wheel location (in)	18.0
Traffic wander standard deviation (in)	10.0
Design lane width (ft)	12.0

Axle Configuration	
Average axle width (ft)	8.5
Dual tire spacing (in)	12.0
Tire pressure (psi)	120.0

Average Axle Spacing	
Tandem axle spacing (in)	51.6
Tridem axle spacing (in)	49.2
Quad axle spacing (in)	49.2

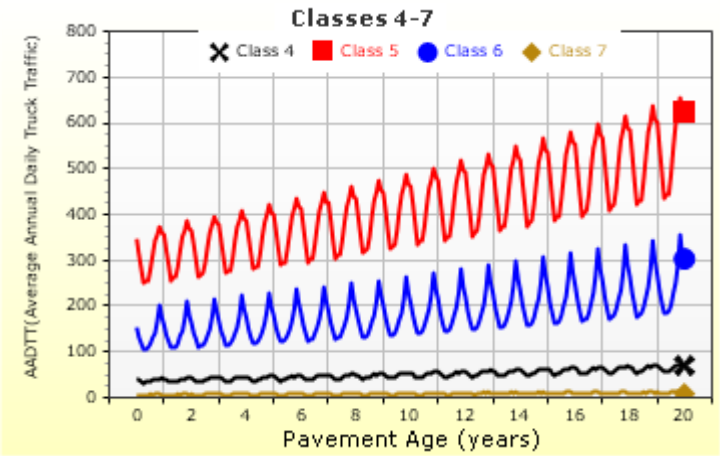
Wheelbase does not apply

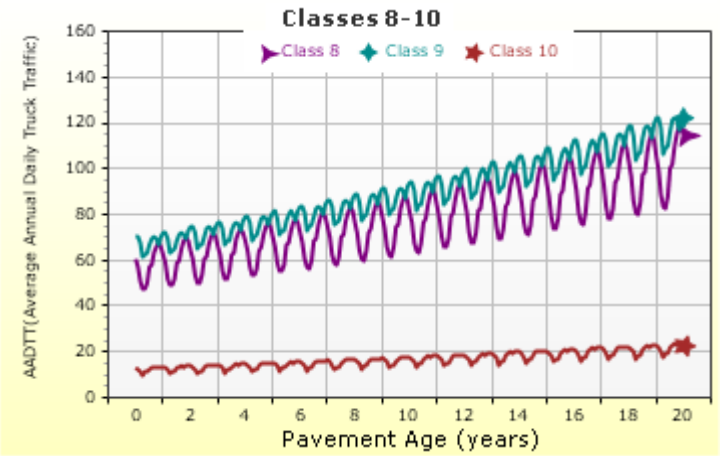
Number of Axles per Truck

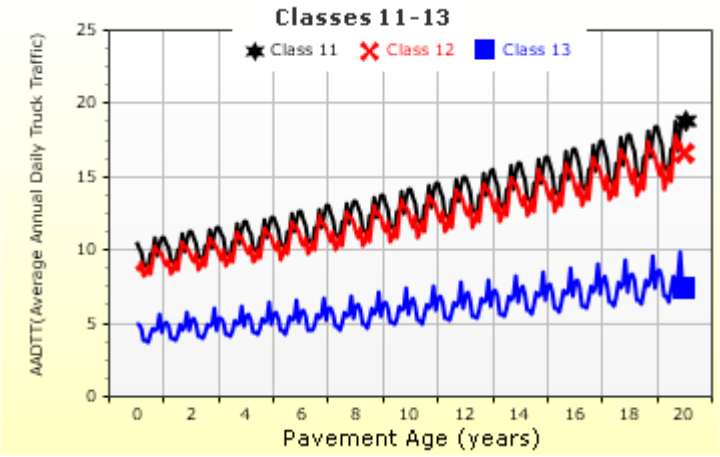
Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.53	0.45	0	0
Class 5	2.02	0.16	0.02	0
Class 6	1.12	0.94	0	0
Class 7	1.19	0.07	0.45	0.02
Class 8	2.41	0.56	0.02	0
Class 9	1.16	1.9	0.01	0
Class 10	1.15	1.01	0.93	0.02
Class 11	4.35	0.29	0.02	0
Class 12	3.27	1.22	0.09	0
Class 13	2.77	1.4	0.51	0.04

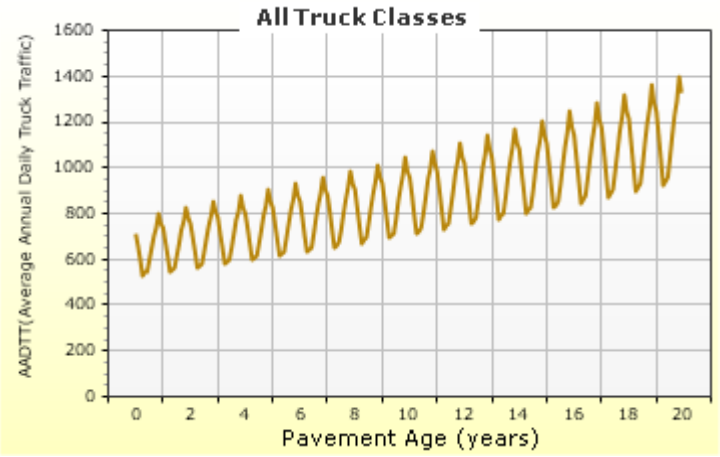
AADTT (Average Annual Daily Truck Traffic) Growth

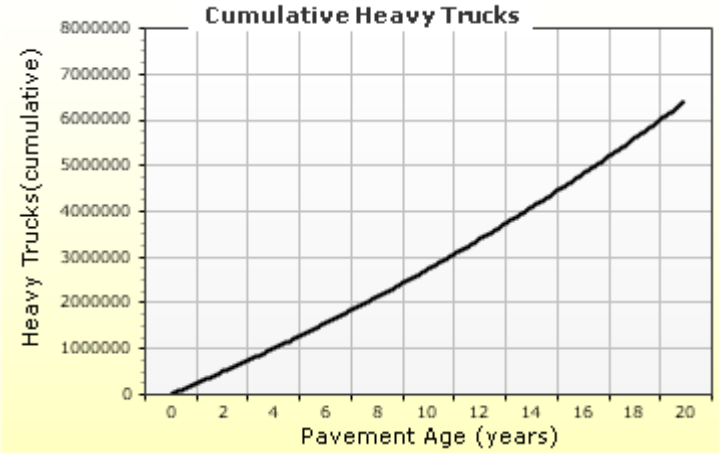
*** Traffic cap is not enforced**







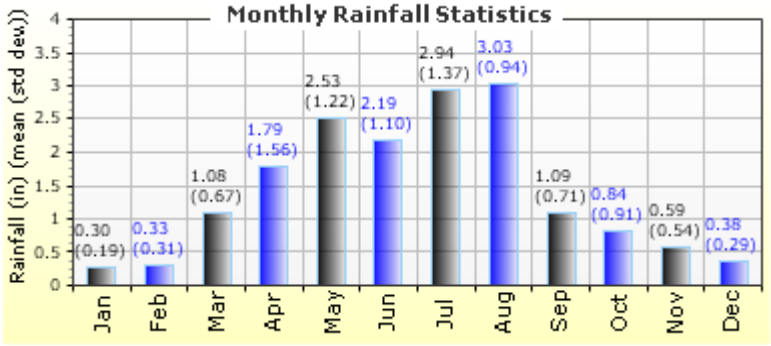




Climate Inputs

Climate Data Sources:

Climate Station Cities:	Location (lat lon elevation(ft))
COLORADO SPRINGS_	38.81200 -104.71100 6170

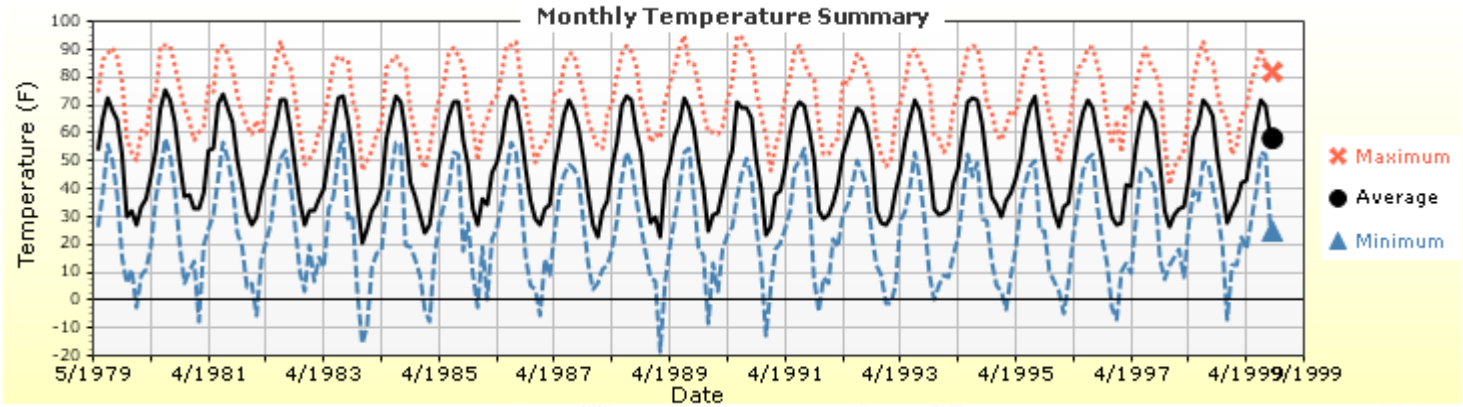


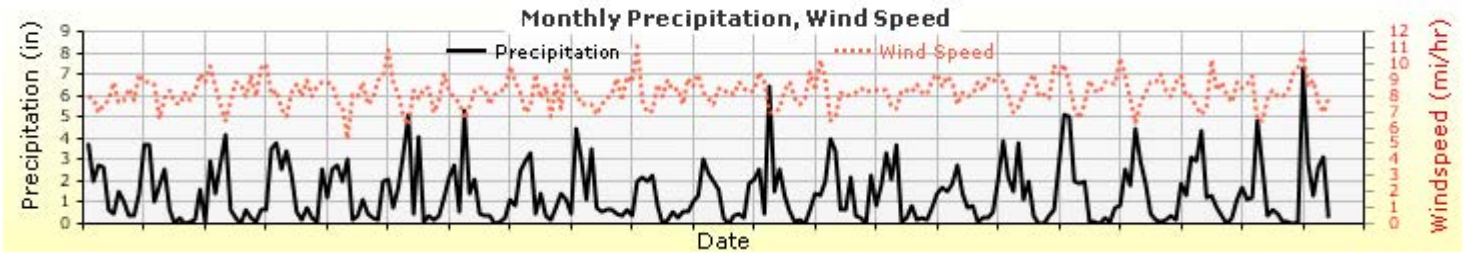
Annual Statistics:

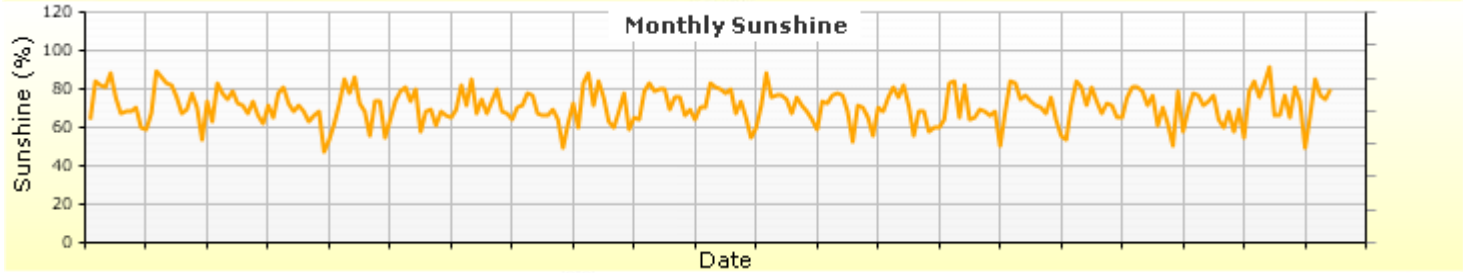
Mean annual air temperature (ºF)	49.11
Mean annual precipitation (in)	17.31
Freezing index (ºF - days)	555.60
Average annual number of freeze/thaw cycles:	83.33

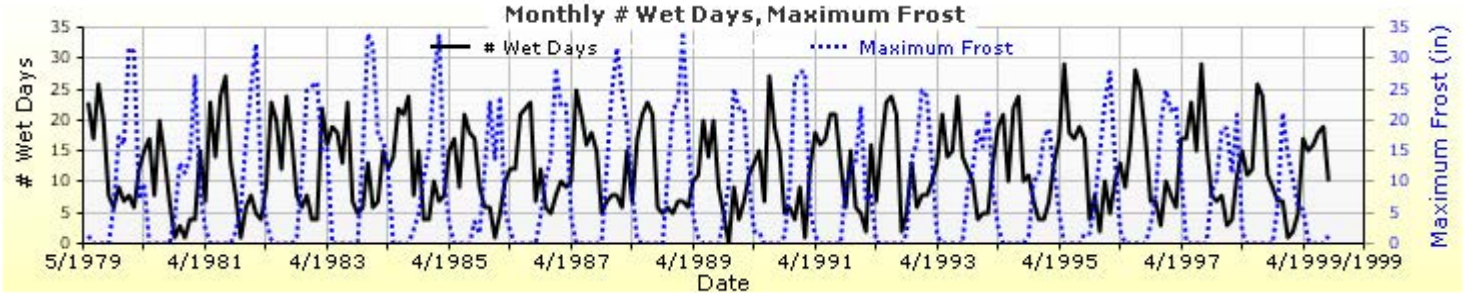
Water table depth (ft)	7.00

Monthly Climate Summary:

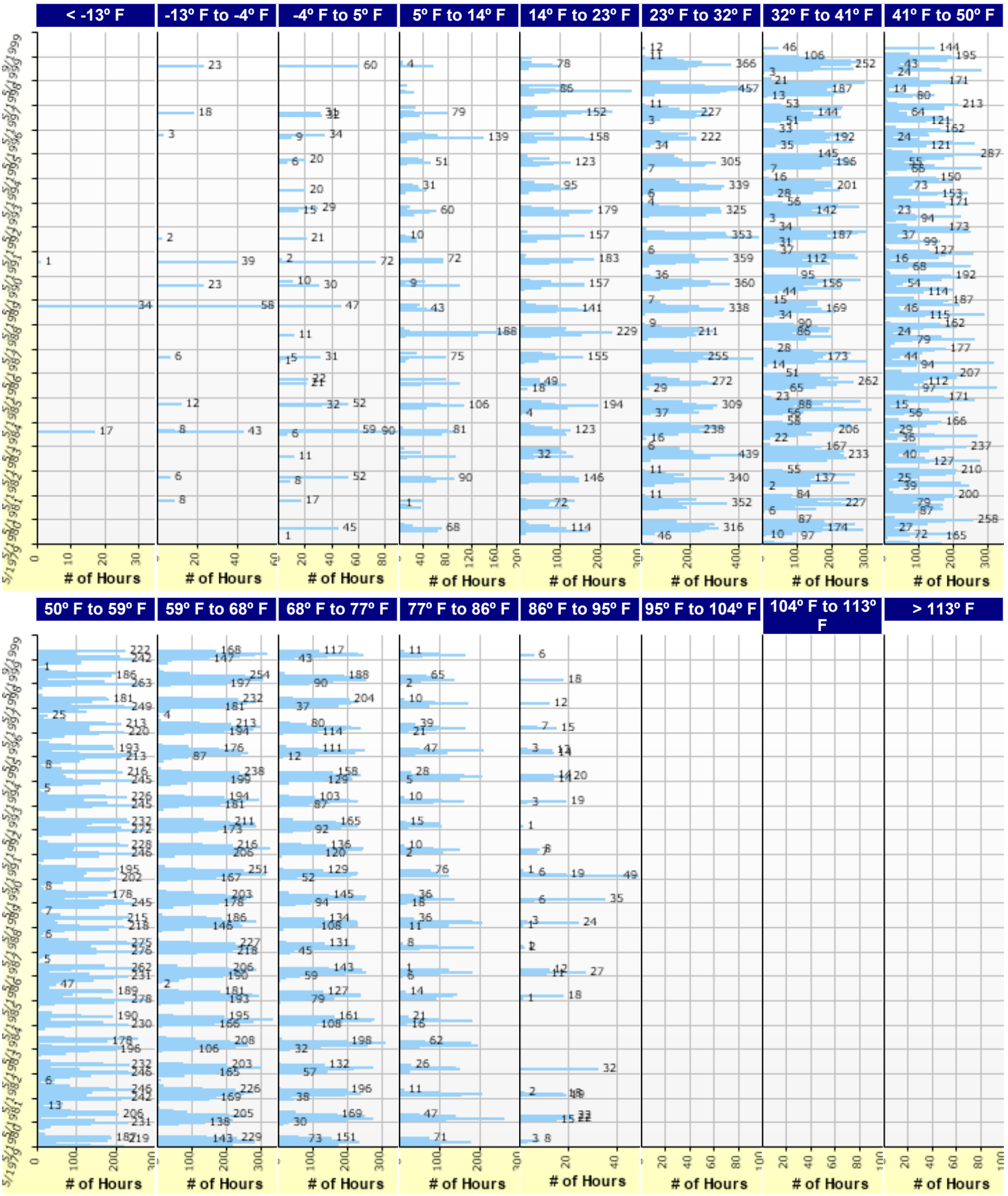








Hourly Air Temperature Distribution by Month:



Design Properties

HMA Design Properties

Use Multilayer Rutting Model	False
Using G* based model (not nationally calibrated)	False
Is NCHRP 1-37A HMA Rutting Model Coefficients	True
Endurance Limit	-
Use Reflective Cracking	True

Structure - ICM Properties	
AC surface shortwave absorptivity	0.85

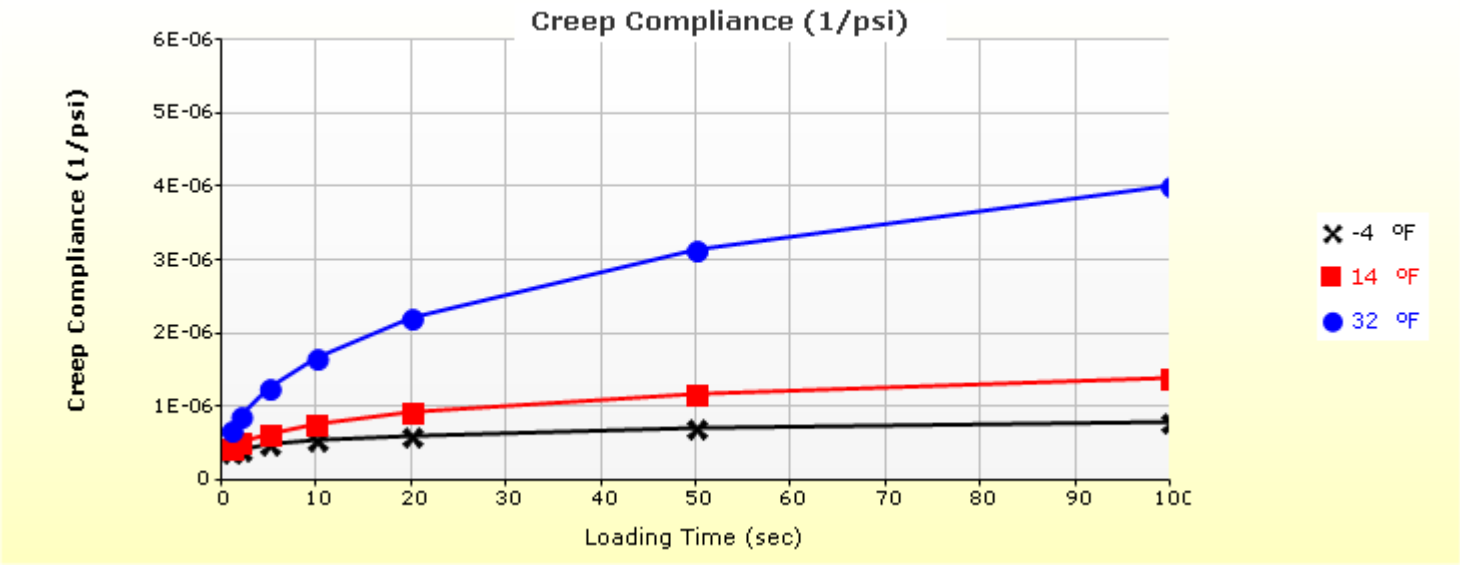
Layer Name	Layer Type	Interface Friction
Layer 1 Flexible : R2 Level 1 SMA	Flexible (1)	1.00
Layer 2 Flexible : R2 Level 1 SX (75) PG 64-22	Flexible (1)	1.00
Layer 3 Non-stabilized Base : Class 6 ABC	Non-stabilized Base (4)	1.00
Layer 4 Subgrade : Clayey Sand	Subgrade (5)	1.00
Layer 5 Subgrade : A-6	Subgrade (5)	-

Thermal Cracking (Input Level: 1)

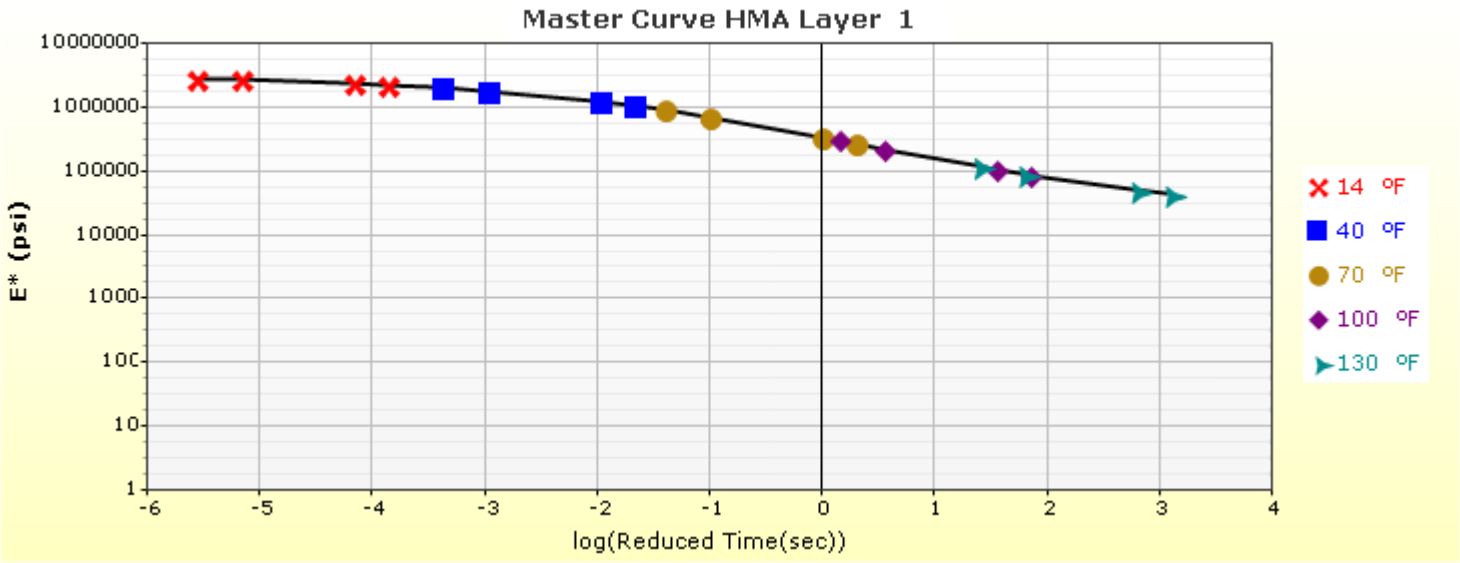
Indirect tensile strength at 14 ºF (psi)	515.00

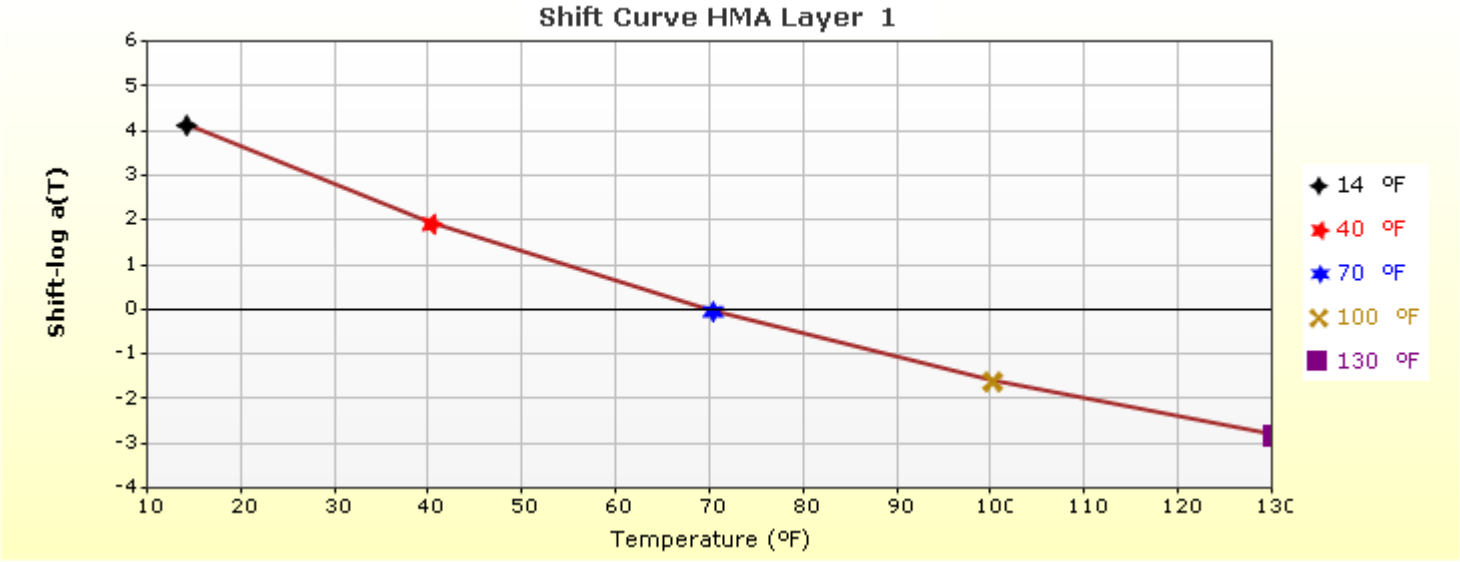
Thermal Contraction	
Is thermal contraction calculated?	True
Mix coefficient of thermal contraction (in/in/ºF)	-
Aggregate coefficient of thermal contraction (in/in/ºF)	5.0e-006
Voids in Mineral Aggregate (%)	16.9

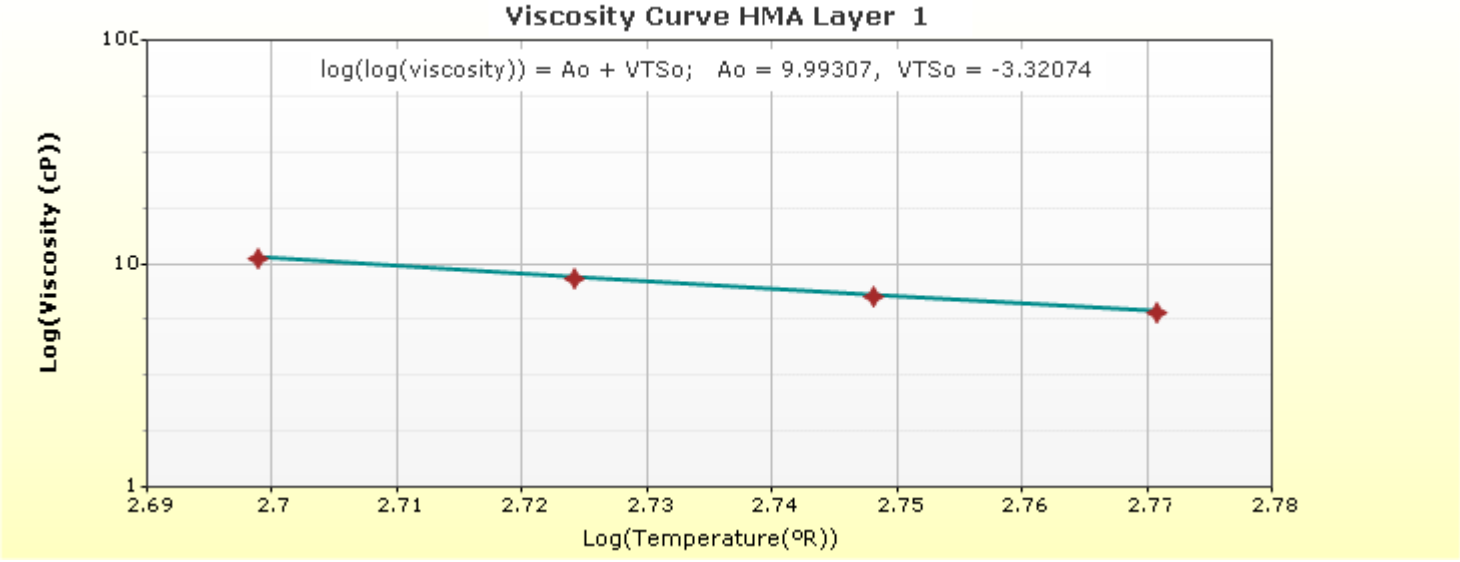
	Creep Compliance (1/psi)		
Loading time (sec)	-4 ºF	14 ºF	32 ºF
1	4.01e-007	4.45e-007	6.88e-007
2	4.28e-007	5.41e-007	8.96e-007
5	4.98e-007	6.37e-007	1.27e-006
10	5.51e-007	7.85e-007	1.69e-006
20	6.17e-007	9.33e-007	2.23e-006
50	7.19e-007	1.18e-006	3.14e-006
100	7.96e-007	1.39e-006	4.01e-006



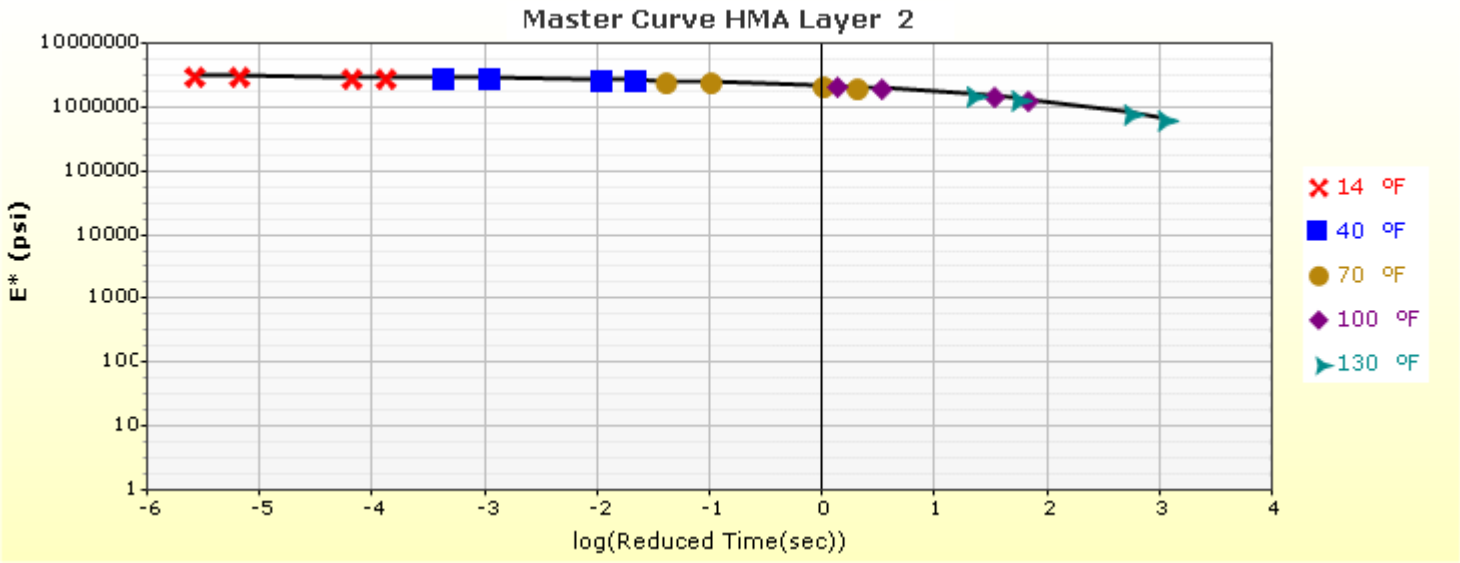
HMA Layer 1: Layer 1 Flexible : R2 Level 1 SMA

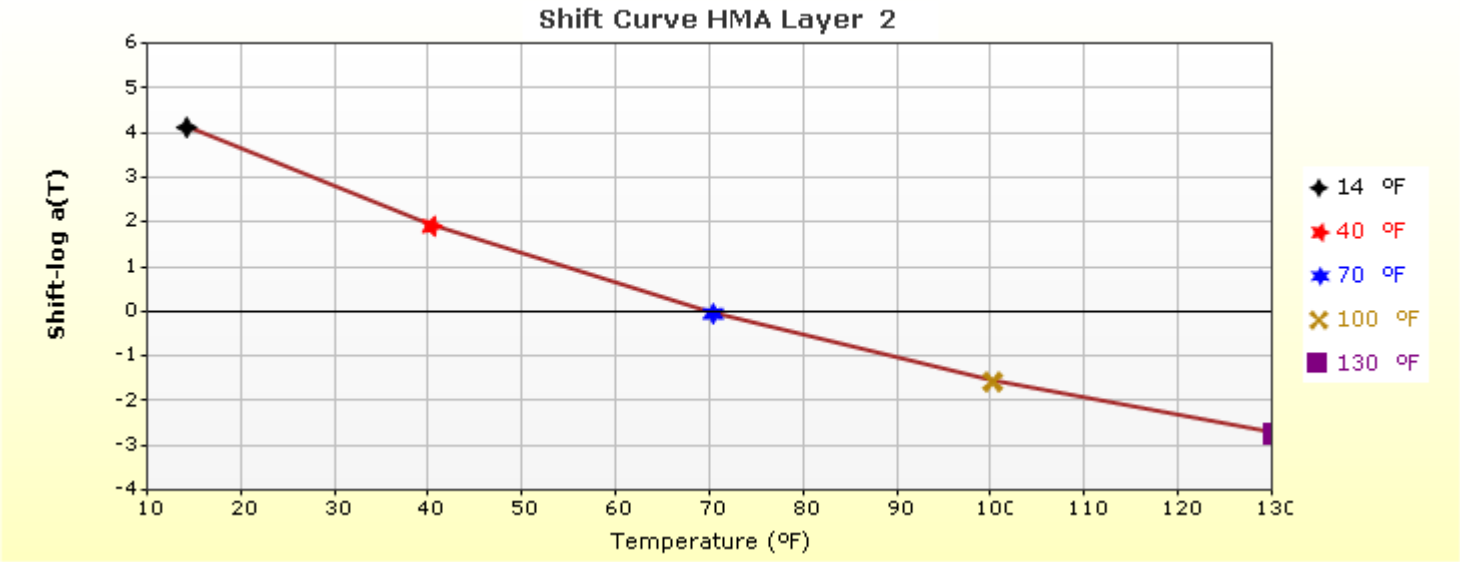


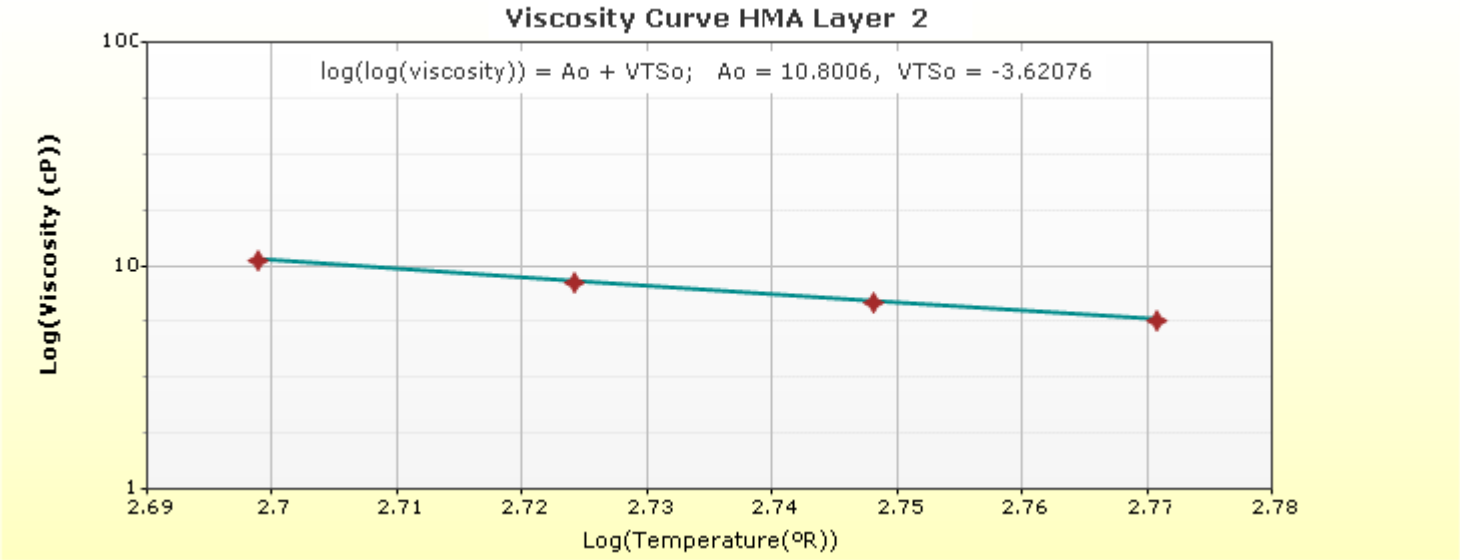




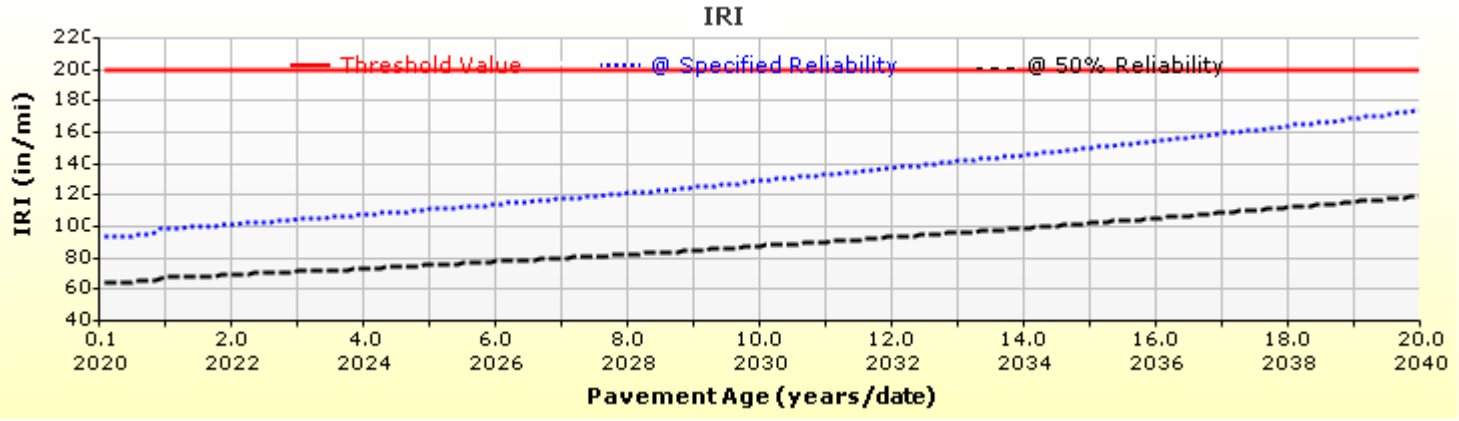
HMA Layer 2: Layer 2 Flexible : R2 Level 1 SX(75) PG 64-22

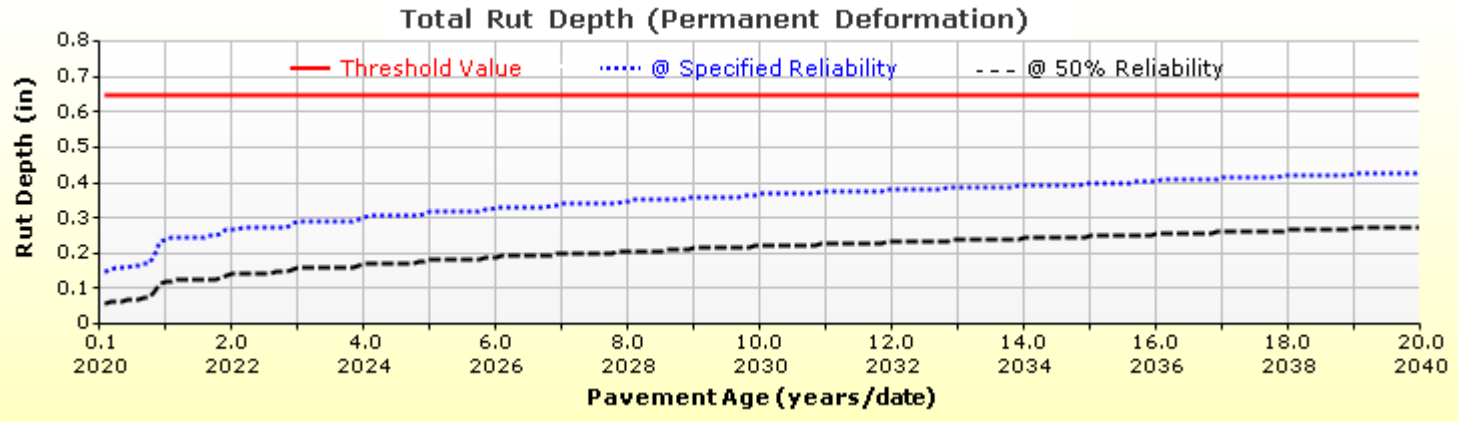


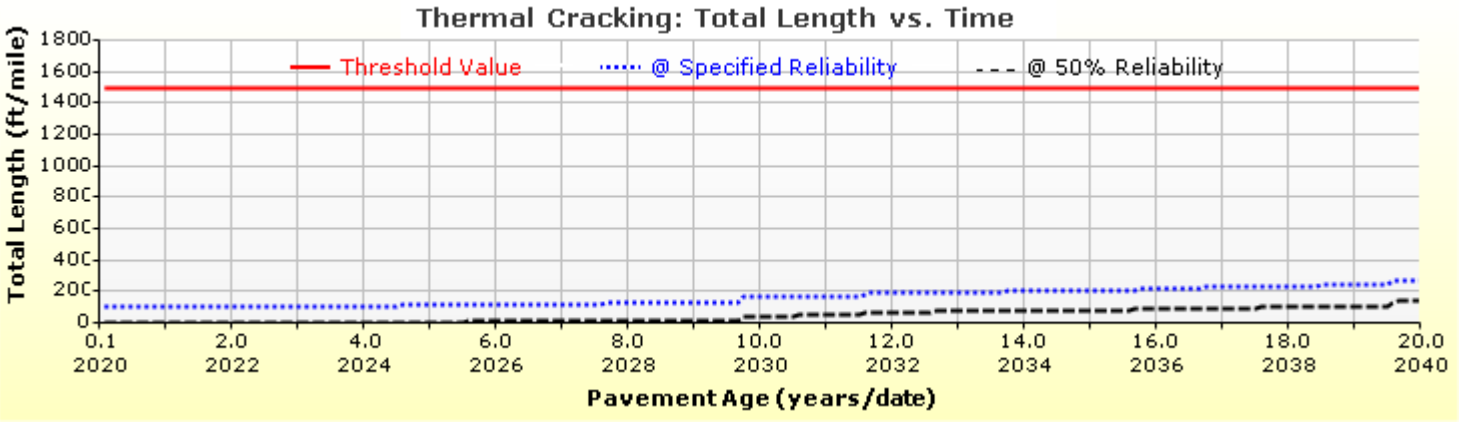


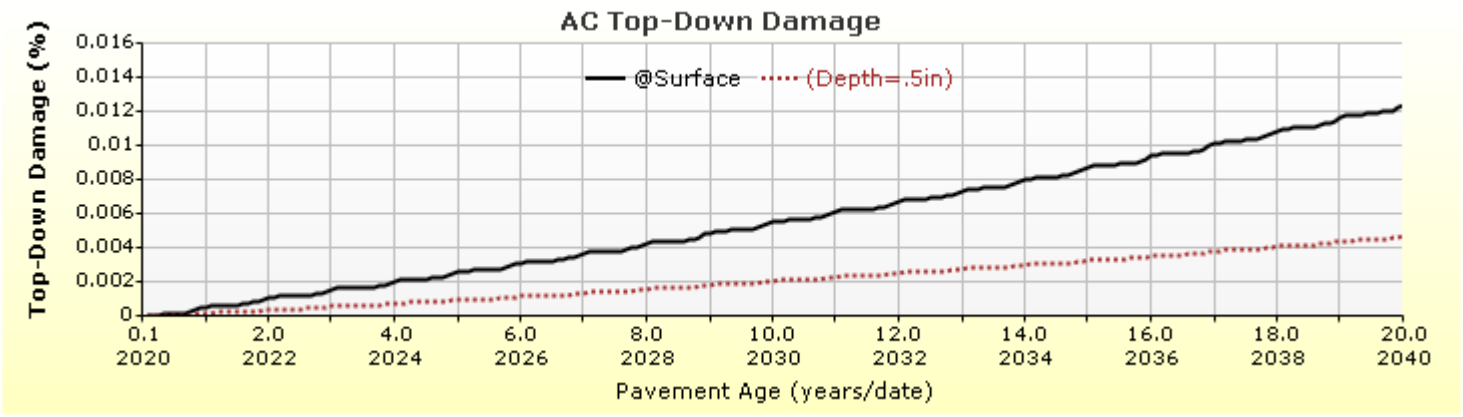


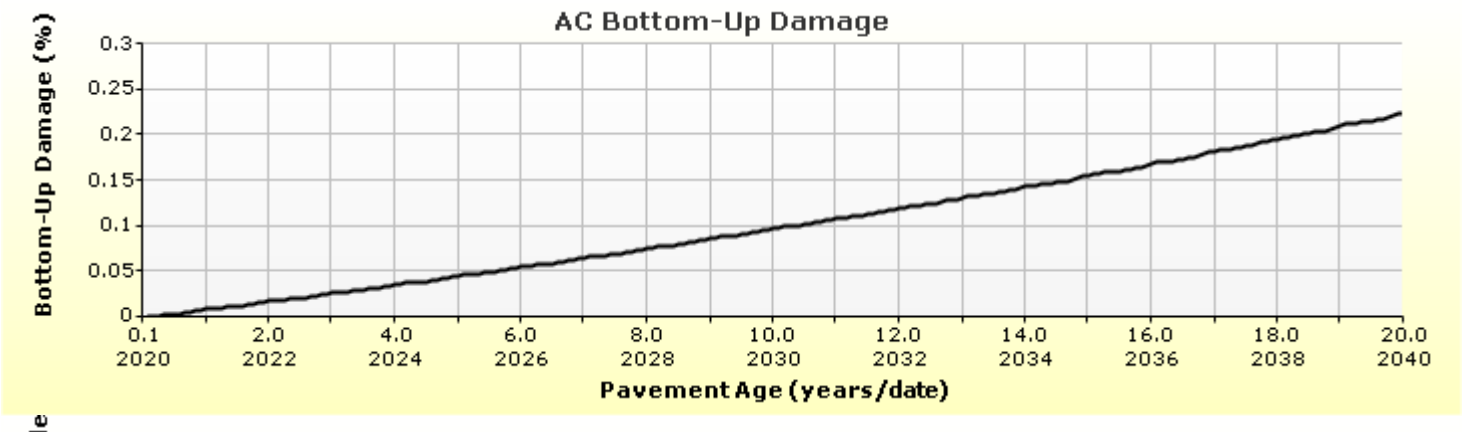
Analysis Output Charts

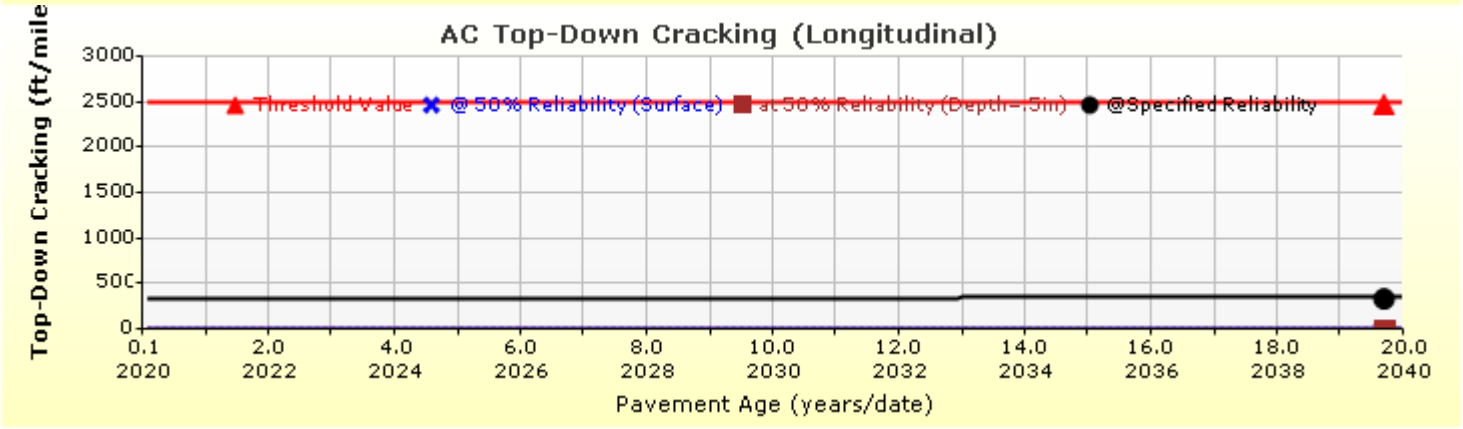


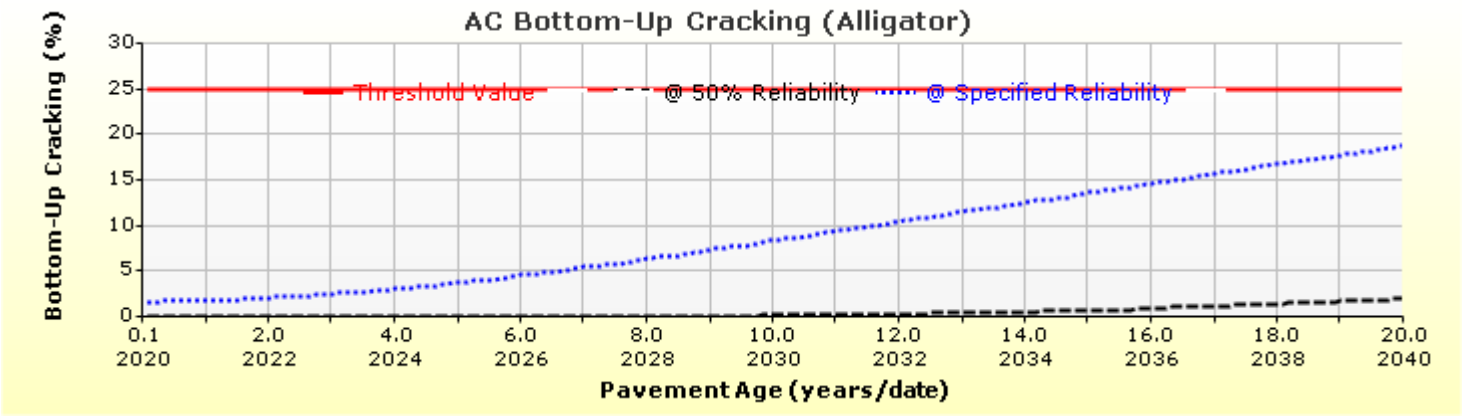


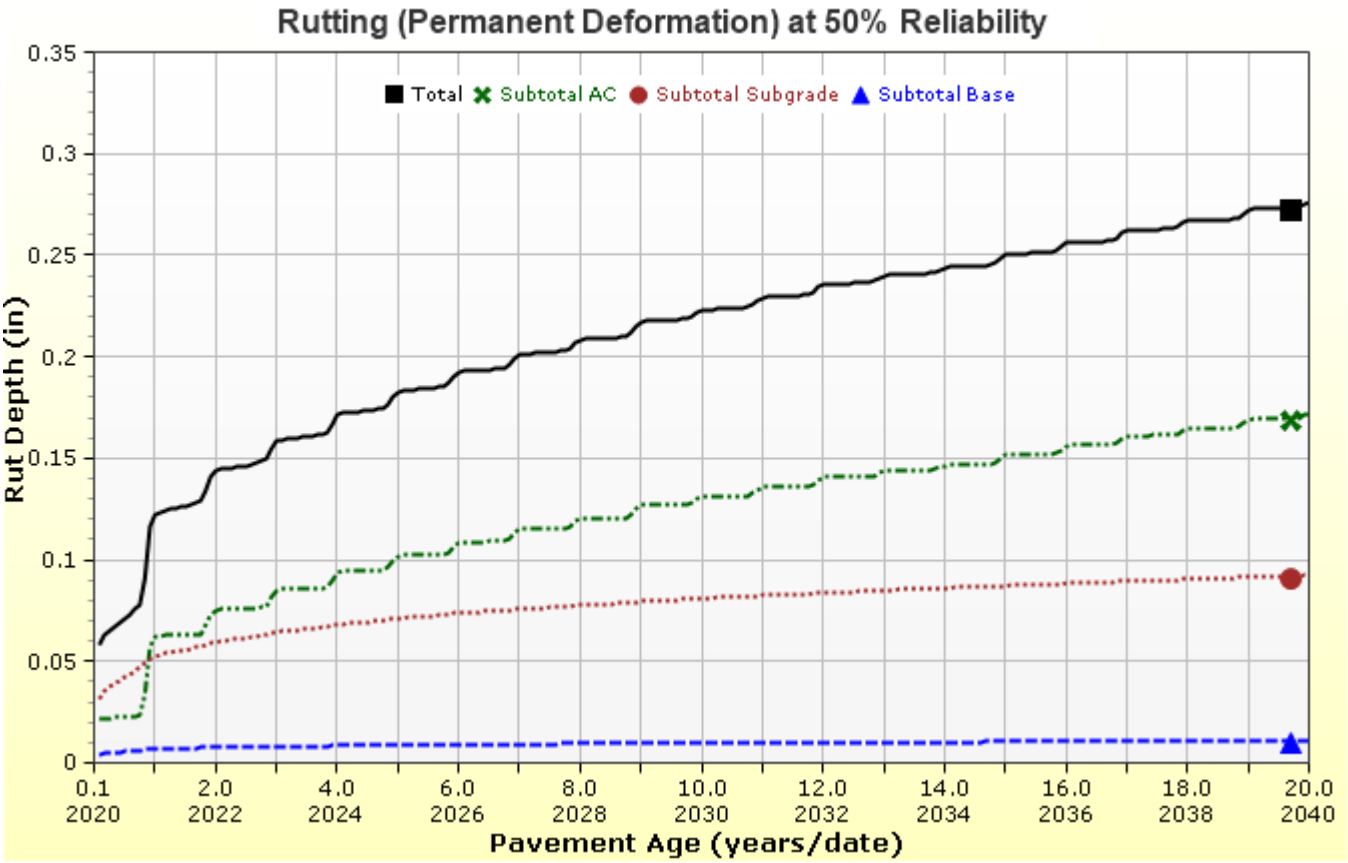


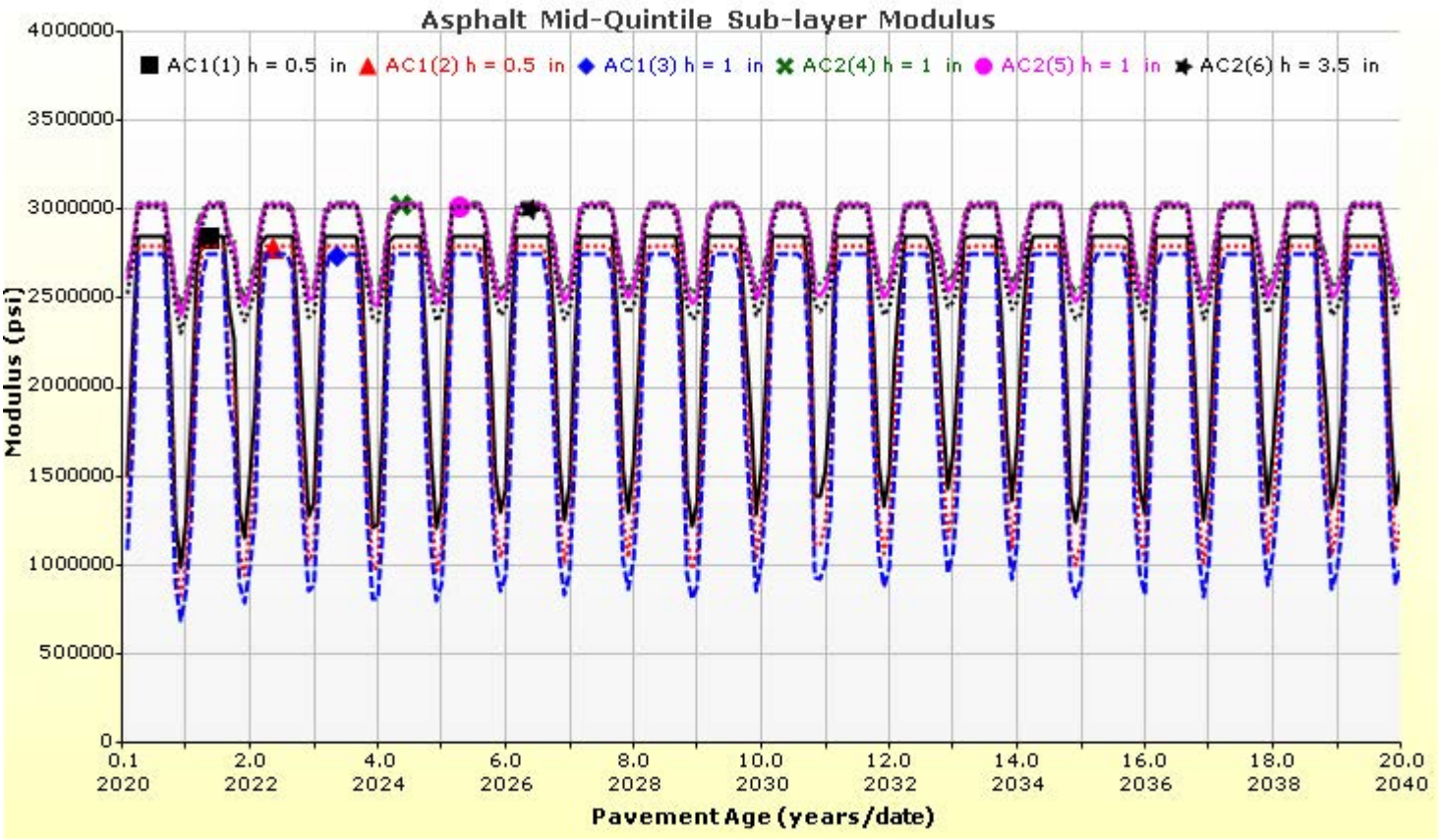

AC Top-Down Damage
Top-Down Damage (%)
@Surface
(Depth=.5in)
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
0.1
2020
2.0
2022
4.0
2024
6.0
2026
8.0
2028
10.0
2030
12.0
2032
14.0
2034
16.0
2036
18.0
2038
20.0
2040
Pavement Age (years/date)

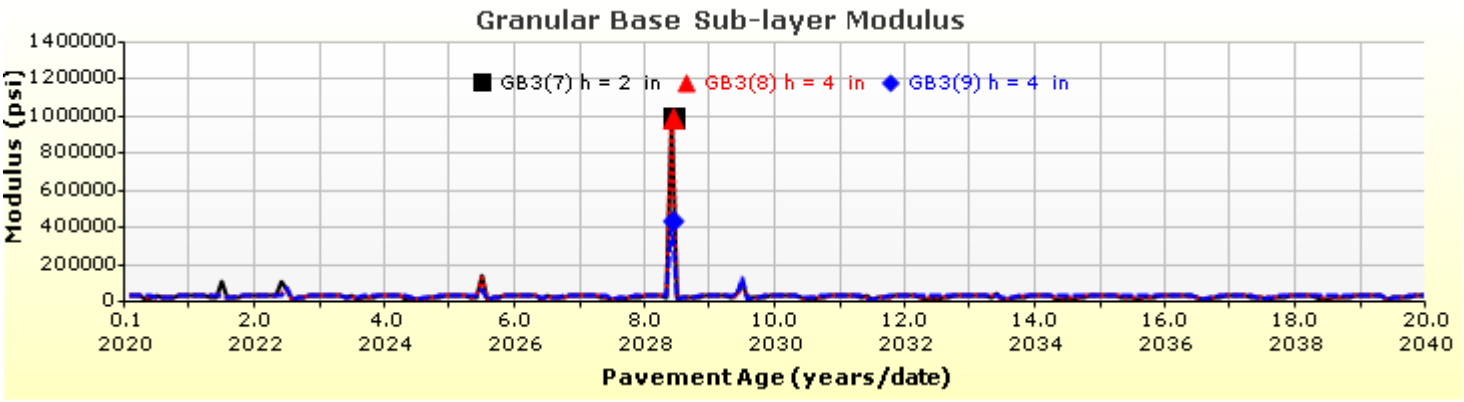

AC Bottom-Up Damage
Bottom-Up Damage (%)
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1
2020
2.0
2022
4.0
2024
6.0
2026
8.0
2028
10.0
2030
12.0
2032
14.0
2034
16.0
2036
18.0
2038
20.0
2040
Pavement Age (years/date)

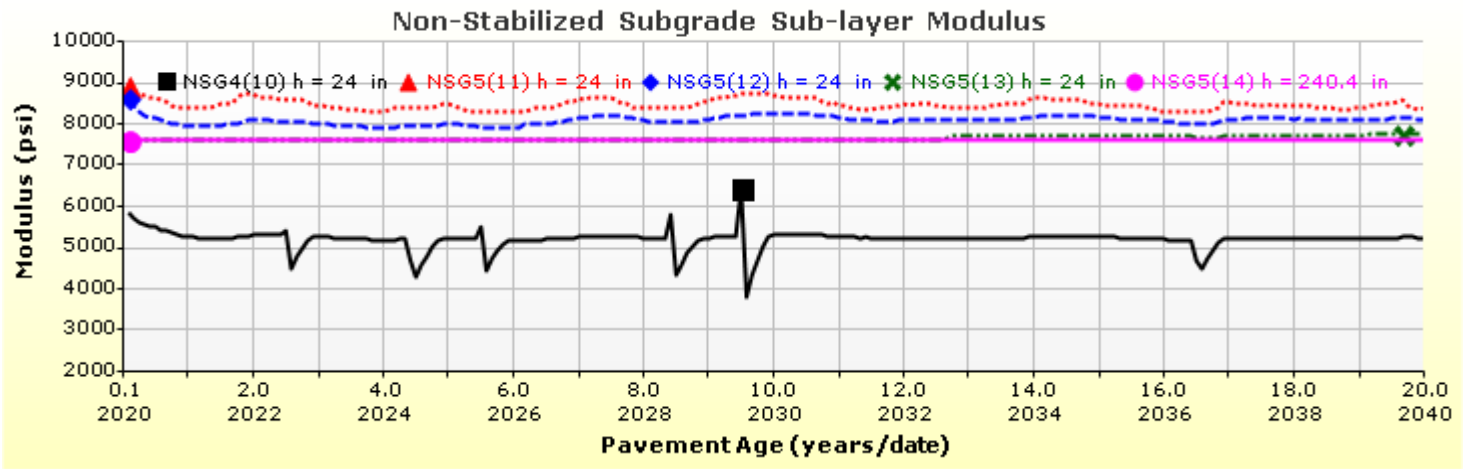

AC Top-Down Cracking (Longitudinal)
Top-Down Cracking (ft/mile
Threshold Value
@ 50% Reliability (Surface)
@ 50% Reliability (Depth=.5in)
@Specified Reliability
3000
2500
2000
1500
1000
500
0
0.1
2020
2.0
2022
4.0
2024
6.0
2026
8.0
2028
10.0
2030
12.0
2032
14.0
2034
16.0
2036
18.0
2038
20.0
2040
Pavement Age (years/date)


AC Bottom-Up Cracking (Alligator)
Bottom-Up Cracking (%)
Threshold Value
@ 50% Reliability
@ Specified Reliability
30
25
20
15
10
5
0
0.1
2020
2.0
2022
4.0
2024
6.0
2026
8.0
2028
10.0
2030
12.0
2032
14.0
2034
16.0
2036
18.0
2038
20.0
2040
Pavement Age (years/date)


Rutting (Permanent Deformation) at 50% Reliability
Total
Subtotal AC
Subtotal Subgrade
Subtotal Base
Rut Depth (in)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1
2020
2.0
2022
4.0
2024
6.0
2026
8.0
2028
10.0
2030
12.0
2032
14.0
2034
16.0
2036
18.0
2038
20.0
2040
Pavement Age (years/date)


Asphalt Mid-Quintile Sub-layer Modulus
AC1(1) h = 0.5 in
AC1(2) h = 0.5 in
AC1(3) h = 1 in
AC2(4) h = 1 in
AC2(5) h = 1 in
AC2(6) h = 3.5 in
Modulus (psi)
4000000
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)


Granular Base Sub-layer Modulus
GB3(7) h = 2 in
GB3(8) h = 4 in
GB3(9) h = 4 in
Modulus (psi)
1400000
1200000
1000000
800000
600000
400000
200000
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)


Non-Stabilized Subgrade Sub-layer Modulus
NSG4(10) h = 24 in
NSG5(11) h = 24 in
NSG5(12) h = 24 in
NSG5(13) h = 24 in
NSG5(14) h = 240.4 in
Modulus (psi)
10000
9000
8000
7000
6000
5000
4000
3000
2000
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)

Layer Information

Layer 1 Flexible : R2 Level 1 SMA

Asphalt		
Thickness (in)	2.0	
Unit weight (pcf)	145.0	
Poisson's ratio	Is Calculated?	True
	Ratio	-
	Parameter A	-1.63
	Parameter B	3.84E-06

Asphalt Dynamic Modulus (Input Level: 1)

T (ºF)	0.5 Hz	1 Hz	10 Hz	25 Hz
14	1875400	2299039	2624309	2726019
40	846575	1309050	1799540	1983379
70	230100	427271	753122	918360
100	76296	127286	231357	296468
130	40803	55308	84229	102895

Asphalt Binder

Temperature (ºF)	Binder Gstar (Pa)	Phase angle (deg)
158	1233	64
168.8	673	66
179.6	383	68

General Info

Name	Value
Reference temperature (ºF)	70
Effective binder content (%)	12.2
Air voids (%)	4.7
Thermal conductivity (BTU/hr-ft-ºF)	0.67
Heat capacity (BTU/lb-ºF)	0.23

Identifiers

Field	Value
Display name/identifier	R2 Level 1 SMA
Description of object	Mix ID # FS1919
Author	CDOT
Date Created	4/3/2013 12:00:00 AM
Approver	CDOT
Date approved	4/3/2013 12:00:00 AM
State	Colorado
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	SMA
User defined field 2	
User defined field 3	
Revision Number	0

Layer 2 Flexible : R2 Level 1 SX(75) PG 64-22

Asphalt		
Thickness (in)	5.5	
Unit weight (pcf)	140.5	
Poisson's ratio	Is Calculated?	True
	Ratio	-
	Parameter A	-1.63
	Parameter B	3.84E-06

Asphalt Dynamic Modulus (Input Level: 1)

T (ºF)	0.5 Hz	1 Hz	10 Hz	25 Hz
14	2910500	2947100	3034800	3058600
40	2620500	2695700	2882400	2934800
70	2057300	2190500	2549800	2658300
100	1334300	1500400	2017600	2195500
130	697600	836500	1365200	1584000

Asphalt Binder

Temperature (ºF)	Binder Gstar (Pa)	Phase angle (deg)
168.8	451	85
147.2	1857	81.6
158	889	83.1

General Info

Name	Value
Reference temperature (ºF)	70
Effective binder content (%)	11.8
Air voids (%)	6.9
Thermal conductivity (BTU/hr-ft-ºF)	0.67
Heat capacity (BTU/lb-ºF)	0.23

Identifiers

Field	Value
Display name/identifier	R2 Level 1 SX(75) PG 64-22
Description of object	Mix ID # 19127A
Author	CDOT
Date Created	4/3/2013 12:00:00 AM
Approver	CDOT
Date approved	4/3/2013 12:00:00 AM
State	Colorado
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	SX
User defined field 2	
User defined field 3	
Revision Number	0

Layer 3 Non-stabilized Base : Class 6 ABC

Unbound	
Layer thickness (in)	10.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
22000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Class 6 ABC
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	20

Sieve

Liquid Limit	30.0
Plasticity Index	6.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	125.8
Saturated hydraulic conductivity (ft/hr)	False	2.257e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	8.3

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	12.2329
bf	1.1153
cf	0.8619
hr	244.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	12.0
#100	
#80	
#60	
#50	
#40	
#30	
#20	
#16	
#10	
#8	55.0
#4	65.0
3/8-in.	
1/2-in.	
3/4-in.	95.0
1-in.	100.0
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 4 Subgrade : Clayey Sand

Unbound	
Layer thickness (in)	24.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
7000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Clayey Sand
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	33

Sieve

Liquid Limit	37.0
Plasticity Index	18.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	112.9
Saturated hydraulic conductivity (ft/hr)	False	1.153e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	14.9

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	102.5522
bf	0.7198
cf	0.2545
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	47.0
#100	
#80	
#60	
#50	
#40	72.0
#30	
#20	
#16	
#10	
#8	
#4	98.0
3/8-in.	
1/2-in.	
3/4-in.	
1-in.	
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 5 Subgrade : A-6

Unbound	
Layer thickness (in)	Semi-infinite
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
14000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-6
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	33.0
Plasticity Index	16.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	107.9
Saturated hydraulic conductivity (ft/hr)	False	1.95e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	17.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	108.4091
bf	0.6801
cf	0.2161
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	63.2
#100	
#80	73.5
#60	
#50	
#40	82.4
#30	
#20	
#16	
#10	90.2
#8	
#4	93.5
3/8-in.	96.4
1/2-in.	97.4
3/4-in.	98.4
1-in.	99.0
1 1/2-in.	99.5
2-in.	99.8
2 1/2-in.	
3-in.	
3 1/2-in.	100.0

Calibration Coefficients

AC Fatigue

$$N_f = 0.00432 * C * \beta_{f1} k_1 \left(\frac{1}{\varepsilon_1}\right)^{k_2\beta_{f2}} \left(\frac{1}{E}\right)^{k_3\beta_{f3}}$$

$$C = 10^M$$

$$M = 4.84\left(\frac{V_b}{V_a + V_b} - 0.69\right)$$

k1: 0.007566	
k2: 3.9492	
k3: 1.281	
Bf1: 130.3674	
Bf2: 1	
Bf3: 1.217799	

AC Rutting

$$\frac{\varepsilon_p}{\varepsilon_r} = k_z \beta_{r1} 10^{k_1} T^{k_2\beta_{r2}} N^{k_3 B_{r3}}$$

$$k_z = (C_1 + C_2 * depth) * 0.328196^{depth}$$

$$C_1 = -0.1039 * H_\alpha^2 + 2.4868 * H_\alpha - 17.342$$

$$C_2 = 0.0172 * H_\alpha^2 - 1.7331 * H_\alpha + 27.428$$

Where:

$$H_{ac} = total\ AC\ thickness(in)$$

$\varepsilon_p = plastic\ strain\left({}^{in}/_{in}\right)$
$\varepsilon_r = resilient\ strain\left({}^{in}/_{in}\right)$
$T = layer\ temperature(^{\circ}F)$
$N = number\ of\ load\ repetitions$

AC Rutting Standard Deviation	0.1414 * Pow(RUT,0.25) + 0.001	
AC Layer	K1:-3.35412 K2:1.5606 K3:0.3791	Br1:6.7 Br2:1 Br3:1

Thermal Fracture

$$C_f = 400 * N\left(\frac{\log C / h_{ac}}{\sigma}\right)$$

$$\Delta C = (k * \beta t)^{n+1} * A * \Delta K^n$$

$$A = 10^{(4.389 - 2.52 * \log(E * \sigma_m * n))}$$

$C_f = observed\ amount\ of\ thermal\ cracking(ft/500ft)$
$k = refression\ coefficient\ determined\ through\ field\ calibration$
$N() = standard\ normal\ distribution\ evaluated\ at()$
$\sigma = standard\ deviation\ of\ the\ \log\ of\ the\ depth\ of\ cracks\ in\ the\ pavments$
$C = crack\ depth(in)$
$h_{ac} = thickness\ of\ asphalt\ layer(in)$
$\Delta C = Change\ in\ the\ crack\ depth\ due\ to\ a\ cooling\ cycle$
$\Delta K = Change\ in\ the\ stress\ intensity\ factor\ due\ to\ a\ cooling\ cycle$
$A, n = Fracture\ parameters\ for\ the\ asphalt\ mixture$
$E = mixture\ stiffness$
$\sigma_M = Undamaged\ mixture\ tensile\ strength$
$\beta_t = Calibration\ parameter$

Level 1 K: 6.3	Level 1 Standard Deviation: 0.1468 * THERMAL + 65.027
Level 2 K: 0.5	Level 2 Standard Deviation: 0.2841 * THERMAL + 55.462
Level 3 K: 6.3	Level 3 Standard Deviation: 0.3972 * THERMAL + 20.422

CSM Fatigue

$$N_f = 10^{\left(\frac{k_1 \beta_{c1} \left(\frac{\sigma_s}{M_r}\right)}{k_2 \beta_{c2}}\right)}$$

$N_f = number\ of\ repetitions\ to\ fatigue\ cracking$
$\sigma_s = Tensile\ stress(psi)$
$M_r = modulus\ of\ rupture(psi)$

k1: 1	k2: 1	Bc1: 0.75	Bc2:1.1

Subgrade Rutting

$$\delta_a(N) = \beta_{s_1} k_1 \varepsilon_v h \left(\frac{\varepsilon_0}{\varepsilon_r}\right) \left| e^{-\left(\frac{\rho}{N}\right)^{\beta}} \right|$$

$\delta_a = permanent\ deformation\ for\ the\ layer$
$N = number\ of\ repetitions$
$\varepsilon_v = average\ veritcal\ strain(in/in)$
$\varepsilon_0, \beta, \rho = material\ properties$
$\varepsilon_r = resilient\ strain(in/in)$

Granular		Fine	
k1: 2.03	Bs1: 0.22	k1: 1.35	Bs1: 0.37
Standard Deviation (BASERUT) 0.0104 * Pow(BASERUT,0.67) + 0.001		Standard Deviation (BASERUT) 0.0663 * Pow(SUBRUT,0.5) + 0.001	

AC Cracking

AC Top Down Cracking

$$FC_{top} = \left(\frac{C_4}{1 + e^{(C_1 - C_2 * log_{10}(Damage))}}\right) * 10.56$$

c1: 7	c2: 3.5	c3: 0	c4: 1000

AC Cracking Top Standard Deviation

200 + 2300/(1+exp(1.072-2.1654*LOG10(TOP+0.0001)))

AC Bottom Up Cracking

$$FC = \left(\frac{6000}{1 + e^{(C_1 * C_1' + C_2 * C_2' log_{10}(D * 100))}}\right) * \left(\frac{1}{60}\right)$$

$$C_2' = -2.40874 - 39.748 * (1 + h_{ac})^{-2.856}$$

$$C_1' = -2 * C_2'$$

c1: 0.021	c2: 2.35	c3: 6000

AC Cracking Bottom Standard Deviation

1 + 15/(1+exp(-3.1472-4.1349*LOG10(BOTTOM+0.0001)))

CSM Cracking

$$FC_{ctb} = C_1 + \frac{C_2}{1 + e^{C_3 - C_4(Damage)}}$$

C1: 0	C2: 75	C3: 5	C4: 3

CSM Standard Deviation

CTB*1

IRI Flexible Pavements

C1 - Rutting
C2 - Fatigue Crack
C3 - Transverse Crack
C4 - Site Factors

C1: 50	C2: 0.55	C3: 0.0111	C4: 0.02

Powers S AC composite(76-28 SMA over 64-22 sx75)

File Name: C:\Users\darwinME\Desktop\AFK\Powers and Research\HMA\Powers S AC composite(76-28 SMA over 64-22 sx75).dgpx

Design Inputs

Design Life: 20 years
Design Type: FLEXIBLE

Base construction: May, 2020
Pavement construction: June, 2020
Traffic opening: September, 2020

Climate Data Sources (Lat/Lon): 38.812, -104.711

Design Structure

Layer type	Material Type	Thickness (in)
Flexible	R2 Level 1 SMA	2.0
Flexible	R2 Level 1 SX(75) PG 64-22	5.5 (Optimized)
NonStabilized	Class 6 ABC	10.0
Subgrade	Clayey Sand	24.0
Subgrade	A-6	Semi-infinite

Volumetric at Construction:	
Effective binder content (%)	12.2
Air voids (%)	4.7

Traffic

Age (year)	Heavy Trucks (cumulative)
2020 (initial)	2,468
2030 (10 years)	2,959,790
2040 (20 years)	6,564,230

Design Outputs

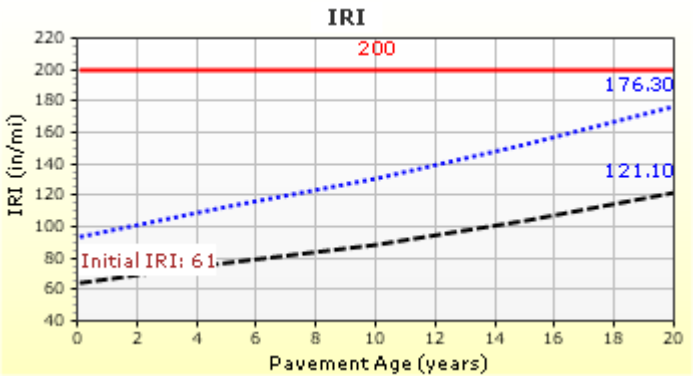
Distress Prediction Summary

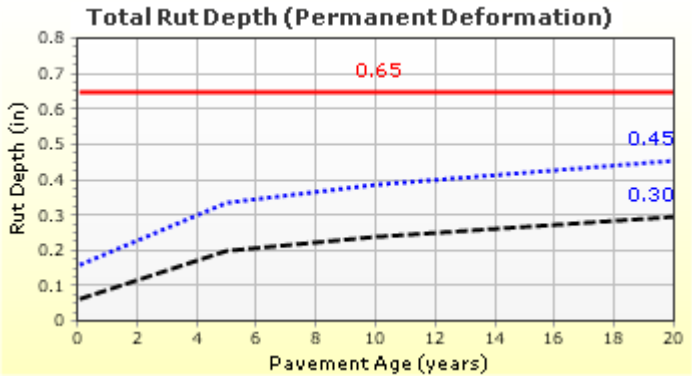
Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	200.00	176.27	95.00	99.07	Pass
Permanent deformation - total pavement (in)	0.65	0.45	95.00	99.99	Pass
AC bottom-up fatigue cracking (% lane area)	25.00	21.87	95.00	97.26	Pass
AC thermal cracking (ft/mile)	1500.00	273.83	95.00	100.00	Pass
AC top-down fatigue cracking (ft/mile)	2500.00	353.93	95.00	100.00	Pass
Permanent deformation - AC only (in)	0.50	0.34	95.00	99.96	Pass

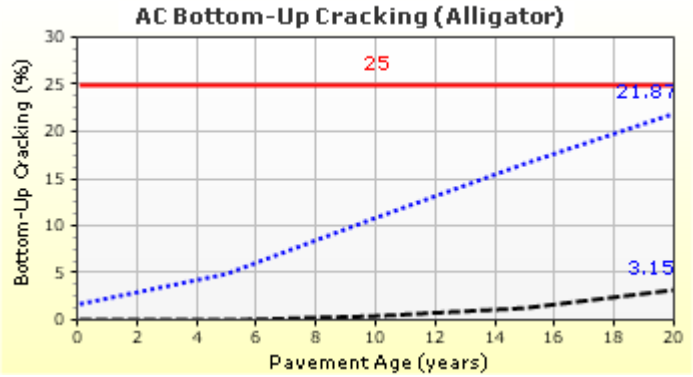
Powers S AC composite(76-28 SMA over 64-22 sx75)

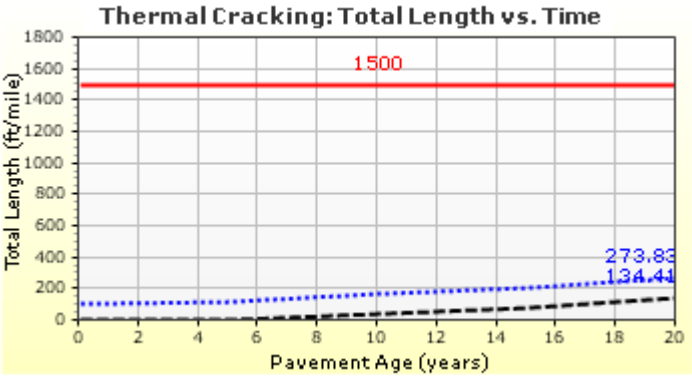
File Name: C:\Users\darwinME\Desktop\AFK\Powers and Research\HMA\Powers S AC composite(76-28 SMA over 64-22 sx75).dgpx

Distress Charts





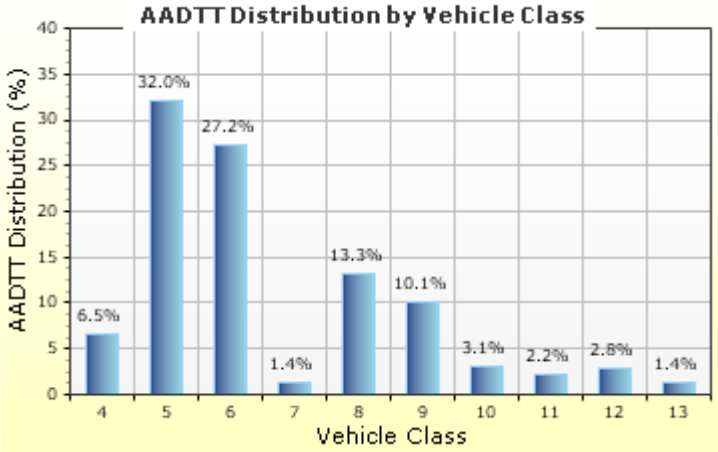


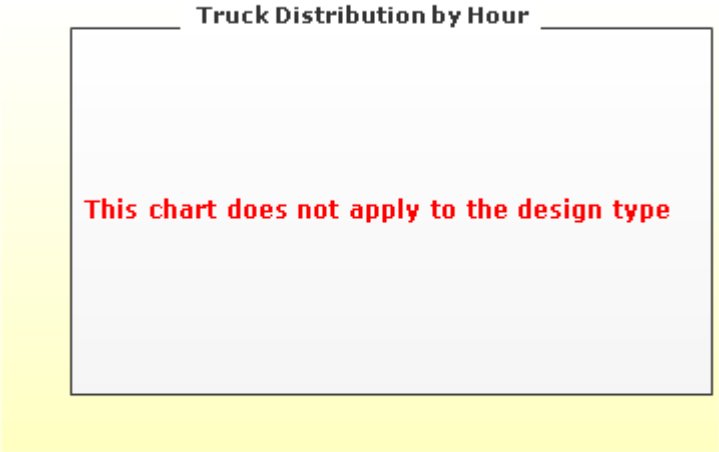


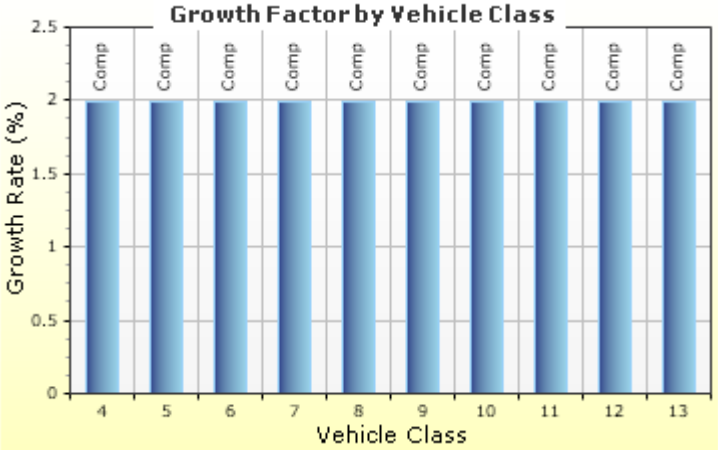
Traffic Inputs

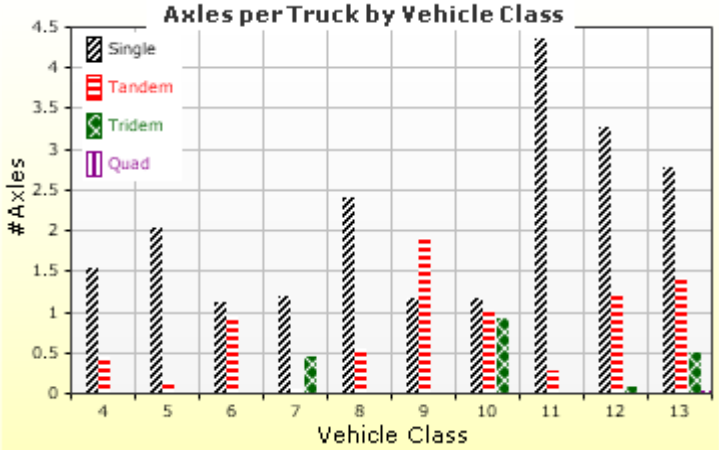
Graphical Representation of Traffic Inputs

Initial two-way AADTT:	2,468	Percent of trucks in design direction (%):	50.0
Number of lanes in design direction:	3	Percent of trucks in design lane (%):	60.0
		Operational speed (mph)	70.0

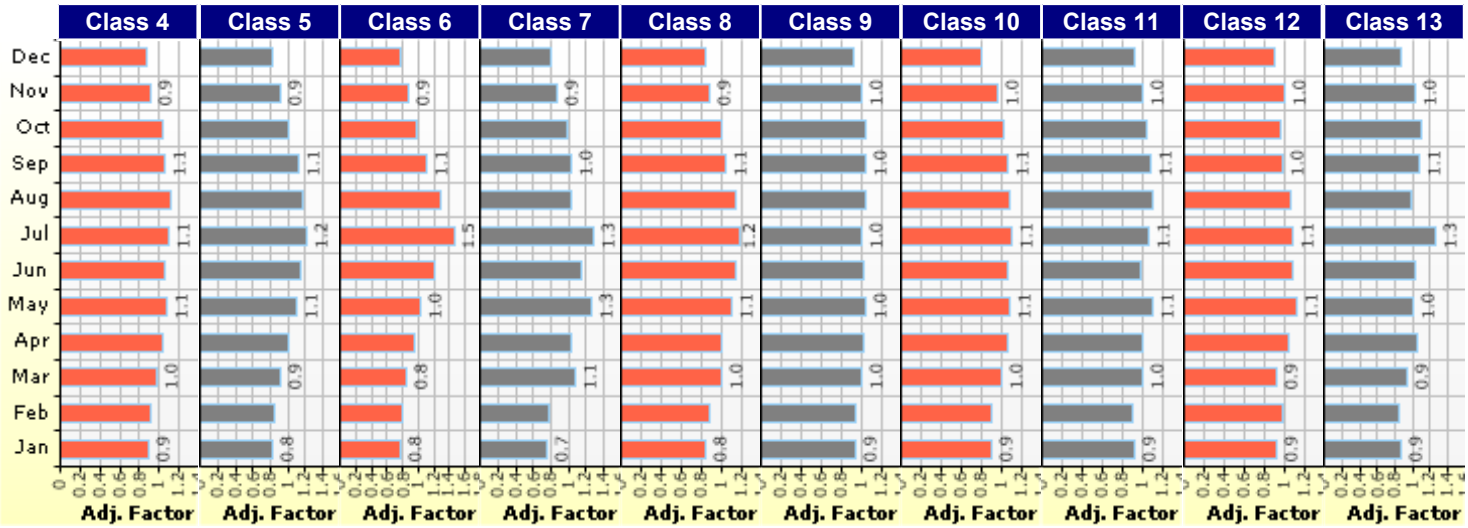








Traffic Volume Monthly Adjustment Factors



Tabular Representation of Traffic Inputs

Volume Monthly Adjustment Factors

Level 3: Default MAF

Month	Vehicle Class									
	4	5	6	7	8	9	10	11	12	13
January	0.9	0.8	0.8	0.7	0.8	0.9	0.9	0.9	0.9	0.9
February	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.8
March	1.0	0.9	0.8	1.1	1.0	1.0	1.0	1.0	0.9	0.9
April	1.0	1.0	0.9	1.0	1.0	1.0	1.1	1.0	1.0	1.1
May	1.1	1.1	1.0	1.3	1.1	1.0	1.1	1.1	1.1	1.0
June	1.1	1.1	1.2	1.1	1.1	1.0	1.1	1.0	1.1	1.0
July	1.1	1.2	1.5	1.3	1.2	1.0	1.1	1.1	1.1	1.3
August	1.1	1.2	1.3	1.0	1.1	1.0	1.1	1.1	1.1	1.0
September	1.1	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1
October	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.1
November	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0
December	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.9	0.9

Distributions by Vehicle Class

Truck Distribution by Hour does not apply

Vehicle Class	AADTT Distribution (%) (Level 3)	Growth Factor	
		Rate (%)	Function
Class 4	6.54%	1.99%	Compound
Class 5	32.02%	1.99%	Compound
Class 6	27.23%	1.99%	Compound
Class 7	1.38%	1.99%	Compound
Class 8	13.25%	1.99%	Compound
Class 9	10.07%	1.99%	Compound
Class 10	3.1%	1.99%	Compound
Class 11	2.19%	1.99%	Compound
Class 12	2.82%	1.99%	Compound
Class 13	1.4%	1.99%	Compound

Axle Configuration

Traffic Wander	
Mean wheel location (in)	18.0
Traffic wander standard deviation (in)	10.0
Design lane width (ft)	12.0

Axle Configuration	
Average axle width (ft)	8.5
Dual tire spacing (in)	12.0
Tire pressure (psi)	120.0

Average Axle Spacing	
Tandem axle spacing (in)	51.6
Tridem axle spacing (in)	49.2
Quad axle spacing (in)	49.2

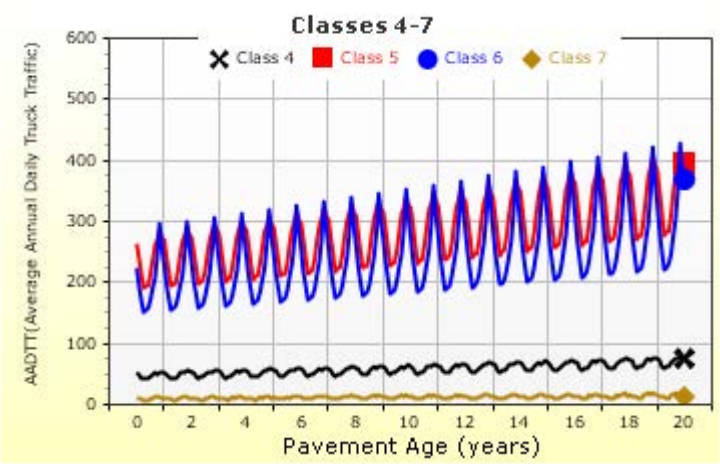
Wheelbase does not apply

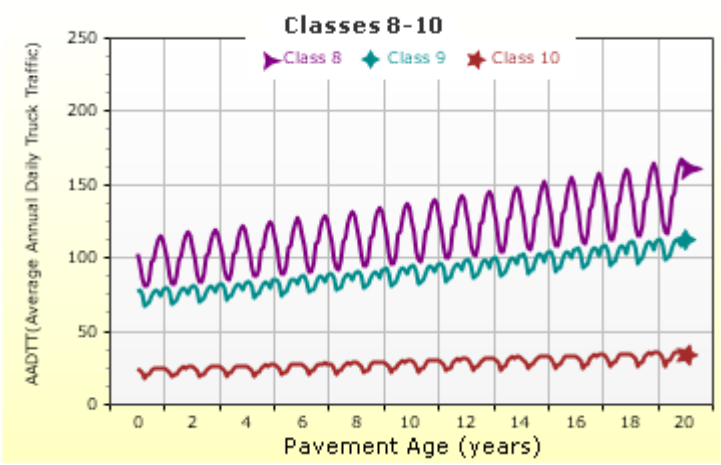
Number of Axles per Truck

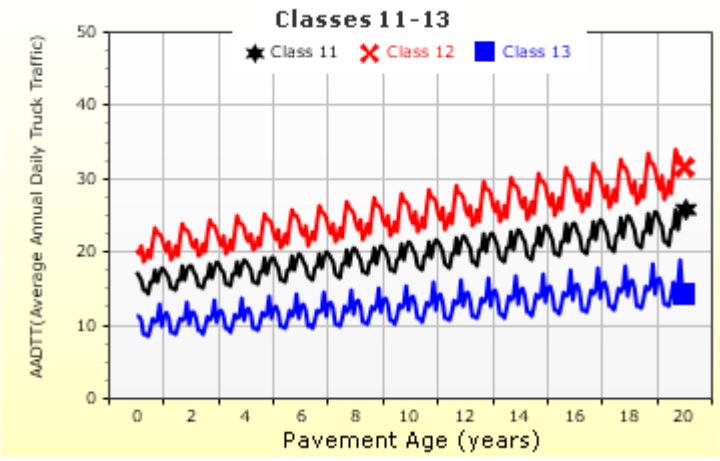
Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.53	0.45	0	0
Class 5	2.02	0.16	0.02	0
Class 6	1.12	0.94	0	0
Class 7	1.19	0.07	0.45	0.02
Class 8	2.41	0.56	0.02	0
Class 9	1.16	1.9	0.01	0
Class 10	1.15	1.01	0.93	0.02
Class 11	4.35	0.29	0.02	0
Class 12	3.27	1.22	0.09	0
Class 13	2.77	1.4	0.51	0.04

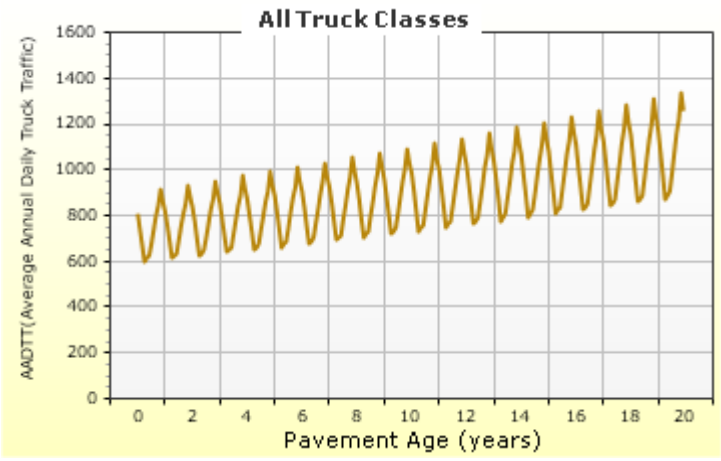
AADTT (Average Annual Daily Truck Traffic) Growth

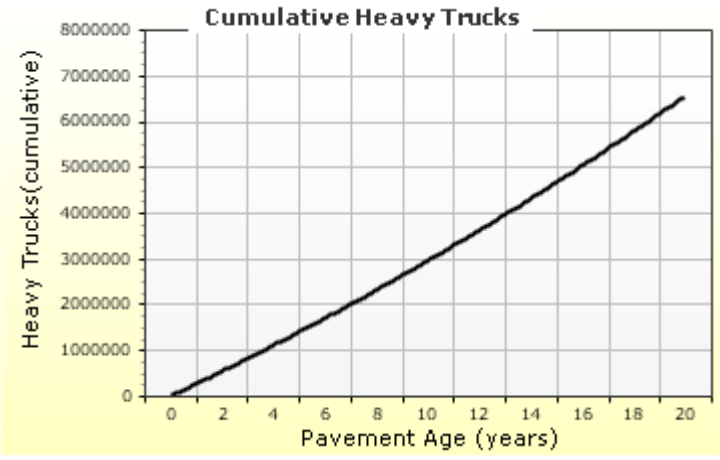
*** Traffic cap is not enforced**







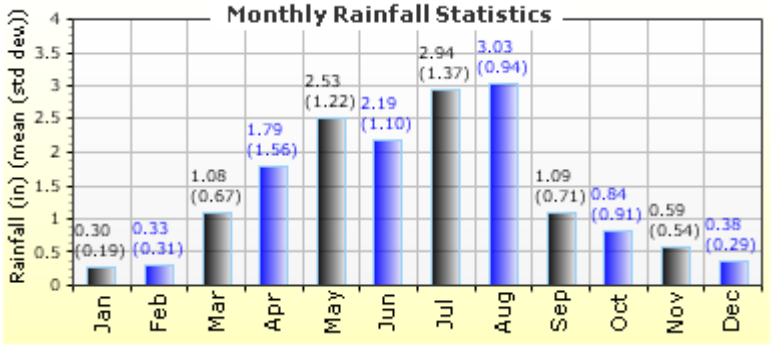




Climate Inputs

Climate Data Sources:

Climate Station Cities:	Location (lat lon elevation(ft))
COLORADO SPRINGS_	38.81200 -104.71100 6170

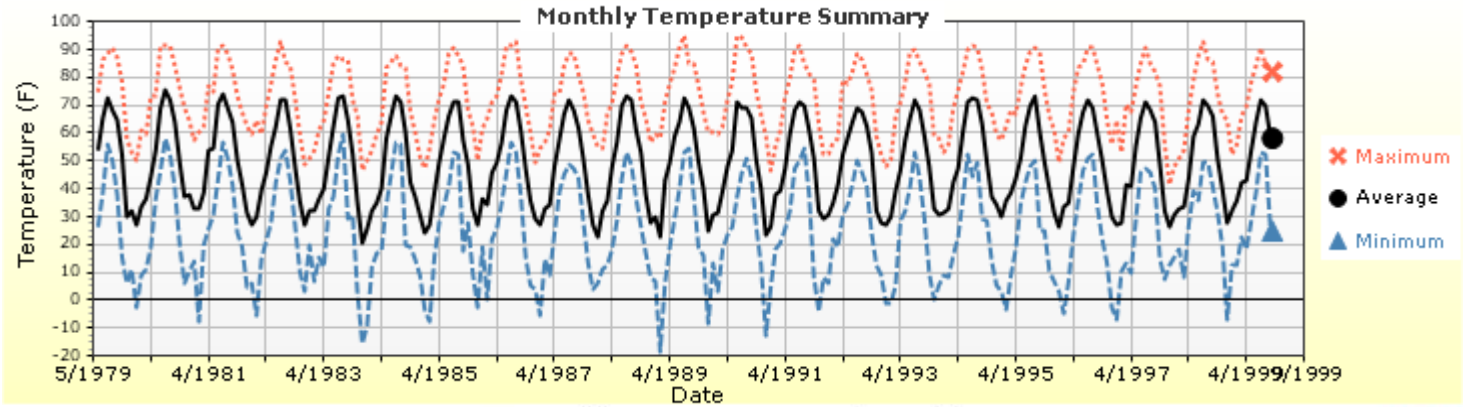


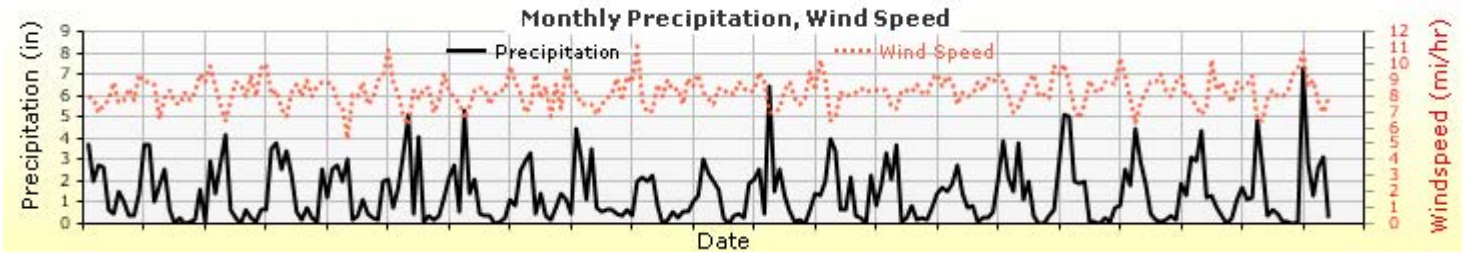
Annual Statistics:

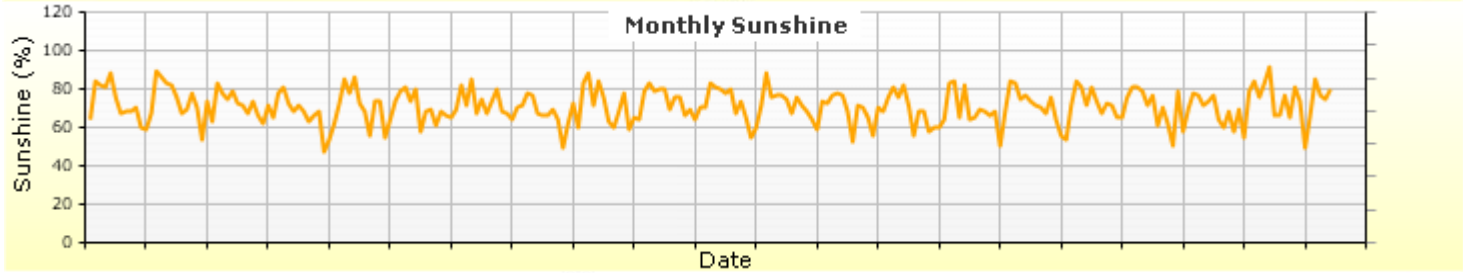
Mean annual air temperature (ºF)	49.11
Mean annual precipitation (in)	17.31
Freezing index (ºF - days)	555.60
Average annual number of freeze/thaw cycles:	83.33

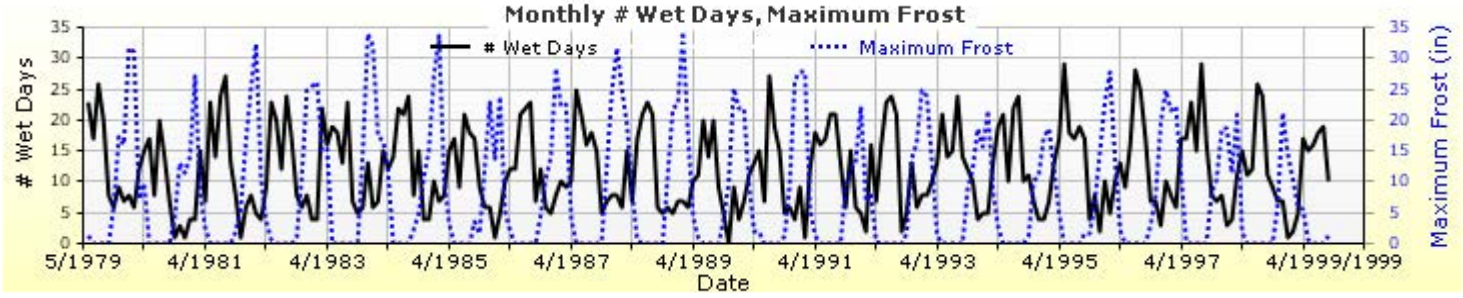
Water table depth (ft)	7.00

Monthly Climate Summary:

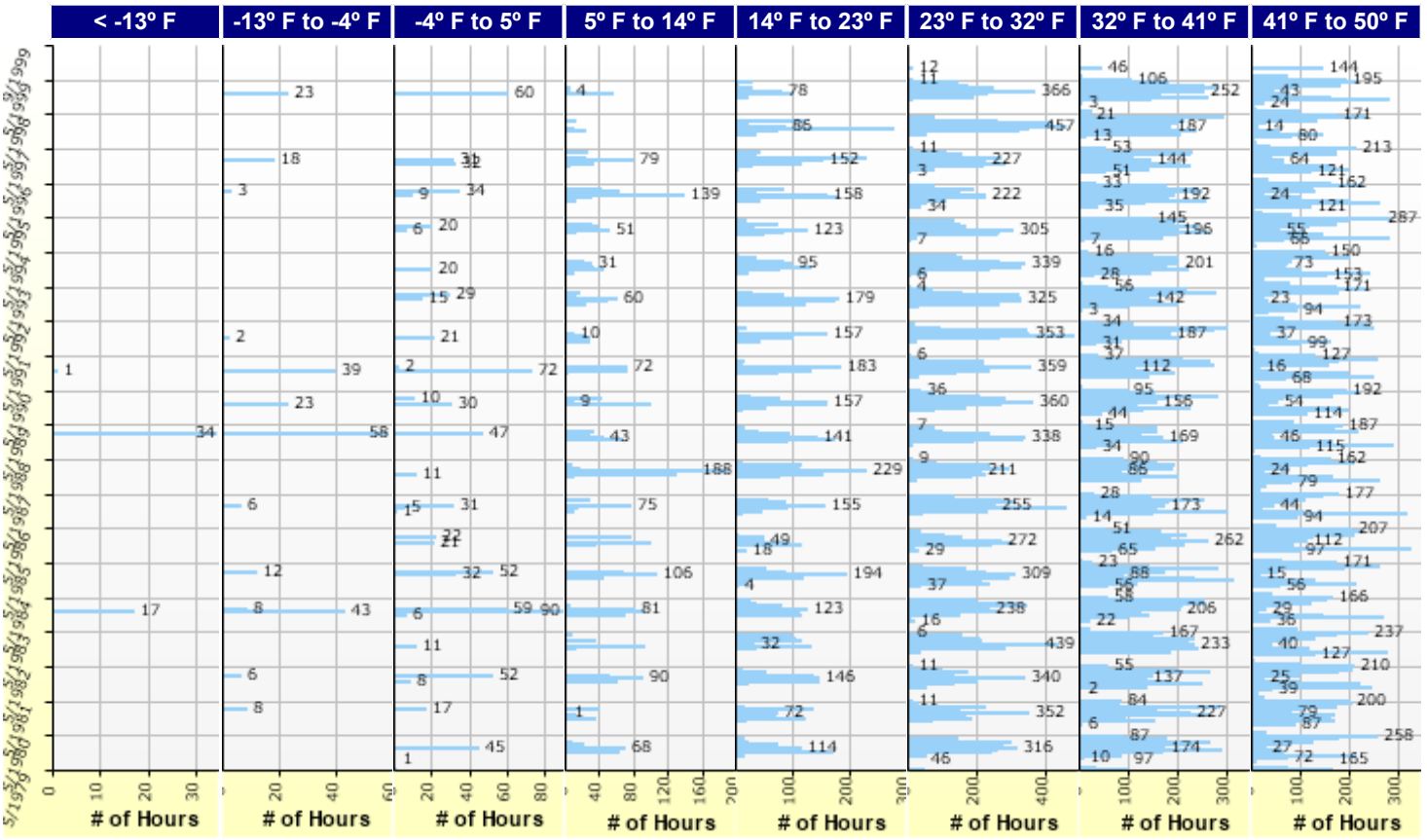


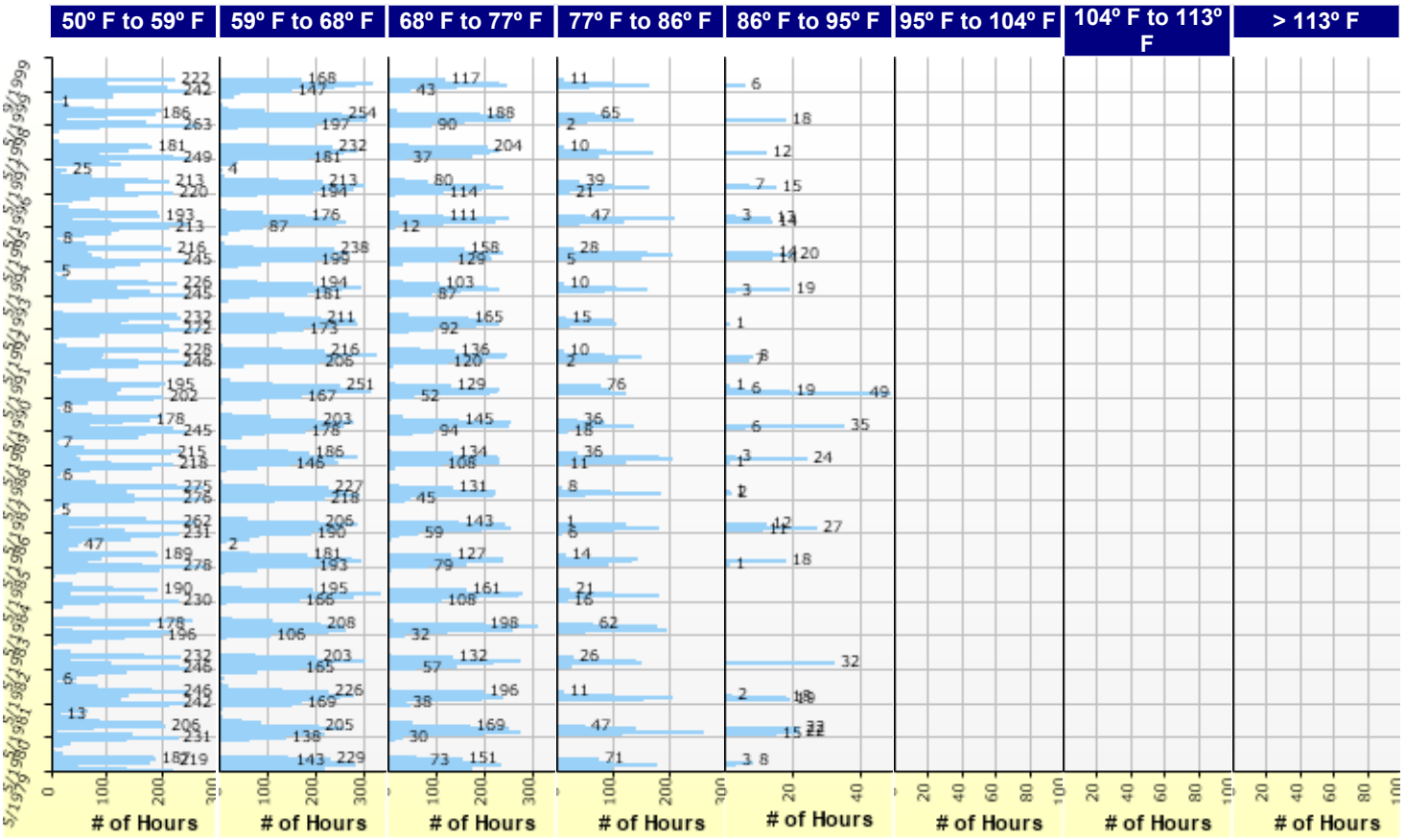






Hourly Air Temperature Distribution by Month:





Design Properties

HMA Design Properties

Use Multilayer Rutting Model	False
Using G* based model (not nationally calibrated)	False
Is NCHRP 1-37A HMA Rutting Model Coefficients	True
Endurance Limit	-
Use Reflective Cracking	True

Structure - ICM Properties	
AC surface shortwave absorptivity	0.85

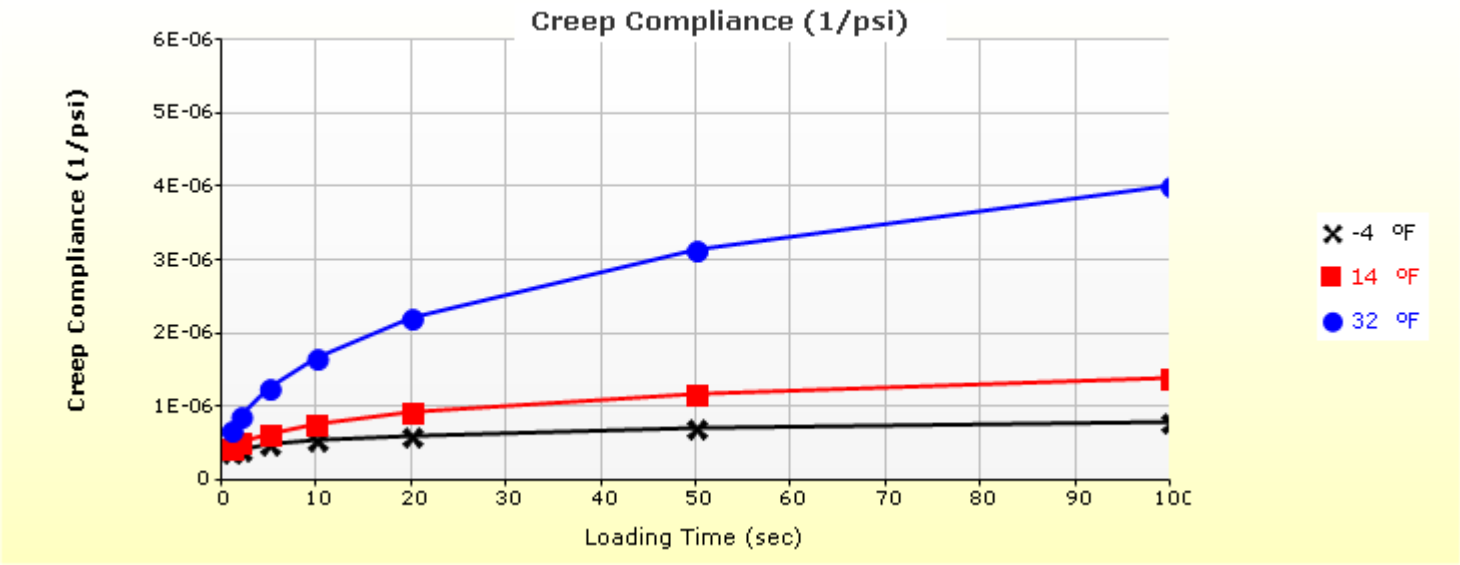
Layer Name	Layer Type	Interface Friction
Layer 1 Flexible : R2 Level 1 SMA	Flexible (1)	1.00
Layer 2 Flexible : R2 Level 1 SX (75) PG 64-22	Flexible (1)	1.00
Layer 3 Non-stabilized Base : Class 6 ABC	Non-stabilized Base (4)	1.00
Layer 4 Subgrade : Clayey Sand	Subgrade (5)	1.00
Layer 5 Subgrade : A-6	Subgrade (5)	-

Thermal Cracking (Input Level: 1)

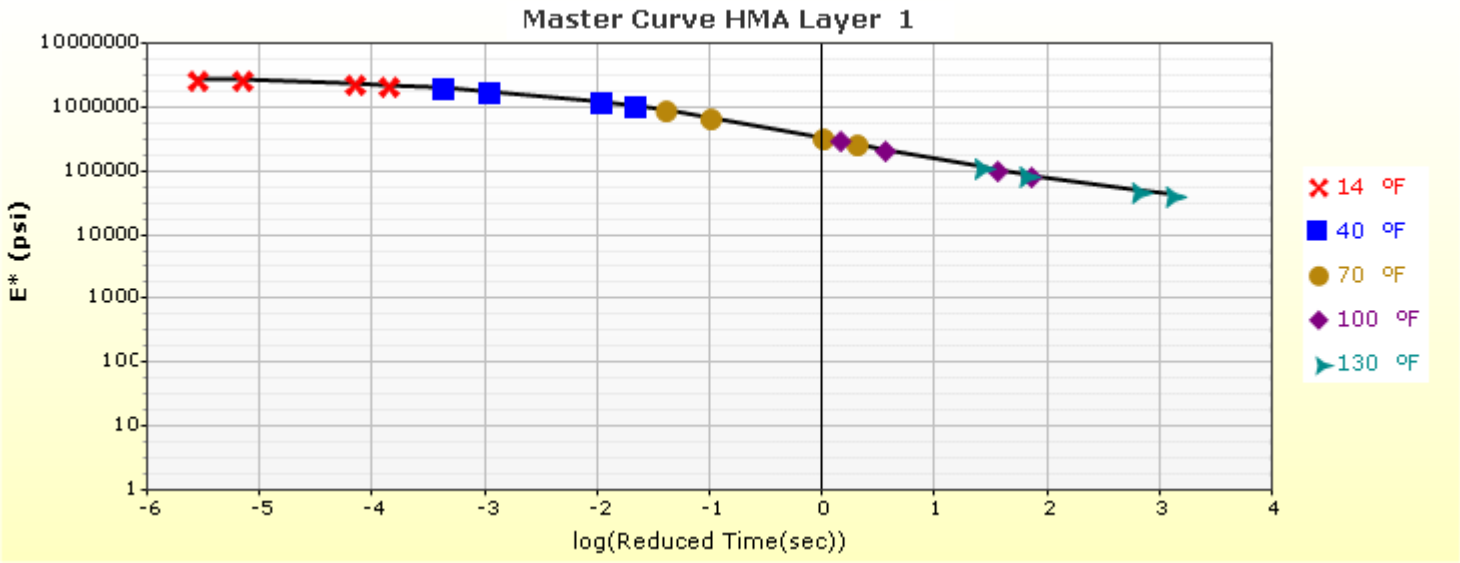
Indirect tensile strength at 14 ºF (psi)	515.00

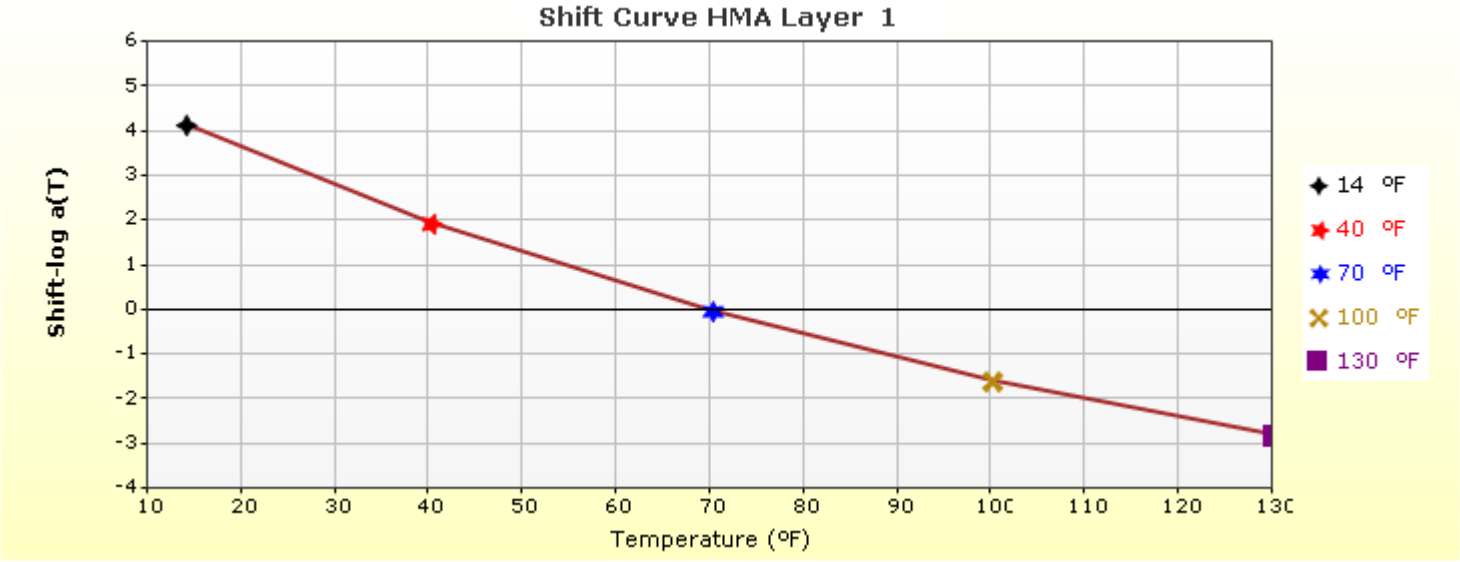
Thermal Contraction	
Is thermal contraction calculated?	True
Mix coefficient of thermal contraction (in/in/ºF)	-
Aggregate coefficient of thermal contraction (in/in/ºF)	5.0e-006
Voids in Mineral Aggregate (%)	16.9

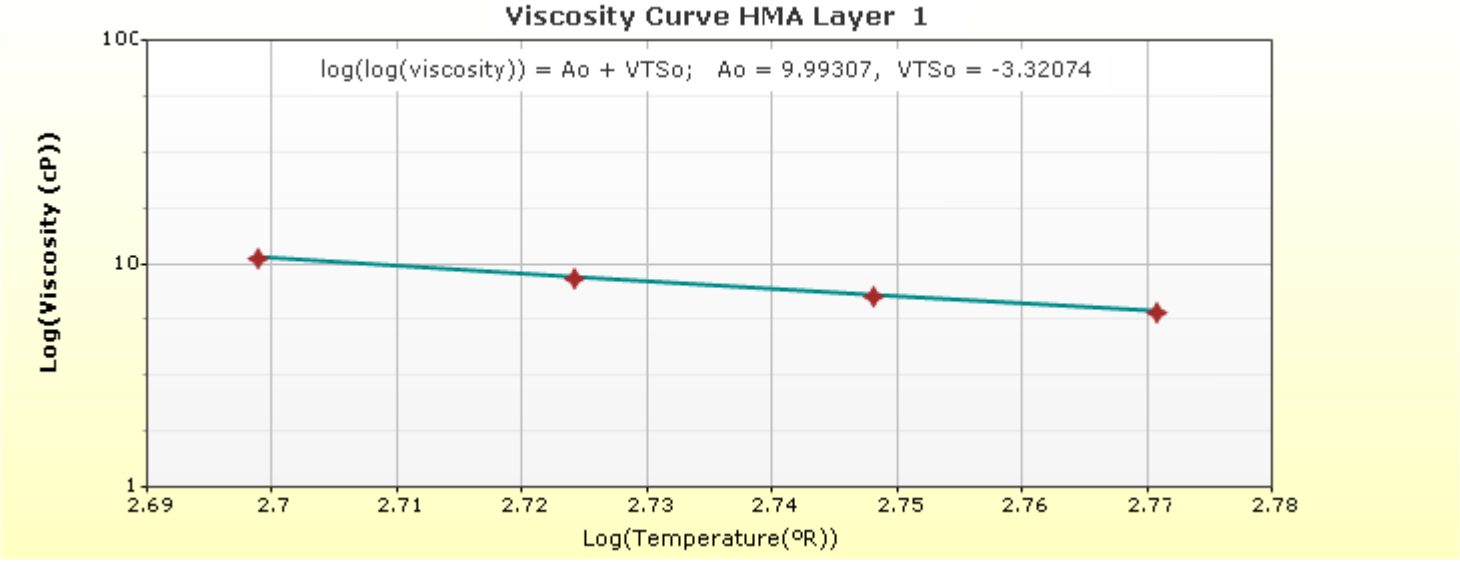
	Creep Compliance (1/psi)		
Loading time (sec)	-4 ºF	14 ºF	32 ºF
1	4.01e-007	4.45e-007	6.88e-007
2	4.28e-007	5.41e-007	8.96e-007
5	4.98e-007	6.37e-007	1.27e-006
10	5.51e-007	7.85e-007	1.69e-006
20	6.17e-007	9.33e-007	2.23e-006
50	7.19e-007	1.18e-006	3.14e-006
100	7.96e-007	1.39e-006	4.01e-006



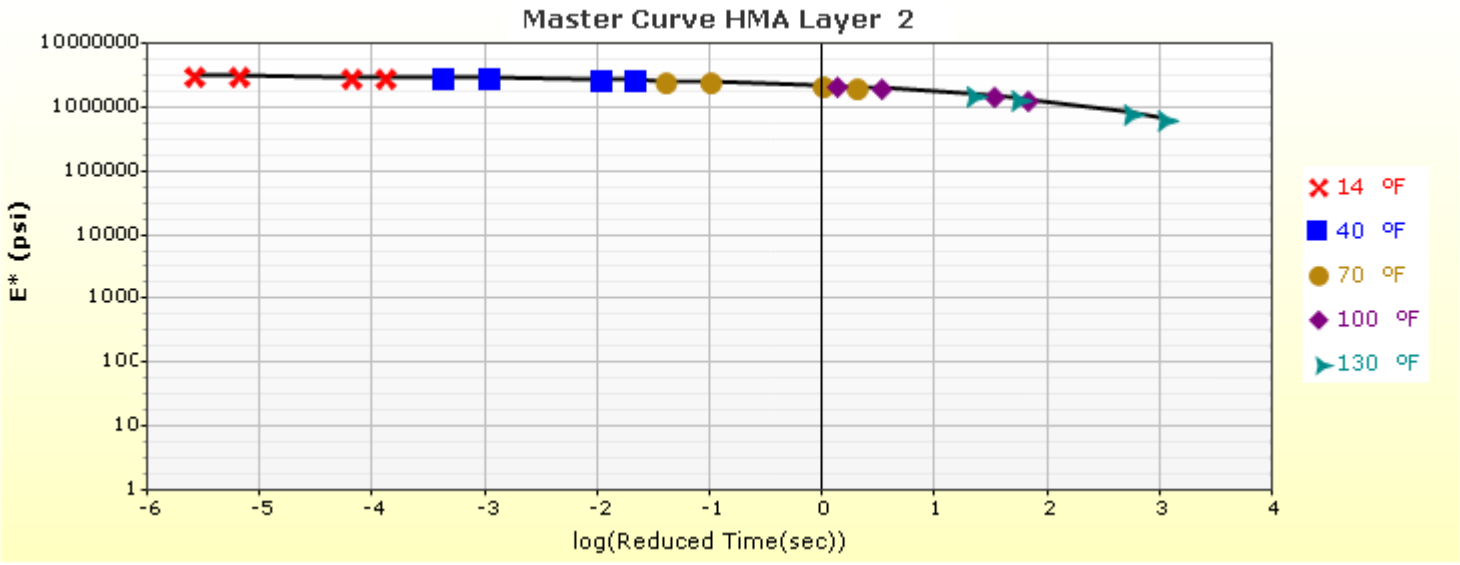
HMA Layer 1: Layer 1 Flexible : R2 Level 1 SMA

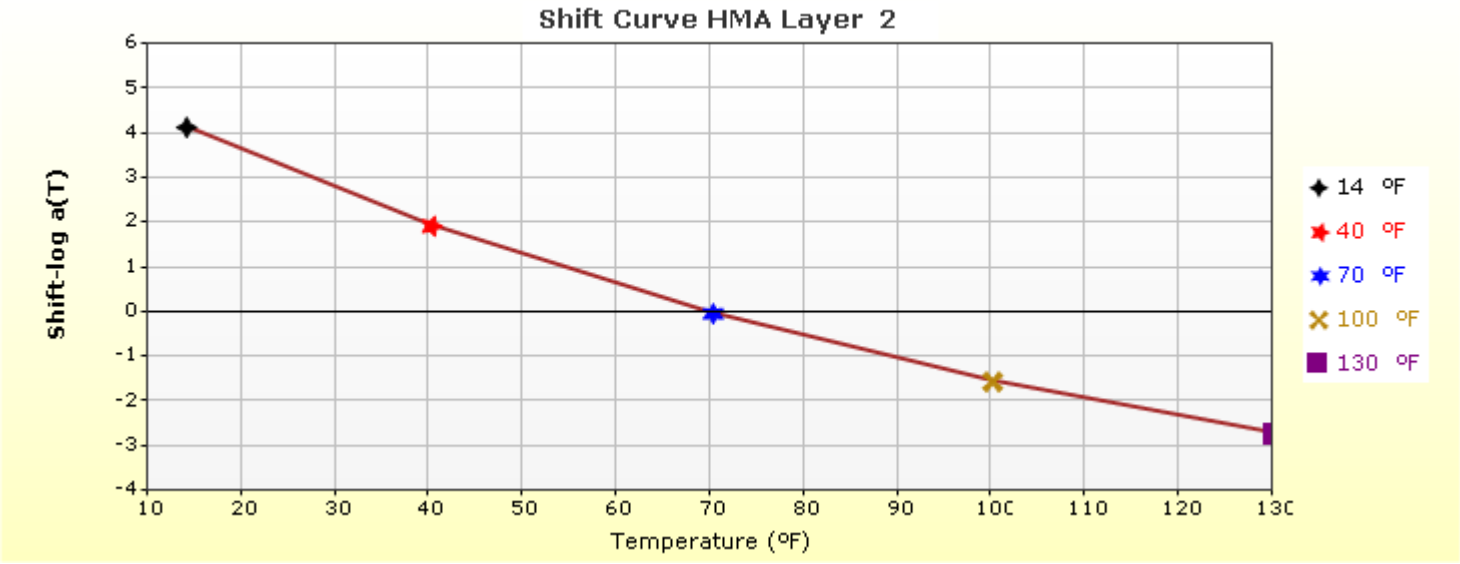


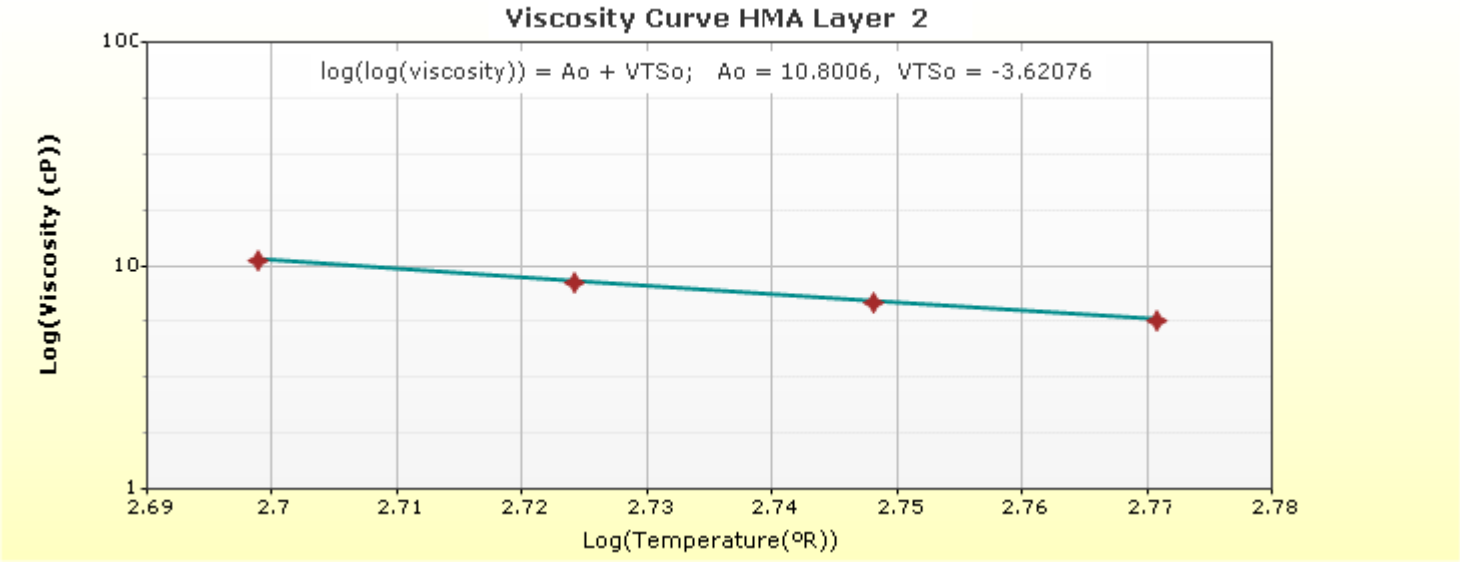




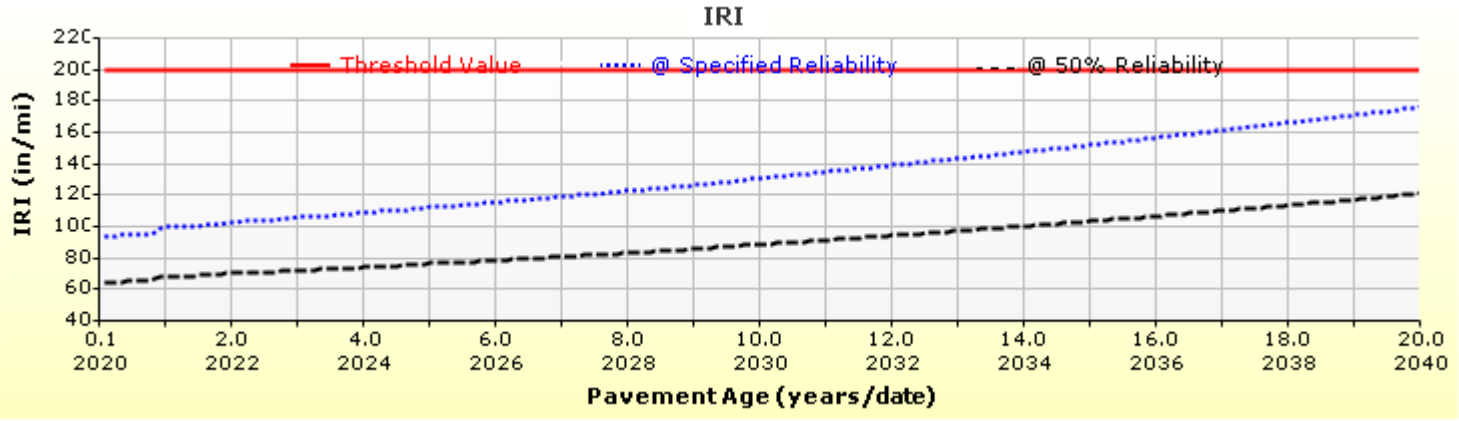
HMA Layer 2: Layer 2 Flexible : R2 Level 1 SX(75) PG 64-22

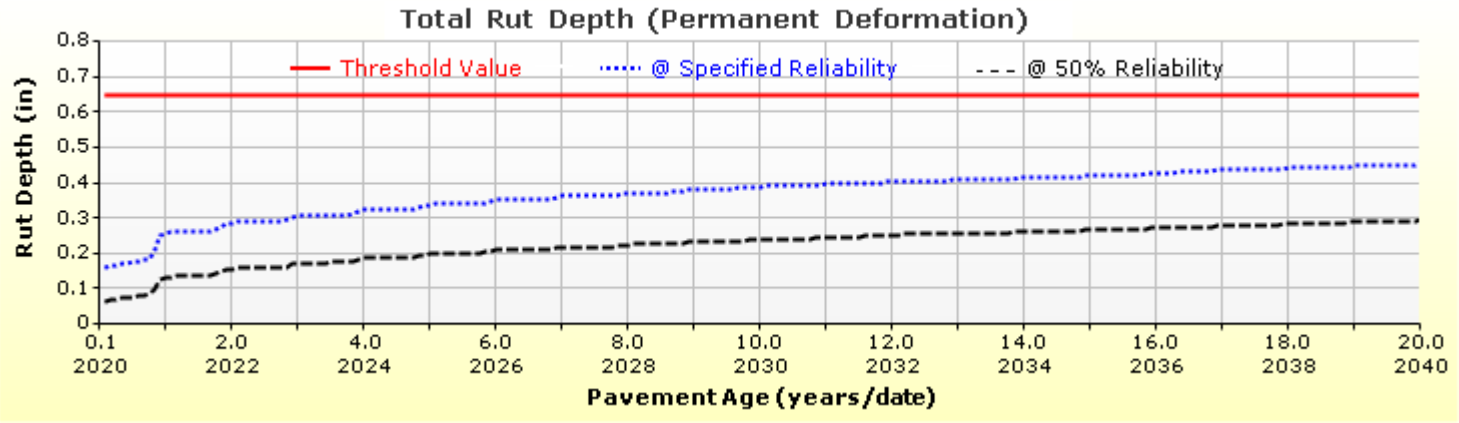


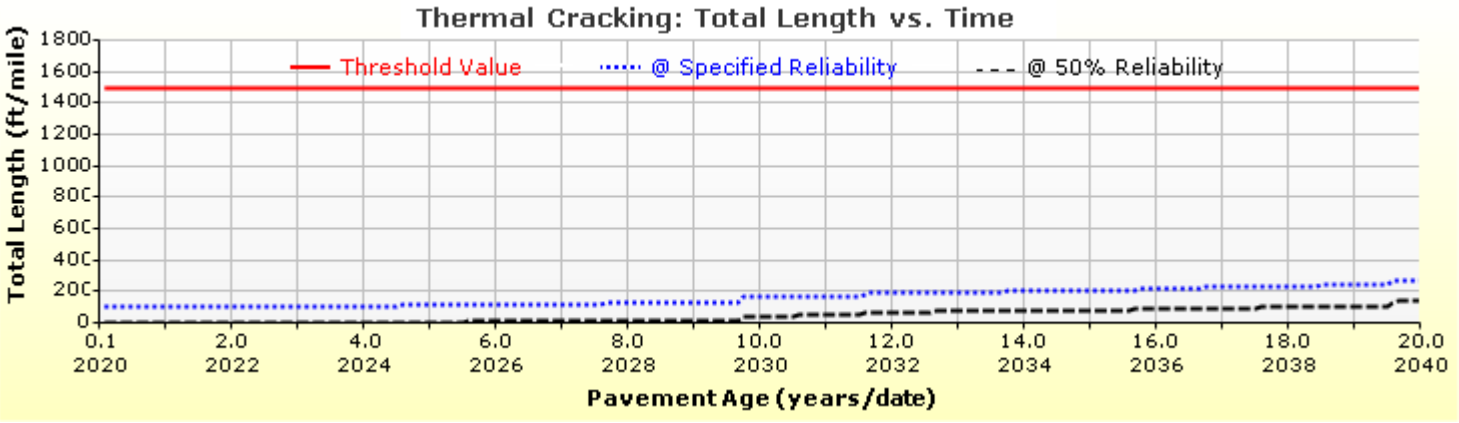


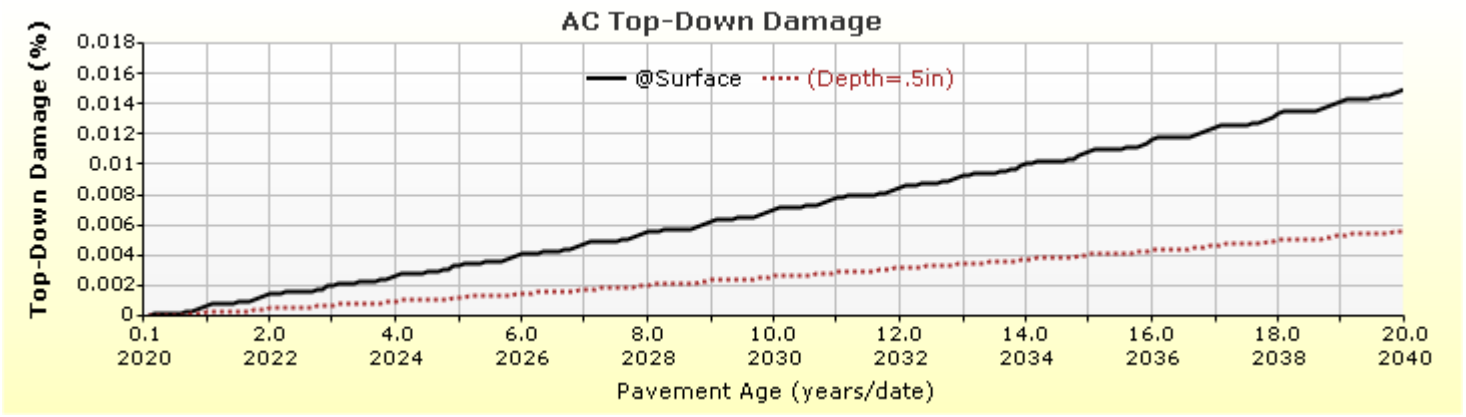


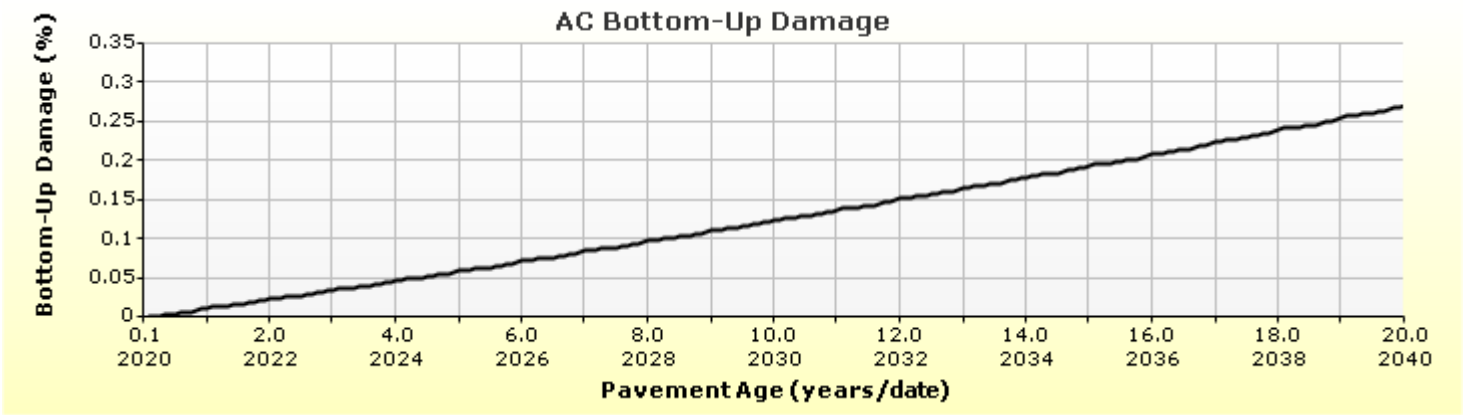
Analysis Output Charts

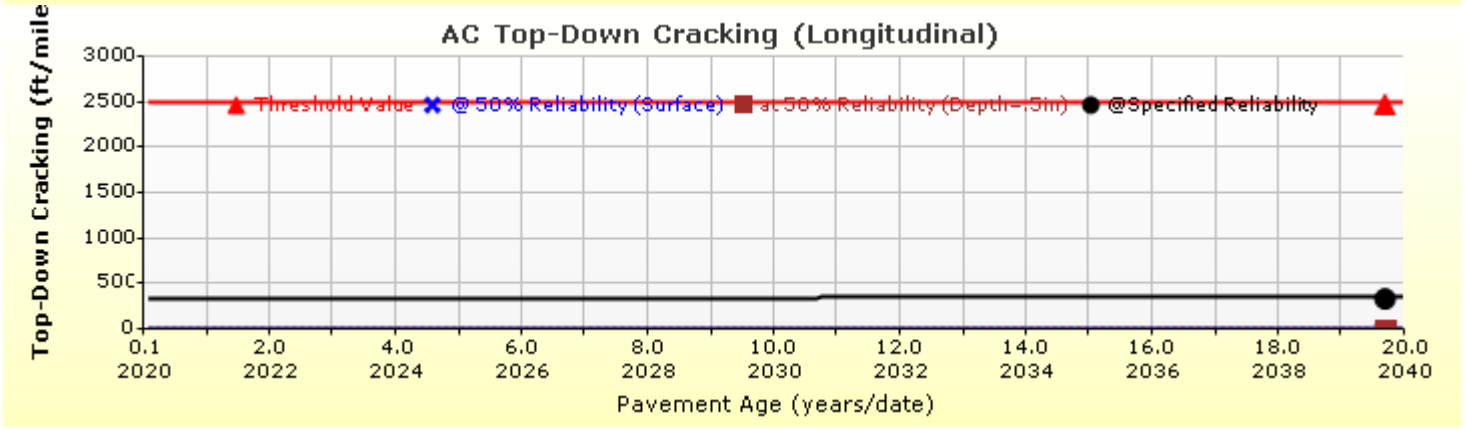


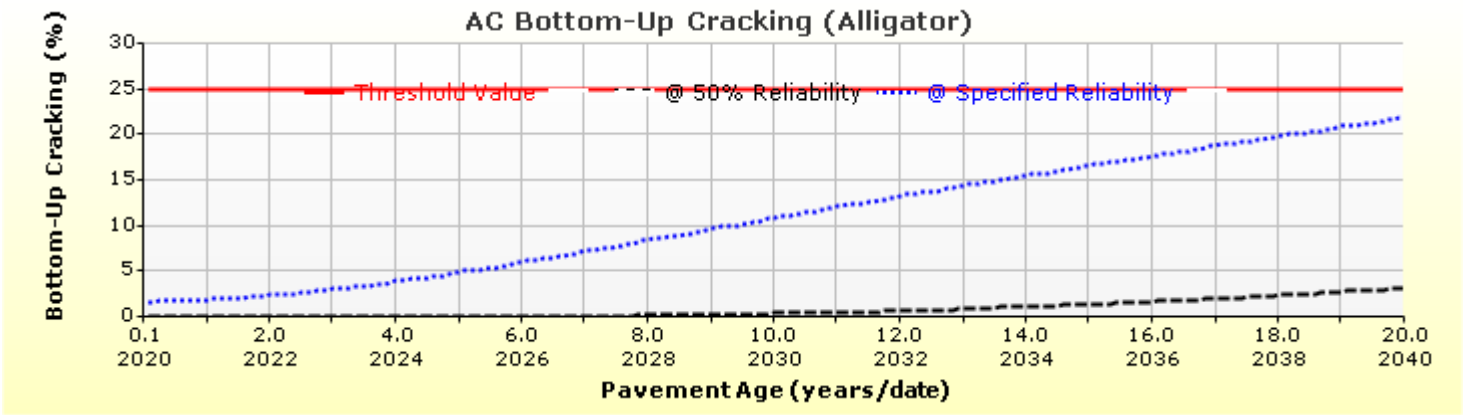


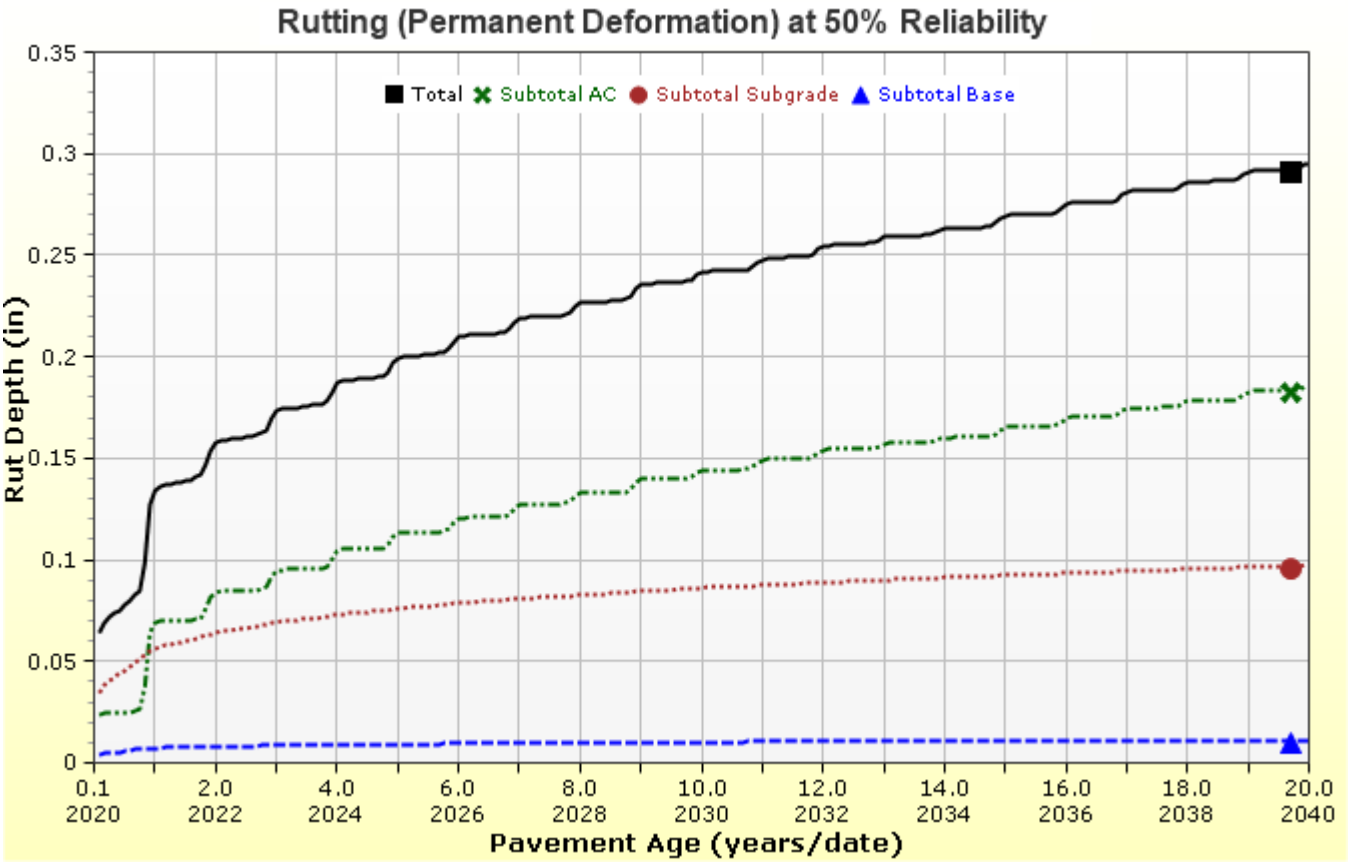


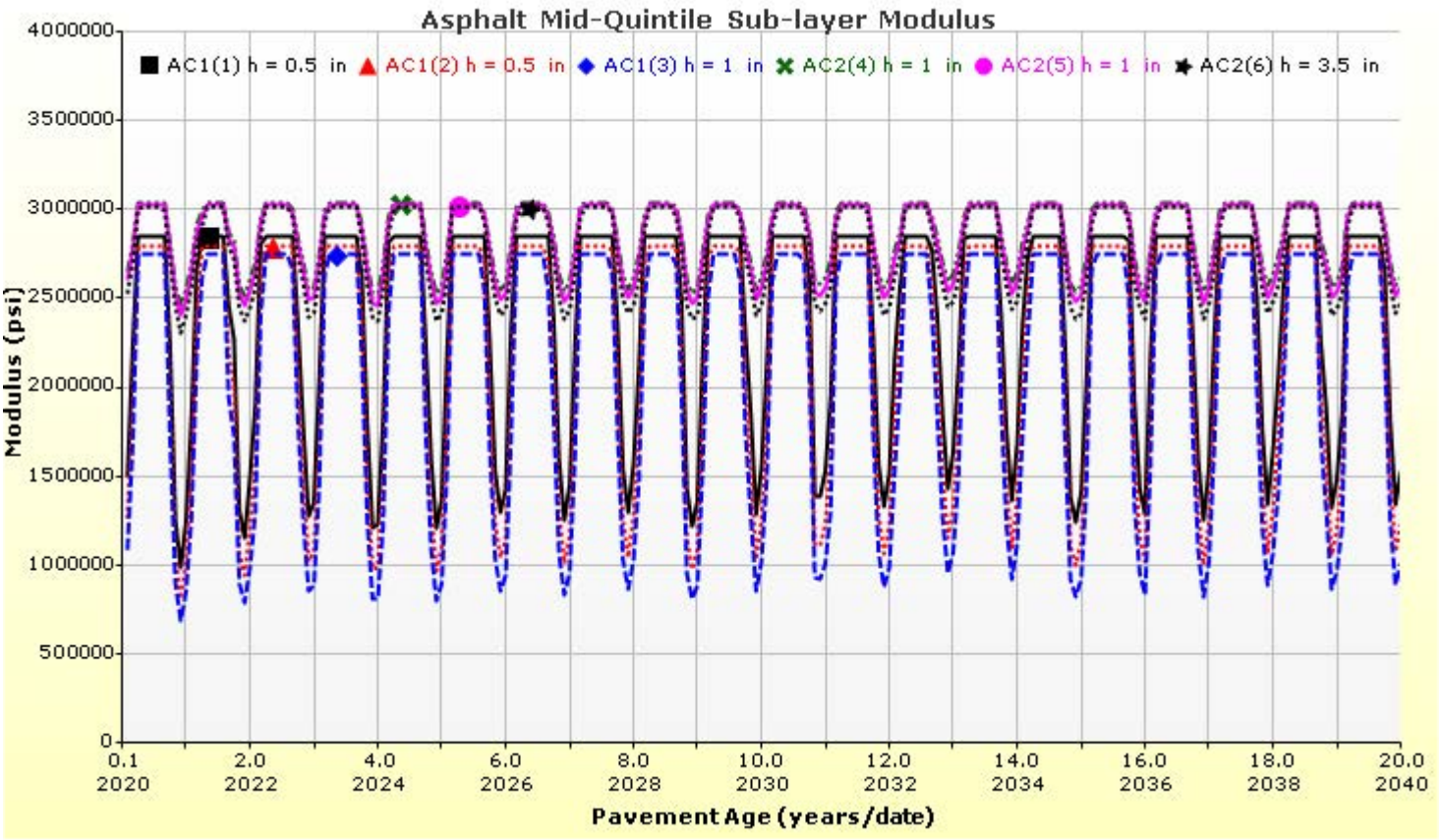

AC Top-Down Damage
Top-Down Damage (%)
@Surface
(Depth=.5in)
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)

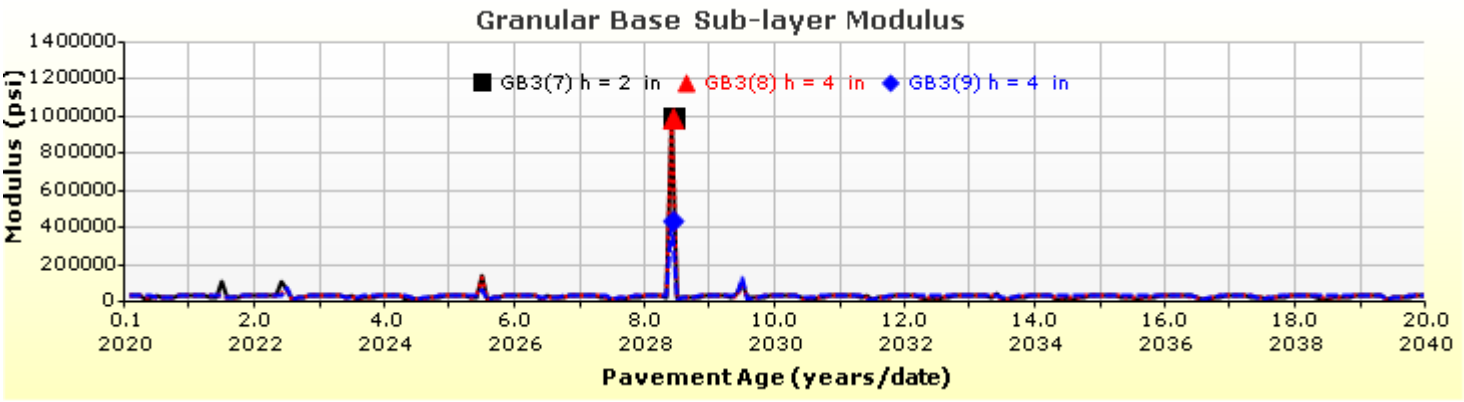

AC Bottom-Up Damage
Bottom-Up Damage (%)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)

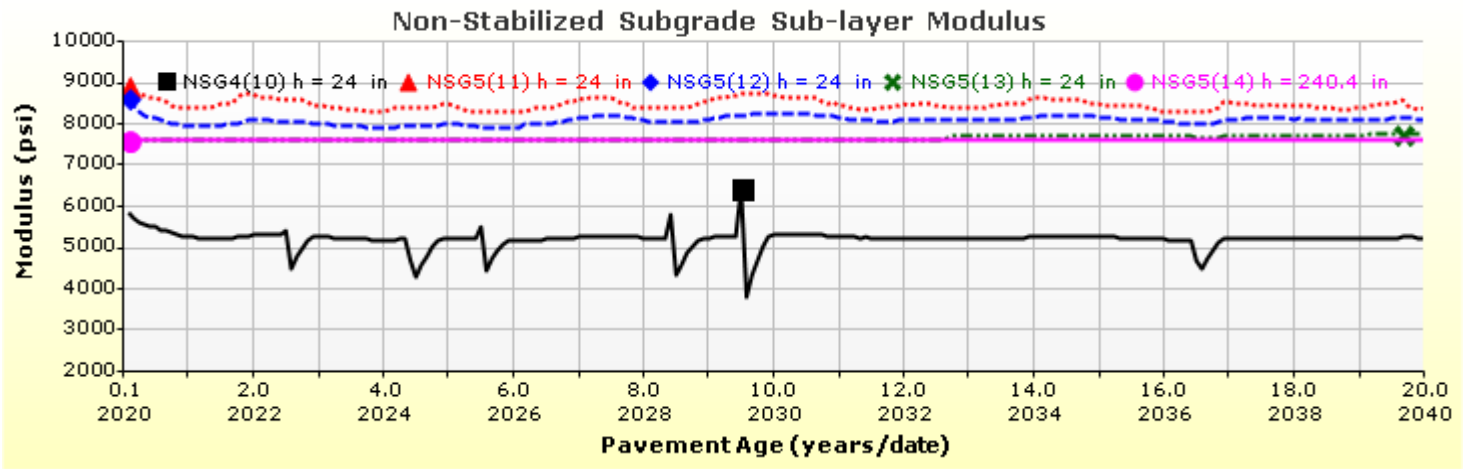

AC Top-Down Cracking (Longitudinal)
Top-Down Cracking (ft/mile
Threshold Value
@ 50% Reliability (Surface)
at 50% Reliability (Depth=.5in)
@Specified Reliability
3000
2500
2000
1500
1000
500
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)


AC Bottom-Up Cracking (Alligator)
Bottom-Up Cracking (%)
Threshold Value
@ 50% Reliability
@ Specified Reliability
30
25
20
15
10
5
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)


Rutting (Permanent Deformation) at 50% Reliability
Total
Subtotal AC
Subtotal Subgrade
Subtotal Base
Rut Depth (in)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1
2020
2.0
2022
4.0
2024
6.0
2026
8.0
2028
10.0
2030
12.0
2032
14.0
2034
16.0
2036
18.0
2038
20.0
2040
Pavement Age (years/date)


Asphalt Mid-Quintile Sub-layer Modulus
AC1(1) h = 0.5 in
AC1(2) h = 0.5 in
AC1(3) h = 1 in
AC2(4) h = 1 in
AC2(5) h = 1 in
AC2(6) h = 3.5 in
Modulus (psi)
4000000
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)


Granular Base Sub-layer Modulus
GB3(7) h = 2 in
GB3(8) h = 4 in
GB3(9) h = 4 in
Modulus (psi)
1400000
1200000
1000000
800000
600000
400000
200000
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)


Non-Stabilized Subgrade Sub-layer Modulus
NSG4(10) h = 24 in
NSG5(11) h = 24 in
NSG5(12) h = 24 in
NSG5(13) h = 24 in
NSG5(14) h = 240.4 in
Modulus (psi)
10000
9000
8000
7000
6000
5000
4000
3000
2000
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)

Layer Information

Layer 1 Flexible : R2 Level 1 SMA

Asphalt		
Thickness (in)	2.0	
Unit weight (pcf)	145.0	
Poisson's ratio	Is Calculated?	True
	Ratio	-
	Parameter A	-1.63
	Parameter B	3.84E-06

Asphalt Dynamic Modulus (Input Level: 1)

T (ºF)	0.5 Hz	1 Hz	10 Hz	25 Hz
14	1875400	2299039	2624309	2726019
40	846575	1309050	1799540	1983379
70	230100	427271	753122	918360
100	76296	127286	231357	296468
130	40803	55308	84229	102895

Asphalt Binder

Temperature (ºF)	Binder Gstar (Pa)	Phase angle (deg)
158	1233	64
168.8	673	66
179.6	383	68

General Info

Name	Value
Reference temperature (ºF)	70
Effective binder content (%)	12.2
Air voids (%)	4.7
Thermal conductivity (BTU/hr-ft-ºF)	0.67
Heat capacity (BTU/lb-ºF)	0.23

Identifiers

Field	Value
Display name/identifier	R2 Level 1 SMA
Description of object	Mix ID # FS1919
Author	CDOT
Date Created	4/3/2013 12:00:00 AM
Approver	CDOT
Date approved	4/3/2013 12:00:00 AM
State	Colorado
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	SMA
User defined field 2	
User defined field 3	
Revision Number	0

Layer 2 Flexible : R2 Level 1 SX(75) PG 64-22

Asphalt		
Thickness (in)	5.5	
Unit weight (pcf)	140.5	
Poisson's ratio	Is Calculated?	True
	Ratio	-
	Parameter A	-1.63
	Parameter B	3.84E-06

Asphalt Dynamic Modulus (Input Level: 1)

T (ºF)	0.5 Hz	1 Hz	10 Hz	25 Hz
14	2910500	2947100	3034800	3058600
40	2620500	2695700	2882400	2934800
70	2057300	2190500	2549800	2658300
100	1334300	1500400	2017600	2195500
130	697600	836500	1365200	1584000

Asphalt Binder

Temperature (ºF)	Binder Gstar (Pa)	Phase angle (deg)
168.8	451	85
147.2	1857	81.6
158	889	83.1

General Info

Name	Value
Reference temperature (ºF)	70
Effective binder content (%)	11.8
Air voids (%)	6.9
Thermal conductivity (BTU/hr-ft-ºF)	0.67
Heat capacity (BTU/lb-ºF)	0.23

Identifiers

Field	Value
Display name/identifier	R2 Level 1 SX(75) PG 64-22
Description of object	Mix ID # 19127A
Author	CDOT
Date Created	4/3/2013 12:00:00 AM
Approver	CDOT
Date approved	4/3/2013 12:00:00 AM
State	Colorado
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	SX
User defined field 2	
User defined field 3	
Revision Number	0

Layer 3 Non-stabilized Base : Class 6 ABC

Unbound	
Layer thickness (in)	10.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
22000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Class 6 ABC
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	20

Sieve

Liquid Limit	30.0
Plasticity Index	6.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	125.8
Saturated hydraulic conductivity (ft/hr)	False	2.257e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	8.3

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	12.2329
bf	1.1153
cf	0.8619
hr	244.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	12.0
#100	
#80	
#60	
#50	
#40	
#30	
#20	
#16	
#10	
#8	55.0
#4	65.0
3/8-in.	
1/2-in.	
3/4-in.	95.0
1-in.	100.0
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 4 Subgrade : Clayey Sand

Unbound	
Layer thickness (in)	24.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
7000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Clayey Sand
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	33

Sieve

Liquid Limit	37.0
Plasticity Index	18.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	112.9
Saturated hydraulic conductivity (ft/hr)	False	1.153e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	14.9

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	102.5522
bf	0.7198
cf	0.2545
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	47.0
#100	
#80	
#60	
#50	
#40	72.0
#30	
#20	
#16	
#10	
#8	
#4	98.0
3/8-in.	
1/2-in.	
3/4-in.	
1-in.	
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 5 Subgrade : A-6

Unbound	
Layer thickness (in)	Semi-infinite
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
14000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-6
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	33.0
Plasticity Index	16.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	107.9
Saturated hydraulic conductivity (ft/hr)	False	1.95e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	17.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	108.4091
bf	0.6801
cf	0.2161
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	63.2
#100	
#80	73.5
#60	
#50	
#40	82.4
#30	
#20	
#16	
#10	90.2
#8	
#4	93.5
3/8-in.	96.4
1/2-in.	97.4
3/4-in.	98.4
1-in.	99.0
1 1/2-in.	99.5
2-in.	99.8
2 1/2-in.	
3-in.	
3 1/2-in.	100.0

Calibration Coefficients

AC Fatigue

$$N_f = 0.00432 * C * \beta_{f1} k_1 \left(\frac{1}{\varepsilon_1}\right)^{k_2\beta_{f2}} \left(\frac{1}{E}\right)^{k_3\beta_{f3}}$$

$$C = 10^M$$

$$M = 4.84\left(\frac{V_b}{V_a + V_b} - 0.69\right)$$

k1: 0.007566
k2: 3.9492
k3: 1.281
Bf1: 130.3674
Bf2: 1
Bf3: 1.217799

AC Rutting

$$\frac{\varepsilon_p}{\varepsilon_r} = k_z \beta_{r1} 10^{k_1} T^{k_2\beta_{r2}} N^{k_3 B_{r3}}$$

$$k_z = (C_1 + C_2 * depth) * 0.328196^{depth}$$

$$C_1 = -0.1039 * H_\alpha^2 + 2.4868 * H_\alpha - 17.342$$

$$C_2 = 0.0172 * H_\alpha^2 - 1.7331 * H_\alpha + 27.428$$

Where:

$$H_{ac} = total\ AC\ thickness(in)$$

$\varepsilon_p = plastic\ strain\left(^{in}/_{in}\right)$
$\varepsilon_r = resilient\ strain\left(^{in}/_{in}\right)$
$T = layer\ temperature(^{\circ}F)$
$N = number\ of\ load\ repetitions$

AC Rutting Standard Deviation	0.1414 * Pow(RUT,0.25) + 0.001	
AC Layer	K1:-3.35412 K2:1.5606 K3:0.3791	Br1:6.7 Br2:1 Br3:1

Thermal Fracture

$$C_f = 400 * N\left(\frac{\log C / h_{ac}}{\sigma}\right)$$

$$\Delta C = (k * \beta t)^{n+1} * A * \Delta K^n$$

$$A = 10^{(4.389 - 2.52 * \log(E * \sigma_m * n))}$$

$C_f = observed\ amount\ of\ thermal\ cracking(ft/500ft)$
$k = refression\ coefficient\ determined\ through\ field\ calibration$
$N() = standard\ normal\ distribution\ evaluated\ at()$
$\sigma = standard\ deviation\ of\ the\ \log\ of\ the\ depth\ of\ cracks\ in\ the\ pavments$
$C = crack\ depth(in)$
$h_{ac} = thickness\ of\ asphalt\ layer(in)$
$\Delta C = Change\ in\ the\ crack\ depth\ due\ to\ a\ cooling\ cycle$
$\Delta K = Change\ in\ the\ stress\ intensity\ factor\ due\ to\ a\ cooling\ cycle$
$A, n = Fracture\ parameters\ for\ the\ asphalt\ mixture$
$E = mixture\ stiffness$
$\sigma_M = Undamaged\ mixture\ tensile\ strength$
$\beta_t = Calibration\ parameter$

Level 1 K: 6.3	Level 1 Standard Deviation: 0.1468 * THERMAL + 65.027
Level 2 K: 0.5	Level 2 Standard Deviation: 0.2841 * THERMAL + 55.462
Level 3 K: 6.3	Level 3 Standard Deviation: 0.3972 * THERMAL + 20.422

CSM Fatigue

$$N_f = 10^{\left(\frac{k_1 \beta_{c1} \left(\frac{\sigma_s}{M_r}\right)}{k_2 \beta_{c2}}\right)}$$

$N_f = number\ of\ repetitions\ to\ fatigue\ cracking$
$\sigma_s = Tensile\ stress(psi)$
$M_r = modulus\ of\ rupture(psi)$

k1: 1	k2: 1	Bc1: 0.75	Bc2:1.1

Subgrade Rutting

$$\delta_a(N) = \beta_{s_1} k_1 \varepsilon_v h \left(\frac{\varepsilon_0}{\varepsilon_r}\right) \left| e^{-\left(\frac{\rho}{N}\right)^{\beta}} \right|$$

$\delta_a = permanent\ deformation\ for\ the\ layer$
$N = number\ of\ repetitions$
$\varepsilon_v = average\ veritcal\ strain(in/in)$
$\varepsilon_0, \beta, \rho = material\ properties$
$\varepsilon_r = resilient\ strain(in/in)$

Granular		Fine	
k1: 2.03	Bs1: 0.22	k1: 1.35	Bs1: 0.37
Standard Deviation (BASERUT) 0.0104 * Pow(BASERUT,0.67) + 0.001		Standard Deviation (BASERUT) 0.0663 * Pow(SUBRUT,0.5) + 0.001	

AC Cracking

AC Top Down Cracking

$$FC_{top} = \left(\frac{C_4}{1 + e^{(C_1 - C_2 * log_{10}(Damage))}}\right) * 10.56$$

c1: 7	c2: 3.5	c3: 0	c4: 1000

AC Cracking Top Standard Deviation

200 + 2300/(1+exp(1.072-2.1654*LOG10 (TOP+0.0001)))

AC Bottom Up Cracking

$$FC = \left(\frac{6000}{1 + e^{(C_1 * C_1' + C_2 * C_2' log_{10}(D * 100))}}\right) * \left(\frac{1}{60}\right)$$

$$C_2' = -2.40874 - 39.748 * (1 + h_{ac})^{-2.856}$$

$$C_1' = -2 * C_2'$$

c1: 0.021	c2: 2.35	c3: 6000

AC Cracking Bottom Standard Deviation

1 + 15/(1+exp(-3.1472-4.1349*LOG10 (BOTTOM+0.0001)))

CSM Cracking

$$FC_{ctb} = C_1 + \frac{C_2}{1 + e^{C_3 - C_4(Damage)}}$$

C1: 0	C2: 75	C3: 5	C4: 3

CSM Standard Deviation

CTB*1

IRI Flexible Pavements

C1 - Rutting
C2 - Fatigue Crack
C3 - Transverse Crack
C4 - Site Factors

C1: 50	C2: 0.55	C3: 0.0111	C4: 0.02

Ramp1 (Powers SB off) composite 76-28 SMA over 64-22 sx75

File Name: C:\Users\darwinME\Desktop\AFK\Powers and Research\HMA\Ramp1 (Powers SB off) composite 76-28 SMA over 64-22 sx75.dgpx

Design Inputs

Design Life: 20 years
Design Type: FLEXIBLE

Base construction: May, 2020
Pavement construction: June, 2020
Traffic opening: September, 2020

Climate Data Sources (Lat/Lon): 38.812, -104.711

Design Structure

Layer type	Material Type	Thickness (in)
Flexible	R2 Level 1 SMA	2.0
Flexible	R2 Level 1 SX(75) PG 64-22	3.5 (Optimized)
NonStabilized	Class 6 ABC	10.0
Subgrade	Clayey Sand	24.0
Subgrade	A-6	Semi-infinite

Volumetric at Construction:	
Effective binder content (%)	12.2
Air voids (%)	4.7

Traffic

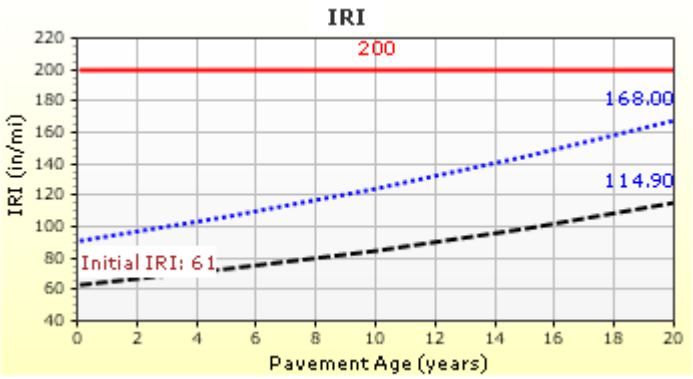
Age (year)	Heavy Trucks (cumulative)
2020 (initial)	101
2030 (10 years)	418,261
2040 (20 years)	967,407

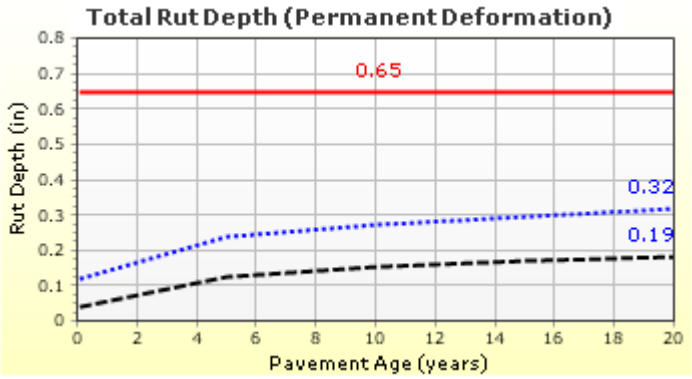
Design Outputs

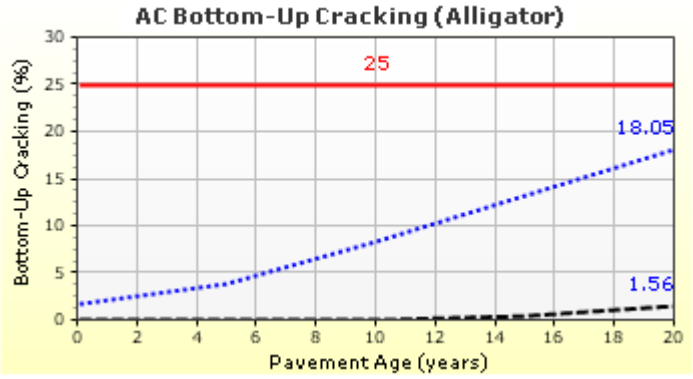
Distress Prediction Summary

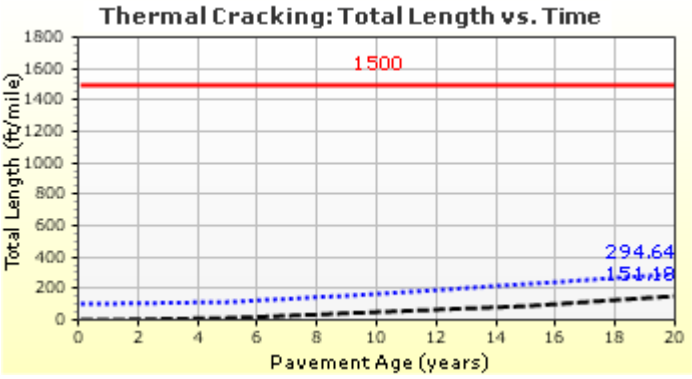
Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	200.00	167.95	95.00	99.58	Pass
Permanent deformation - total pavement (in)	0.65	0.32	95.00	100.00	Pass
AC bottom-up fatigue cracking (% lane area)	25.00	18.05	95.00	99.03	Pass
AC thermal cracking (ft/mile)	1500.00	294.64	95.00	100.00	Pass
AC top-down fatigue cracking (ft/mile)	2500.00	456.50	95.00	100.00	Pass
Permanent deformation - AC only (in)	0.50	0.21	95.00	100.00	Pass

Distress Charts





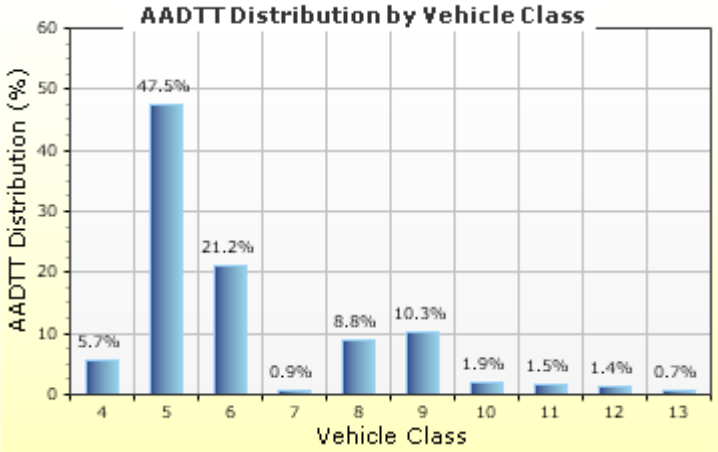


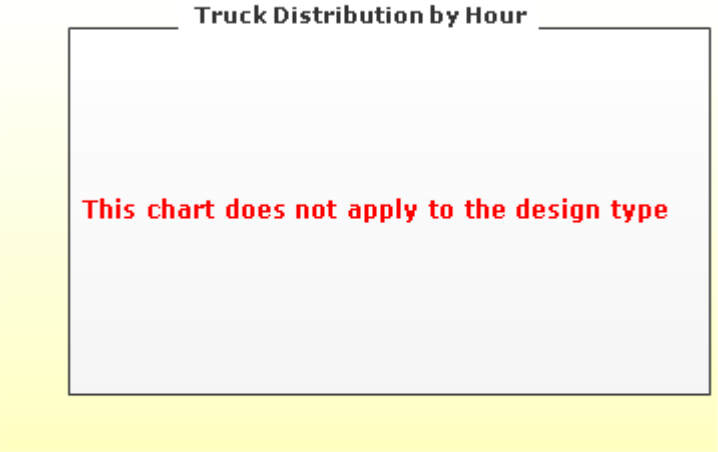


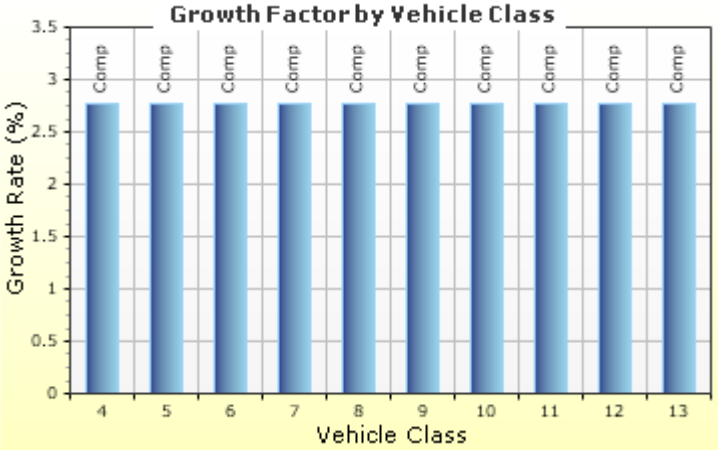
Traffic Inputs

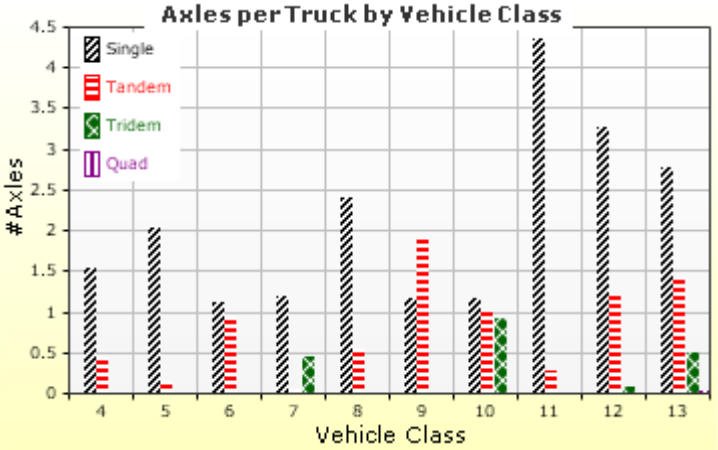
Graphical Representation of Traffic Inputs

Initial two-way AADTT:	101	Percent of trucks in design direction (%):	100.0
Number of lanes in design direction:	1	Percent of trucks in design lane (%):	100.0
		Operational speed (mph)	40.0

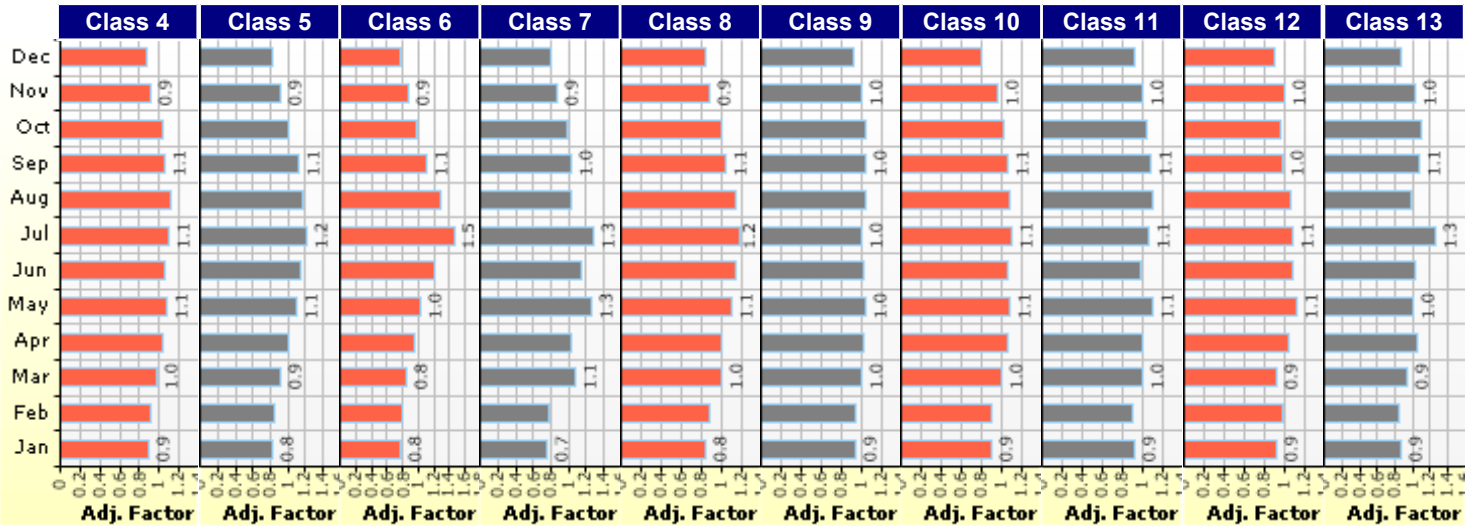








Traffic Volume Monthly Adjustment Factors



Tabular Representation of Traffic Inputs

Volume Monthly Adjustment Factors

Level 3: Default MAF

Month	Vehicle Class									
	4	5	6	7	8	9	10	11	12	13
January	0.9	0.8	0.8	0.7	0.8	0.9	0.9	0.9	0.9	0.9
February	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.8
March	1.0	0.9	0.8	1.1	1.0	1.0	1.0	1.0	0.9	0.9
April	1.0	1.0	0.9	1.0	1.0	1.0	1.1	1.0	1.0	1.1
May	1.1	1.1	1.0	1.3	1.1	1.0	1.1	1.1	1.1	1.0
June	1.1	1.1	1.2	1.1	1.1	1.0	1.1	1.0	1.1	1.0
July	1.1	1.2	1.5	1.3	1.2	1.0	1.1	1.1	1.1	1.3
August	1.1	1.2	1.3	1.0	1.1	1.0	1.1	1.1	1.1	1.0
September	1.1	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1
October	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.1
November	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0
December	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.9	0.9

Distributions by Vehicle Class

Truck Distribution by Hour does not apply

Vehicle Class	AADTT Distribution (%) (Level 3)	Growth Factor	
		Rate (%)	Function
Class 4	5.74%	2.76%	Compound
Class 5	47.46%	2.76%	Compound
Class 6	21.21%	2.76%	Compound
Class 7	0.94%	2.76%	Compound
Class 8	8.84%	2.76%	Compound
Class 9	10.31%	2.76%	Compound
Class 10	1.9%	2.76%	Compound
Class 11	1.51%	2.76%	Compound
Class 12	1.4%	2.76%	Compound
Class 13	0.69%	2.76%	Compound

Axle Configuration

Traffic Wander	
Mean wheel location (in)	18.0
Traffic wander standard deviation (in)	10.0
Design lane width (ft)	12.0

Axle Configuration	
Average axle width (ft)	8.5
Dual tire spacing (in)	12.0
Tire pressure (psi)	120.0

Average Axle Spacing	
Tandem axle spacing (in)	51.6
Tridem axle spacing (in)	49.2
Quad axle spacing (in)	49.2

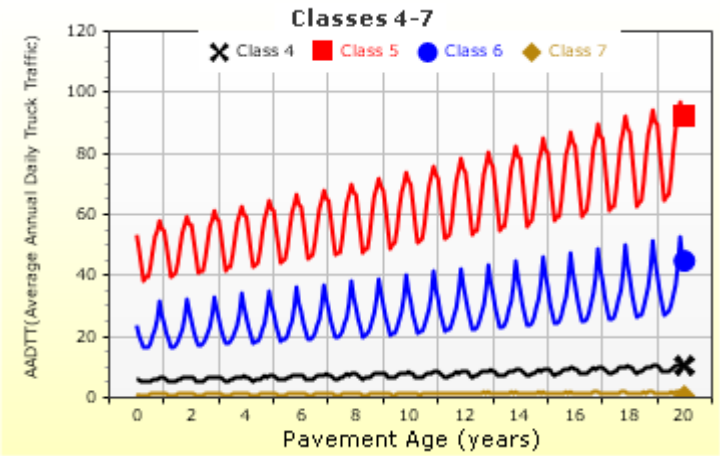
Wheelbase does not apply

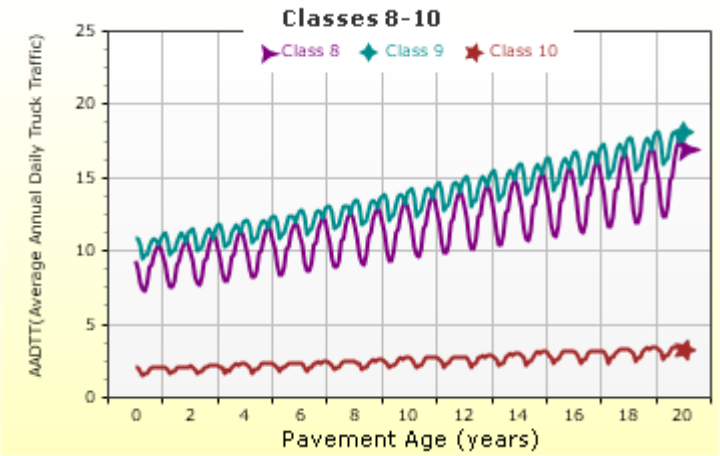
Number of Axles per Truck

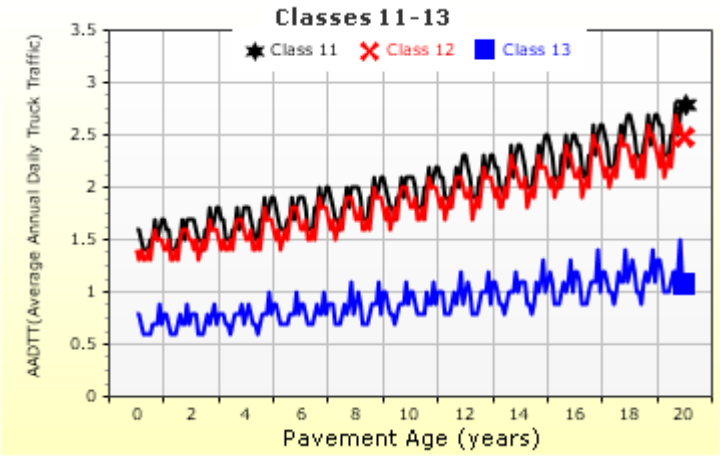
Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.53	0.45	0	0
Class 5	2.02	0.16	0.02	0
Class 6	1.12	0.94	0	0
Class 7	1.19	0.07	0.45	0.02
Class 8	2.41	0.56	0.02	0
Class 9	1.16	1.9	0.01	0
Class 10	1.15	1.01	0.93	0.02
Class 11	4.35	0.29	0.02	0
Class 12	3.27	1.22	0.09	0
Class 13	2.77	1.4	0.51	0.04

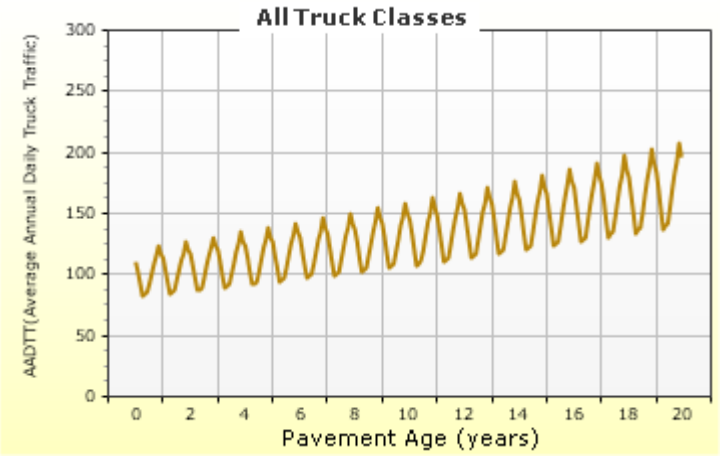
AADTT (Average Annual Daily Truck Traffic) Growth

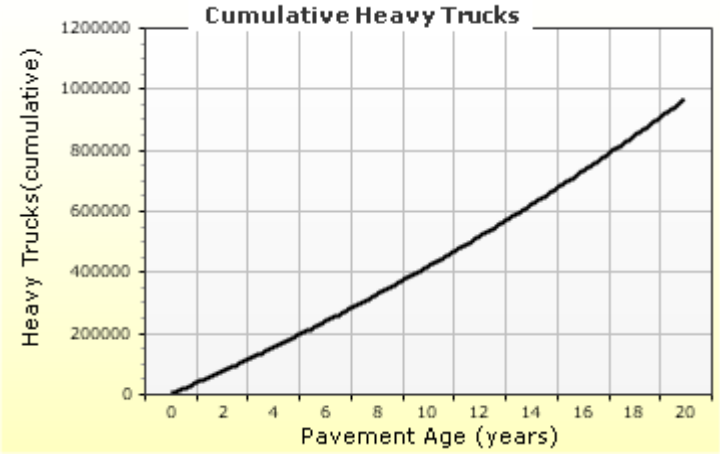
*** Traffic cap is not enforced**







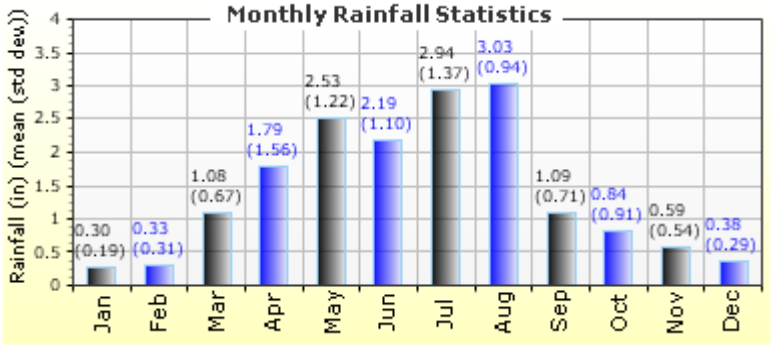




Climate Inputs

Climate Data Sources:

Climate Station Cities:	Location (lat lon elevation(ft))
COLORADO SPRINGS_	38.81200 -104.71100 6170

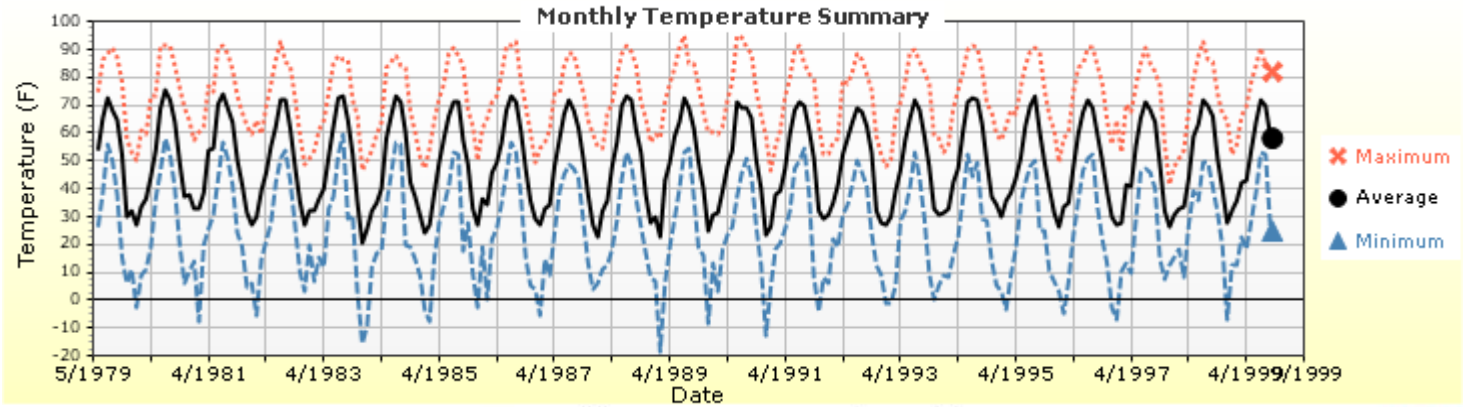


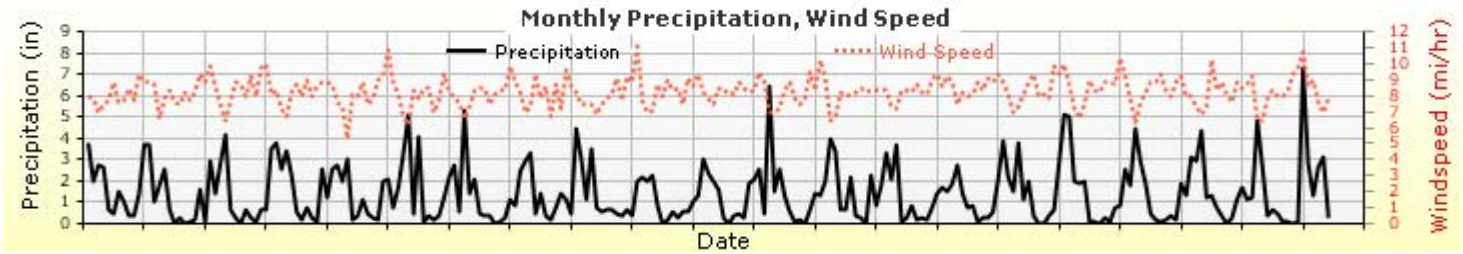
Annual Statistics:

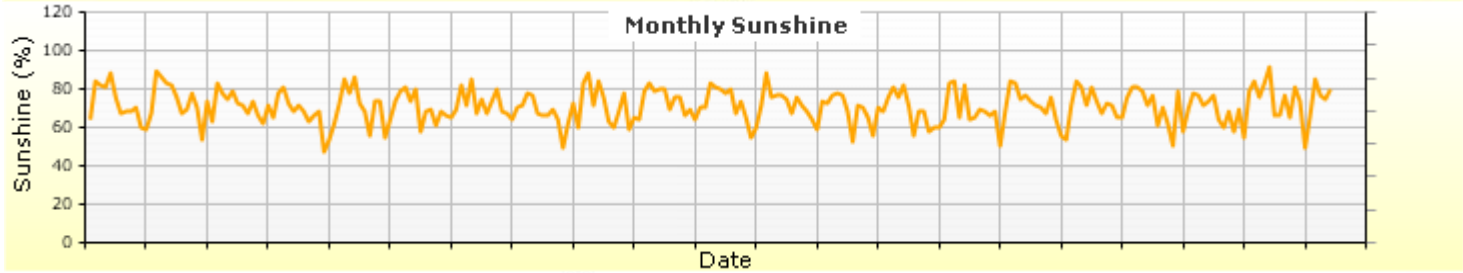
Mean annual air temperature (ºF)	49.11
Mean annual precipitation (in)	17.31
Freezing index (ºF - days)	555.60
Average annual number of freeze/thaw cycles:	83.33

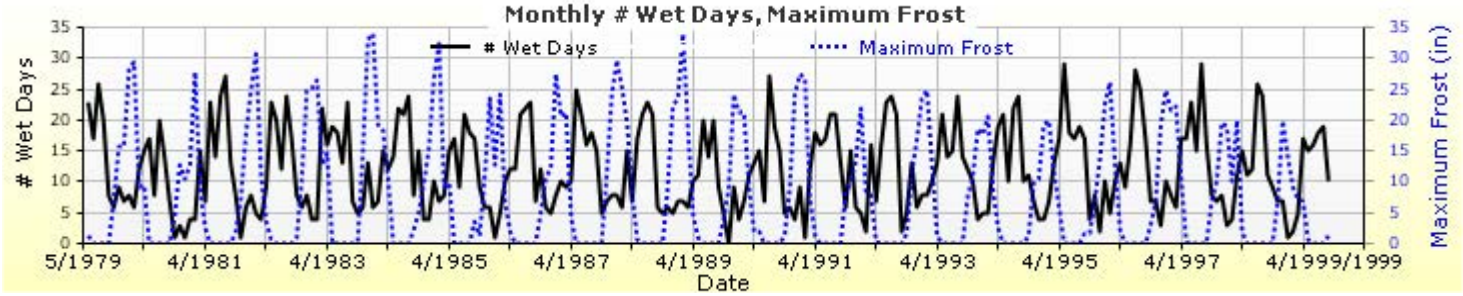
Water table depth (ft)	7.00

Monthly Climate Summary:

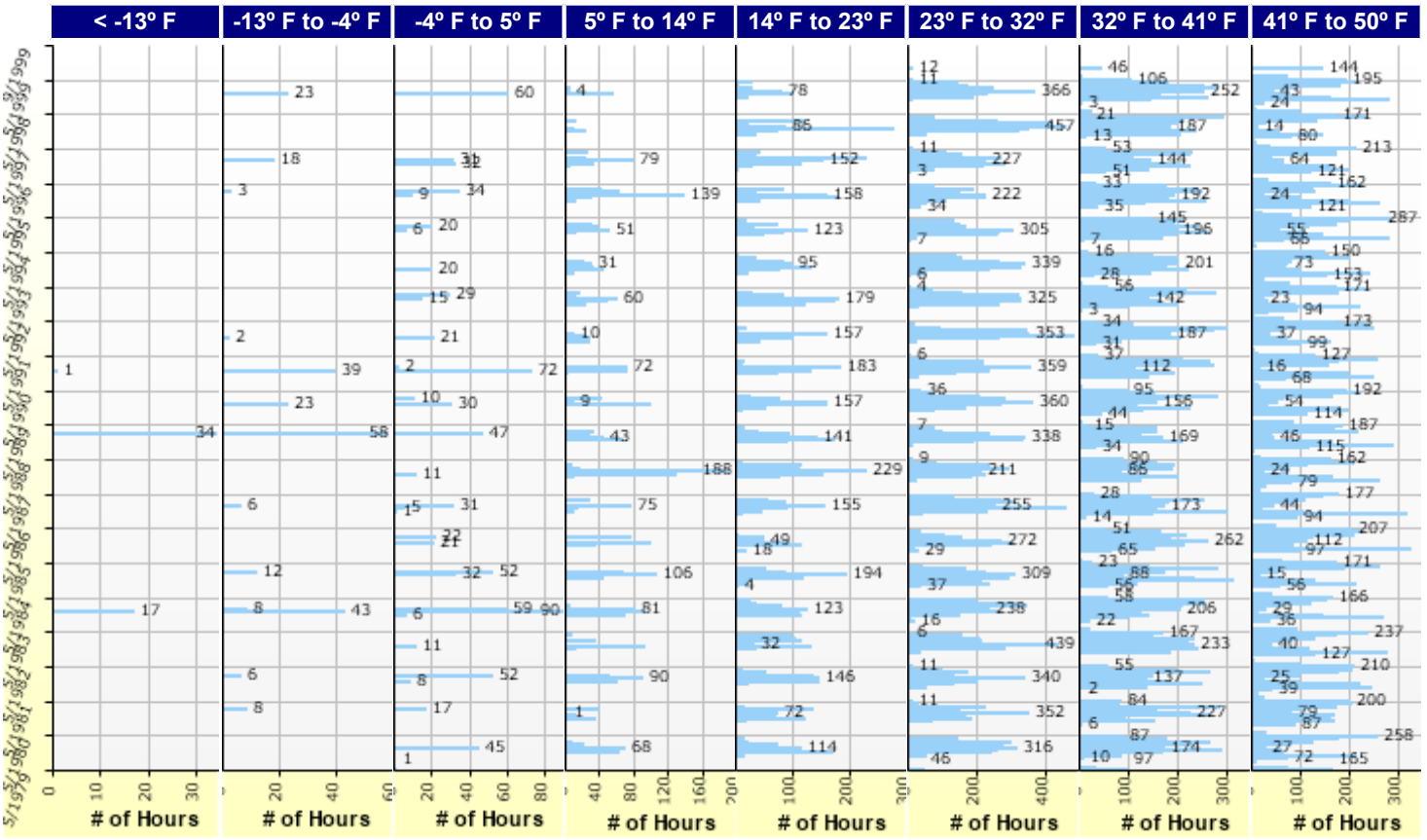


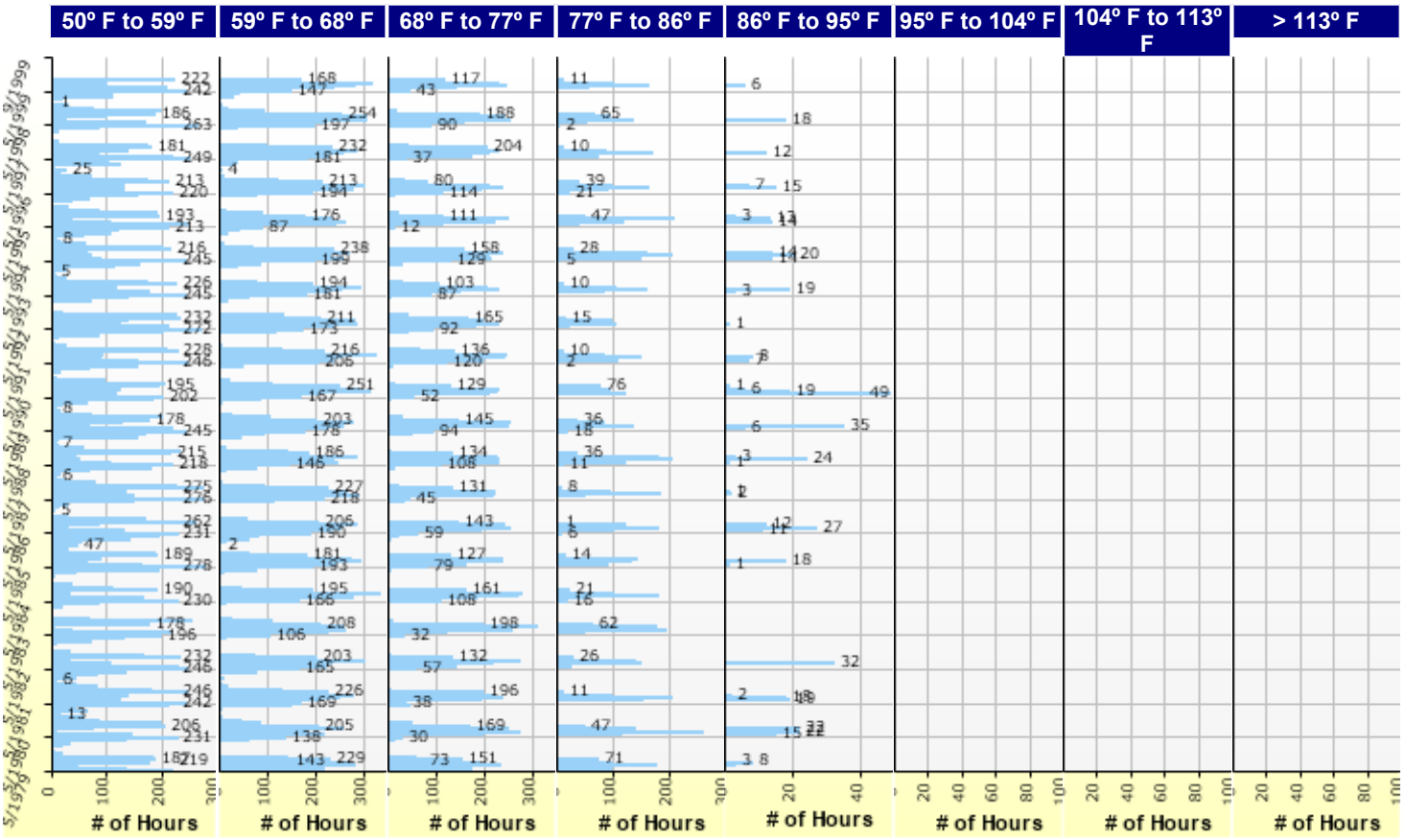






Hourly Air Temperature Distribution by Month:





Design Properties

HMA Design Properties

Use Multilayer Rutting Model	False
Using G* based model (not nationally calibrated)	False
Is NCHRP 1-37A HMA Rutting Model Coefficients	True
Endurance Limit	-
Use Reflective Cracking	True

Structure - ICM Properties	
AC surface shortwave absorptivity	0.85

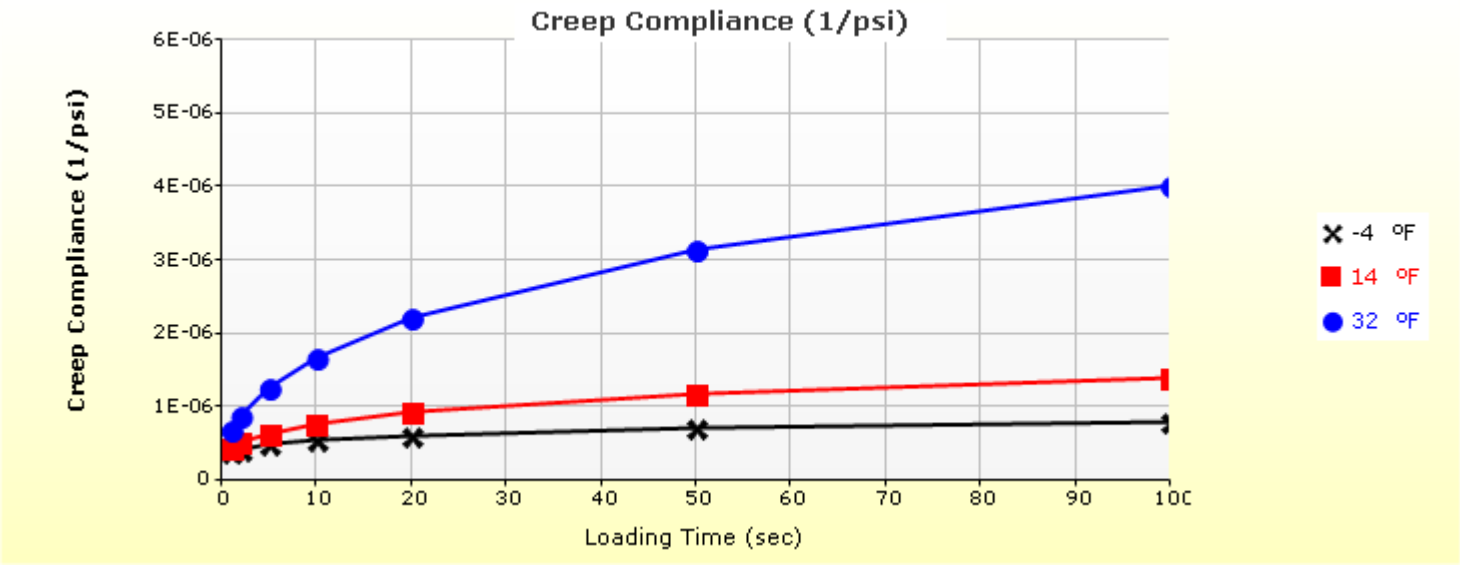
Layer Name	Layer Type	Interface Friction
Layer 1 Flexible : R2 Level 1 SMA	Flexible (1)	1.00
Layer 2 Flexible : R2 Level 1 SX (75) PG 64-22	Flexible (1)	1.00
Layer 3 Non-stabilized Base : Class 6 ABC	Non-stabilized Base (4)	1.00
Layer 4 Subgrade : Clayey Sand	Subgrade (5)	1.00
Layer 5 Subgrade : A-6	Subgrade (5)	-

Thermal Cracking (Input Level: 1)

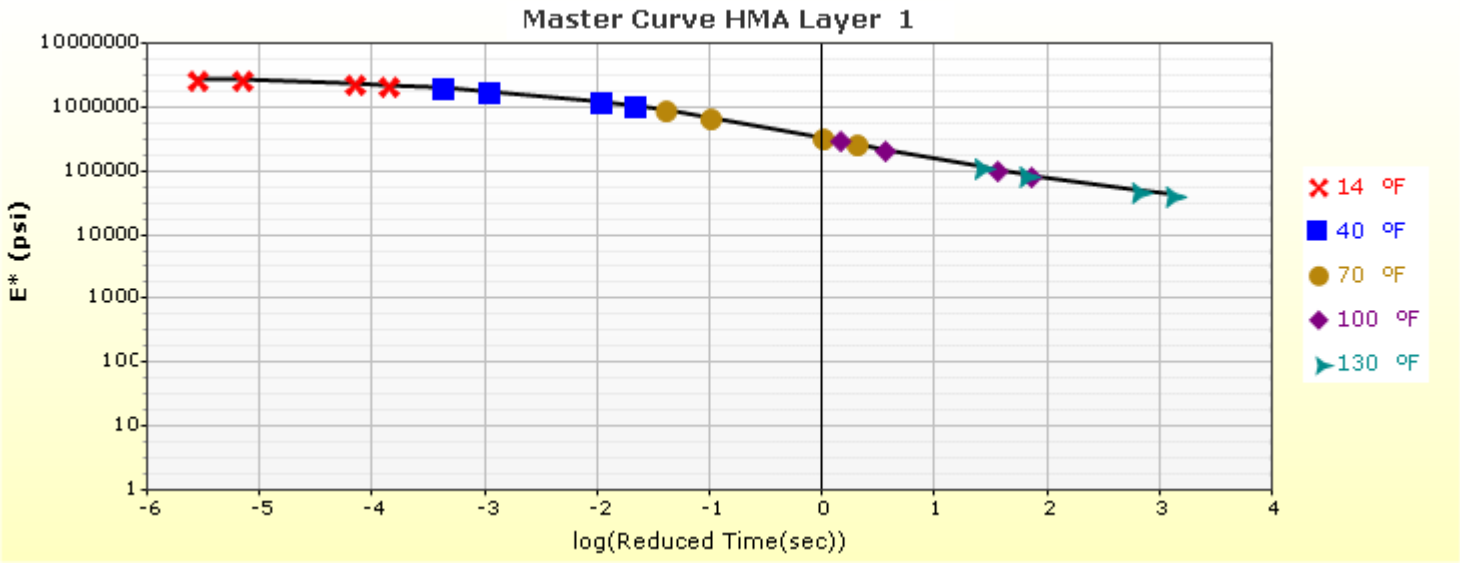
Indirect tensile strength at 14 °F (psi)	515.00

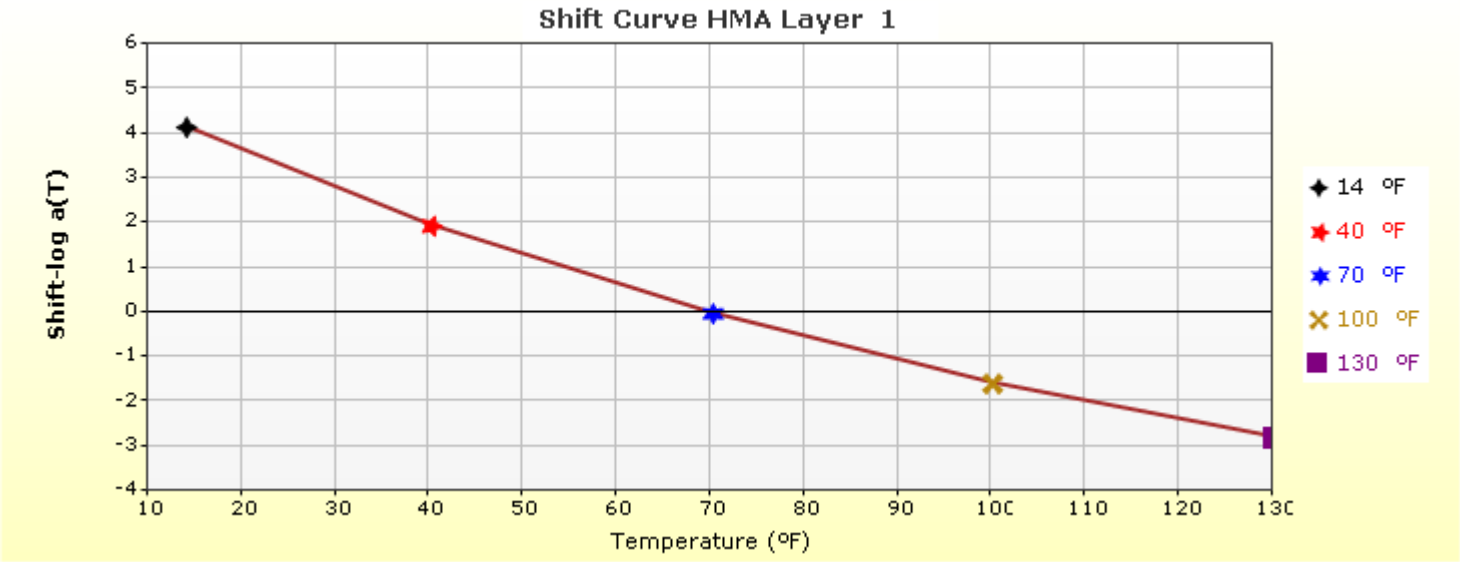
Thermal Contraction	
Is thermal contraction calculated?	True
Mix coefficient of thermal contraction (in/in/°F)	-
Aggregate coefficient of thermal contraction (in/in/°F)	5.0e-006
Voids in Mineral Aggregate (%)	16.9

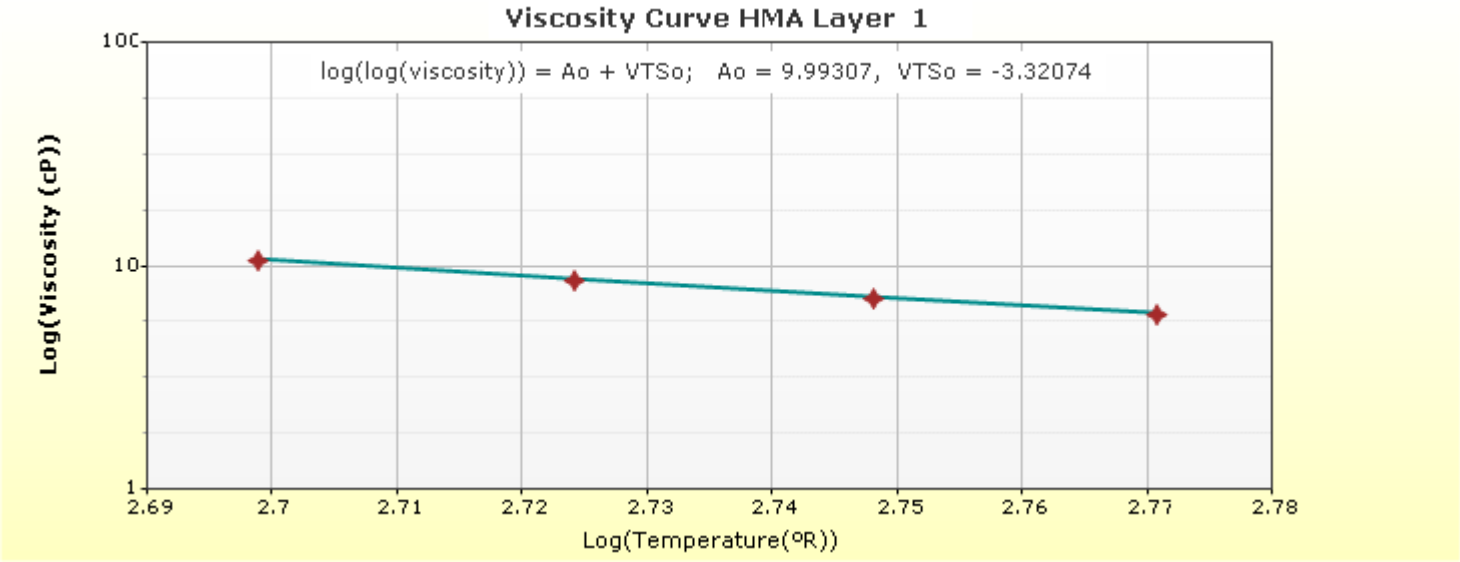
	Creep Compliance (1/psi)		
Loading time (sec)	-4 °F	14 °F	32 °F
1	4.01e-007	4.45e-007	6.88e-007
2	4.28e-007	5.41e-007	8.96e-007
5	4.98e-007	6.37e-007	1.27e-006
10	5.51e-007	7.85e-007	1.69e-006
20	6.17e-007	9.33e-007	2.23e-006
50	7.19e-007	1.18e-006	3.14e-006
100	7.96e-007	1.39e-006	4.01e-006



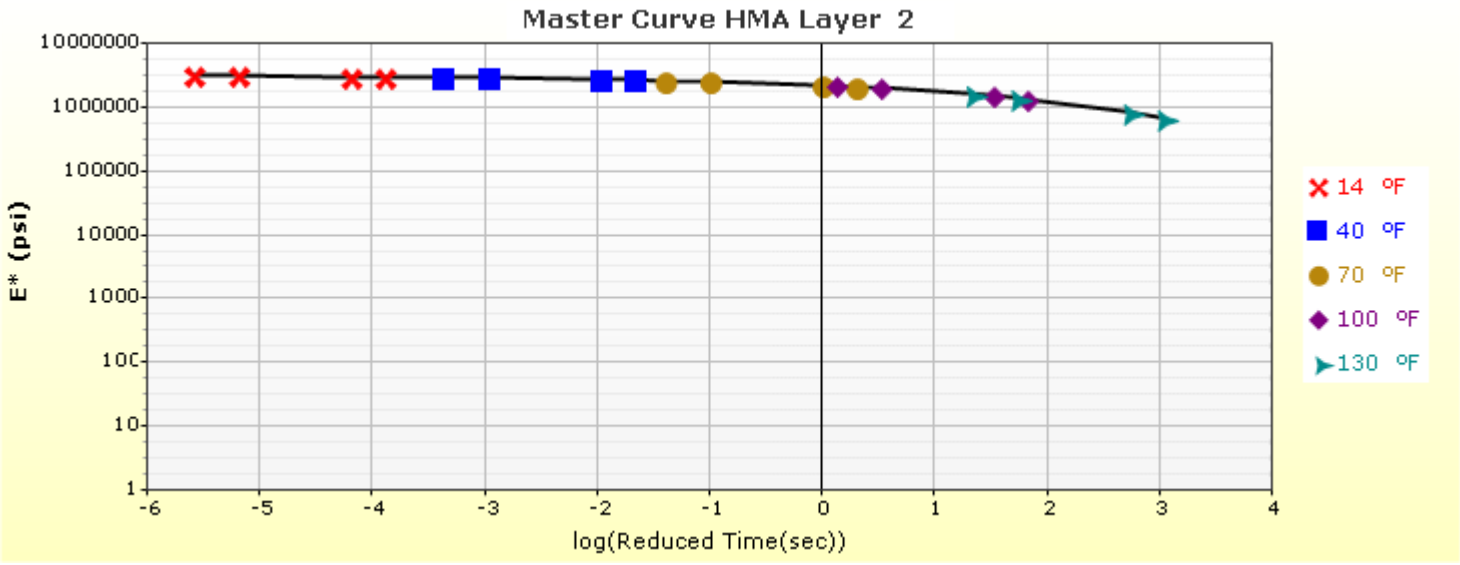
HMA Layer 1: Layer 1 Flexible : R2 Level 1 SMA

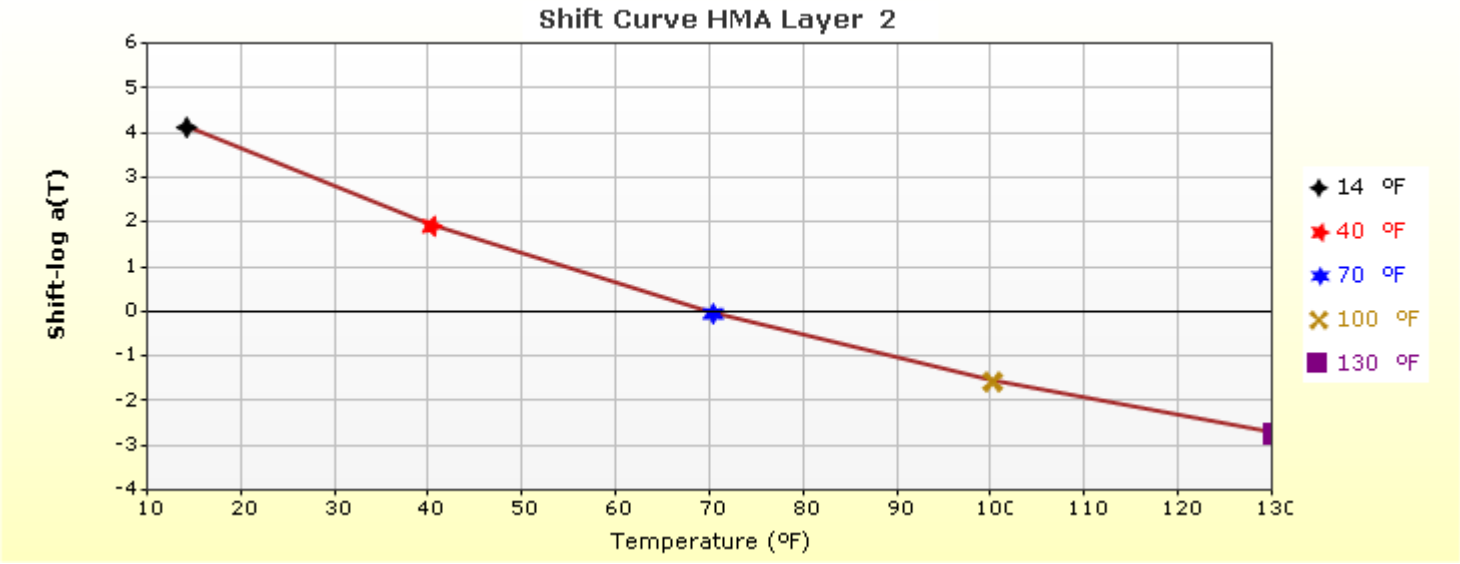


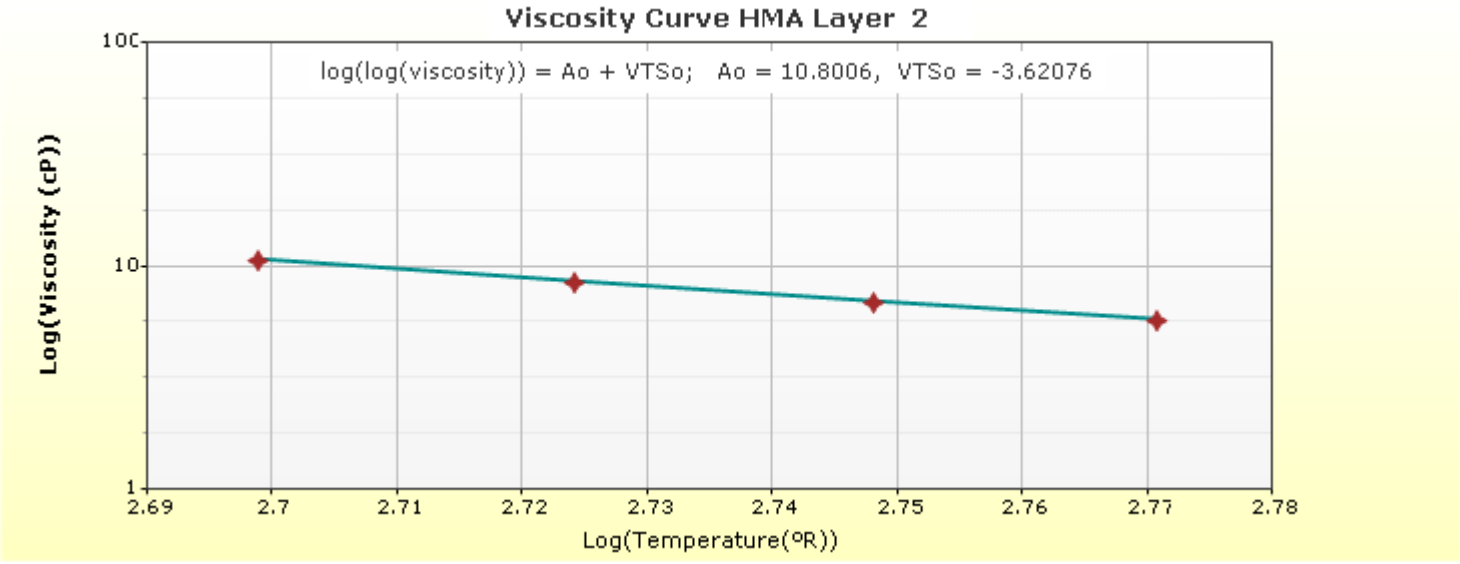




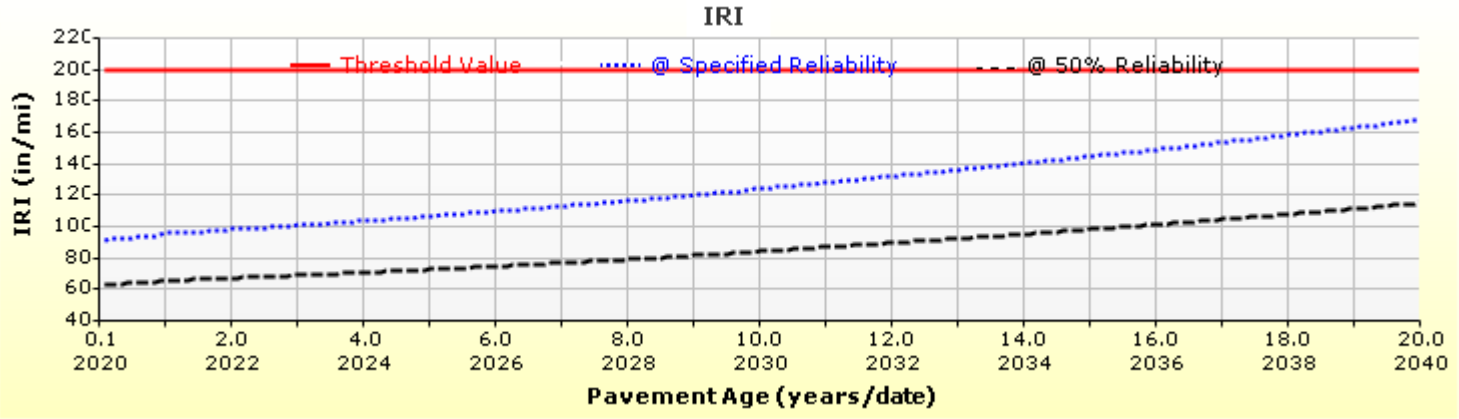
HMA Layer 2: Layer 2 Flexible : R2 Level 1 SX(75) PG 64-22

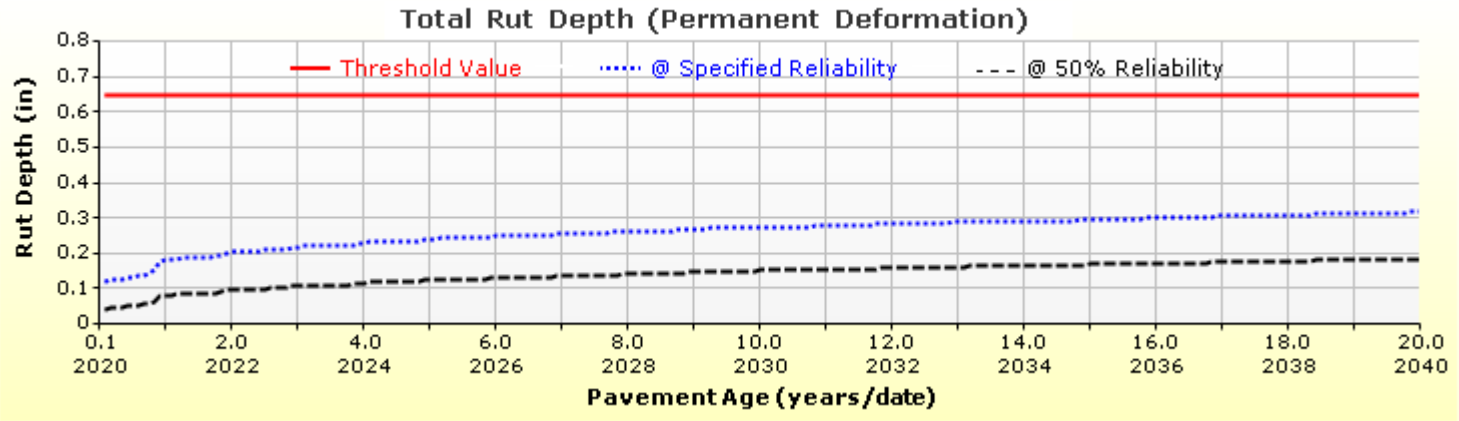


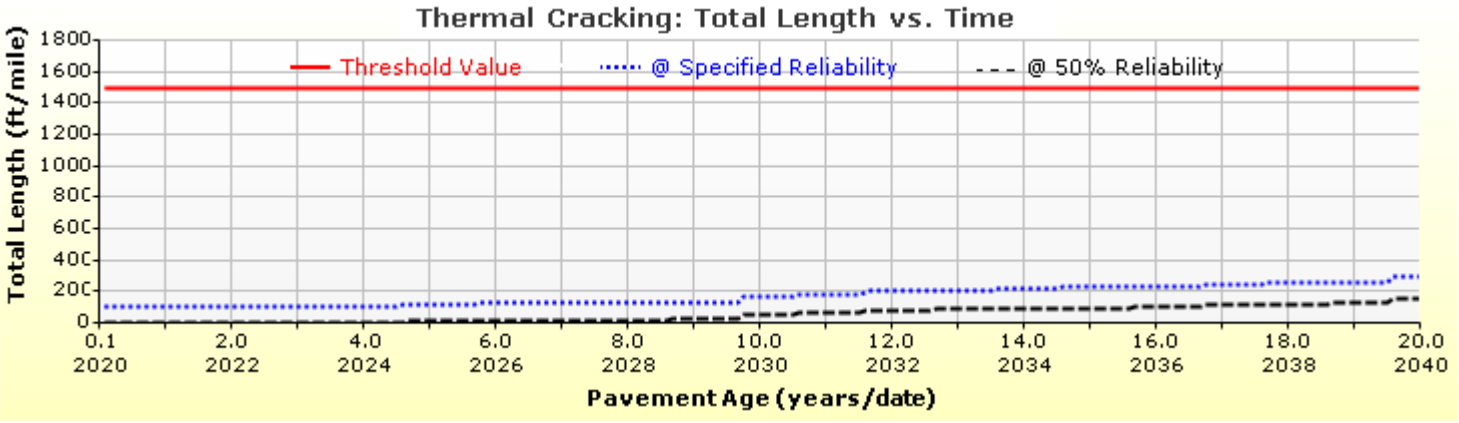


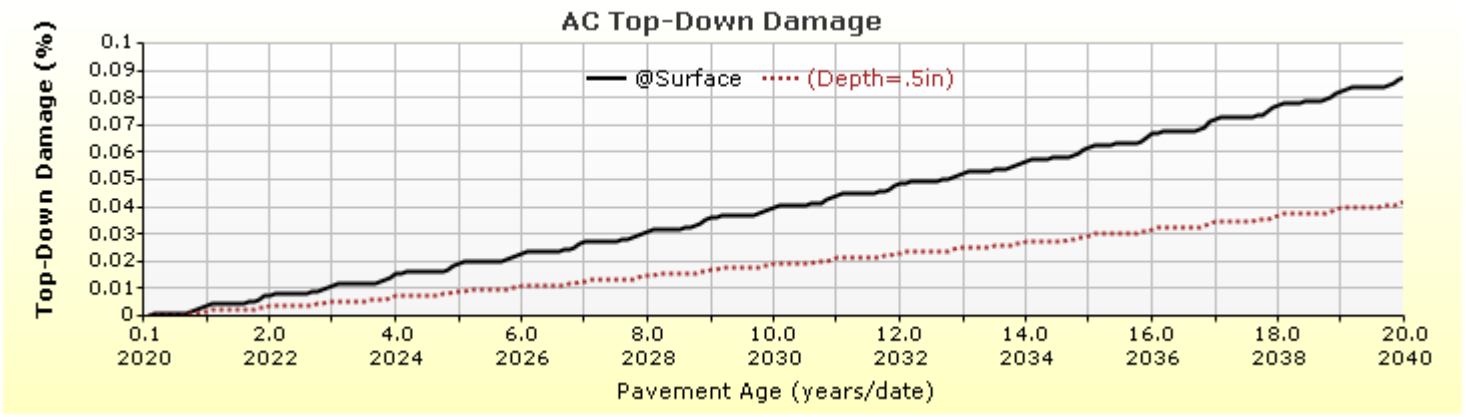


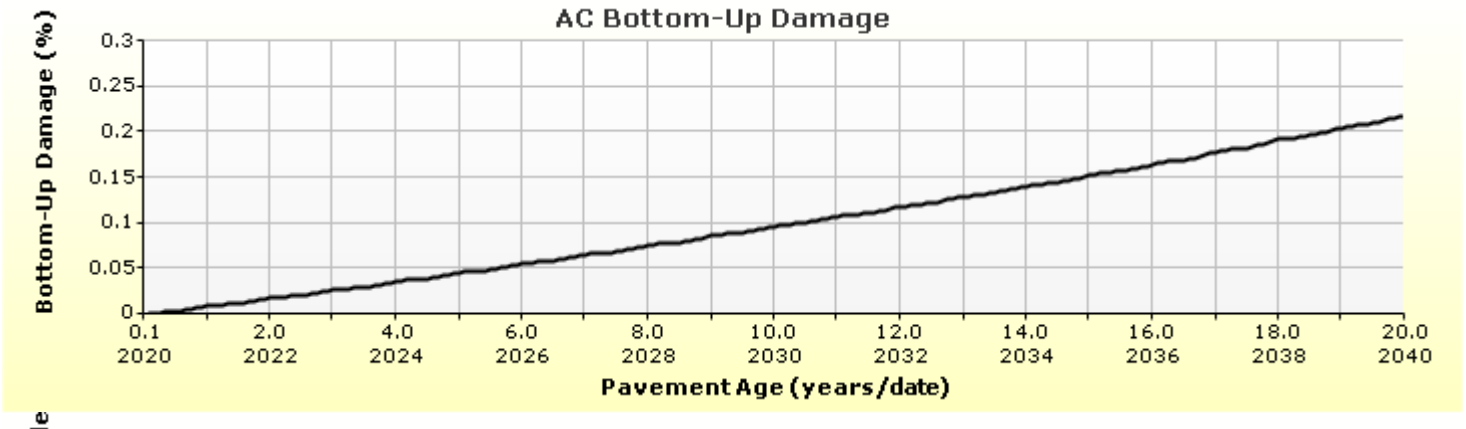
Analysis Output Charts

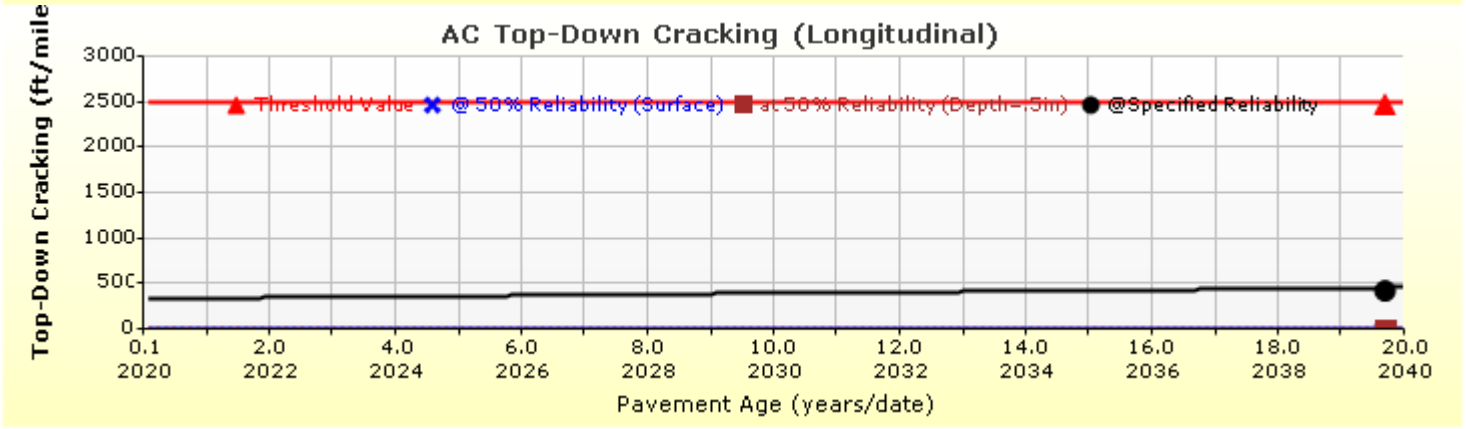


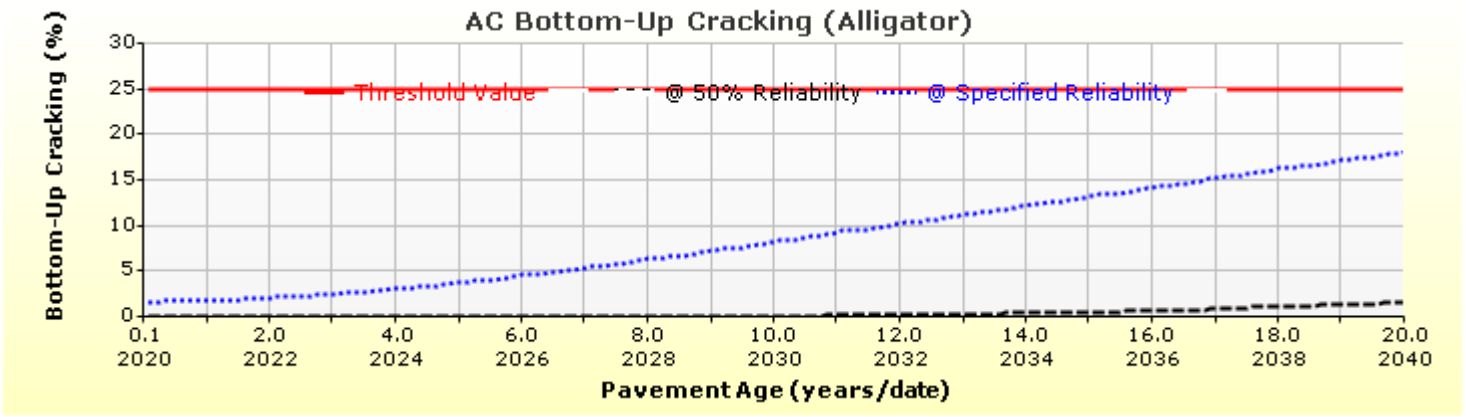


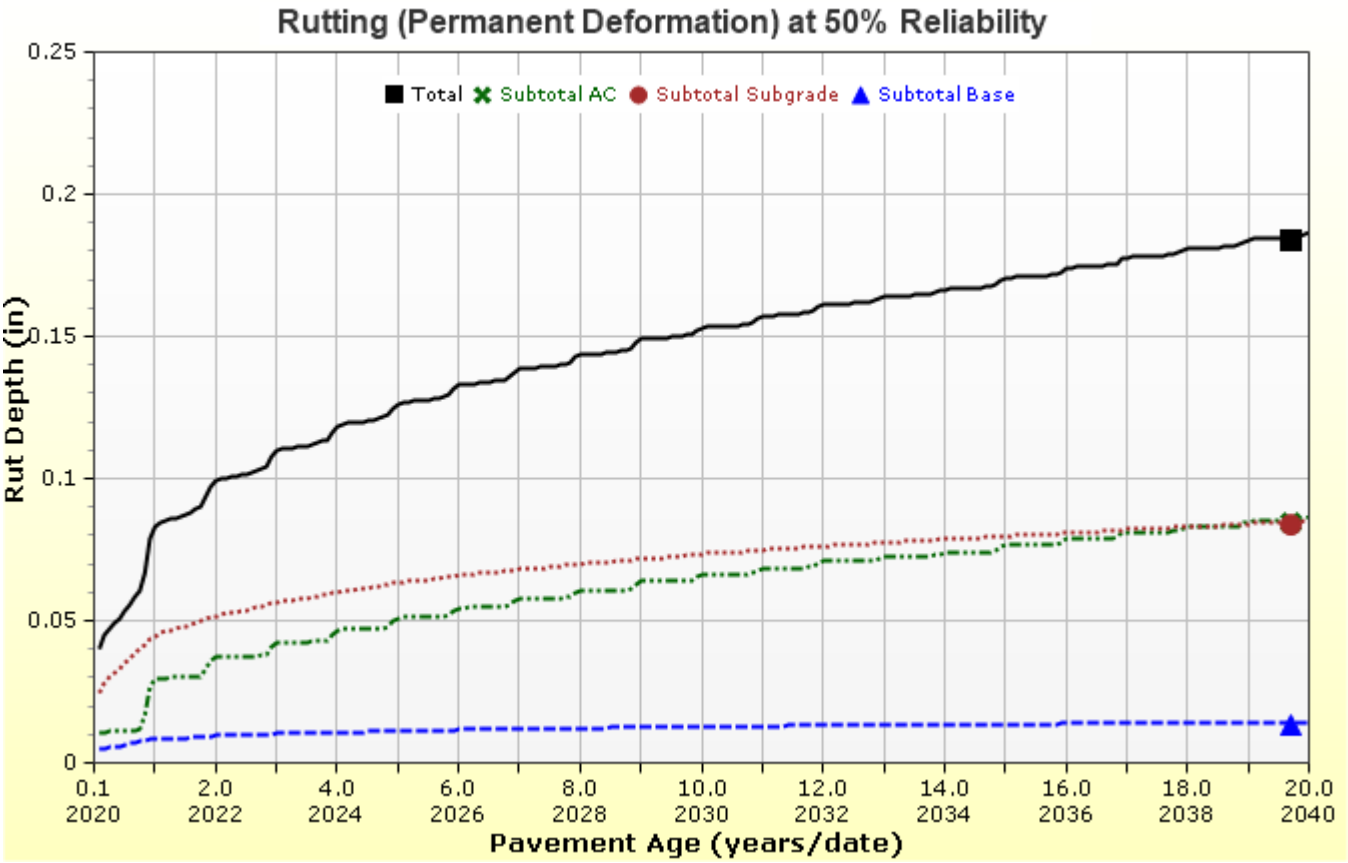


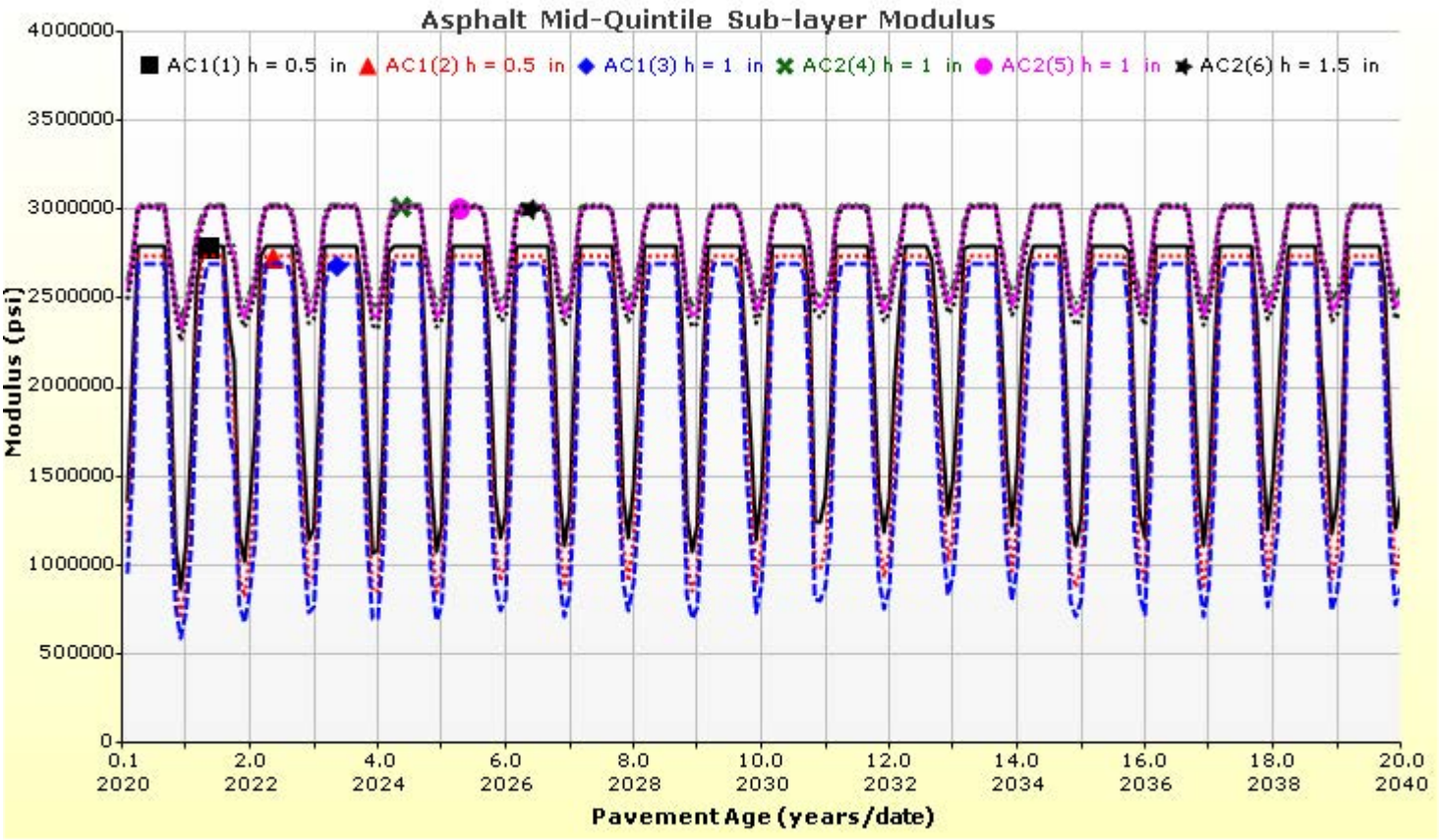

AC Top-Down Damage
Top-Down Damage (%)
@Surface
(Depth=.5in)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0.1 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0 18.0 20.0
2020 2022 2024 2026 2028 2030 2032 2034 2036 2038 2040
Pavement Age (years/date)

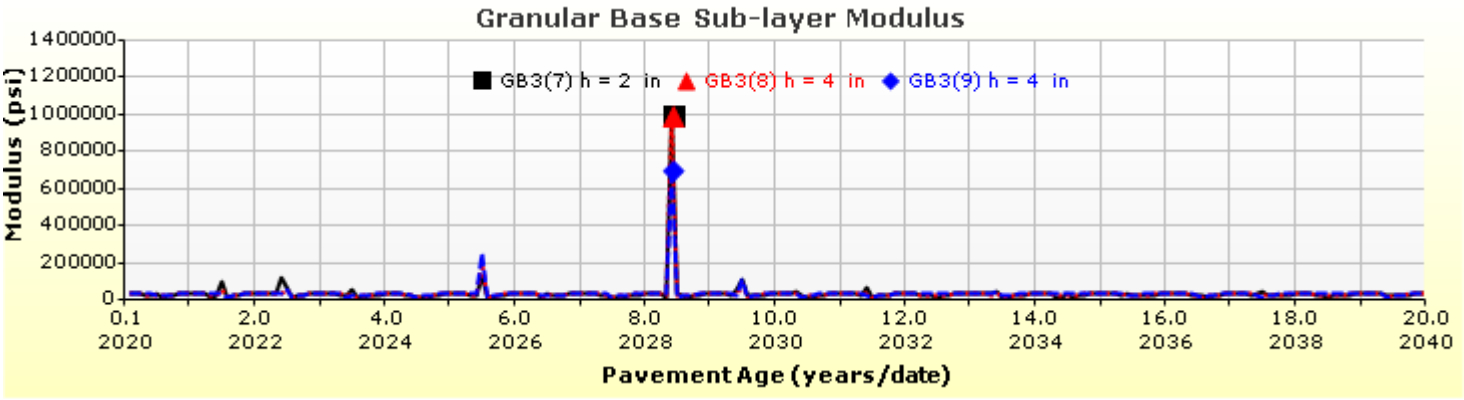

AC Bottom-Up Damage
Bottom-Up Damage (%)
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0 18.0 20.0
2020 2022 2024 2026 2028 2030 2032 2034 2036 2038 2040
Pavement Age (years/date)

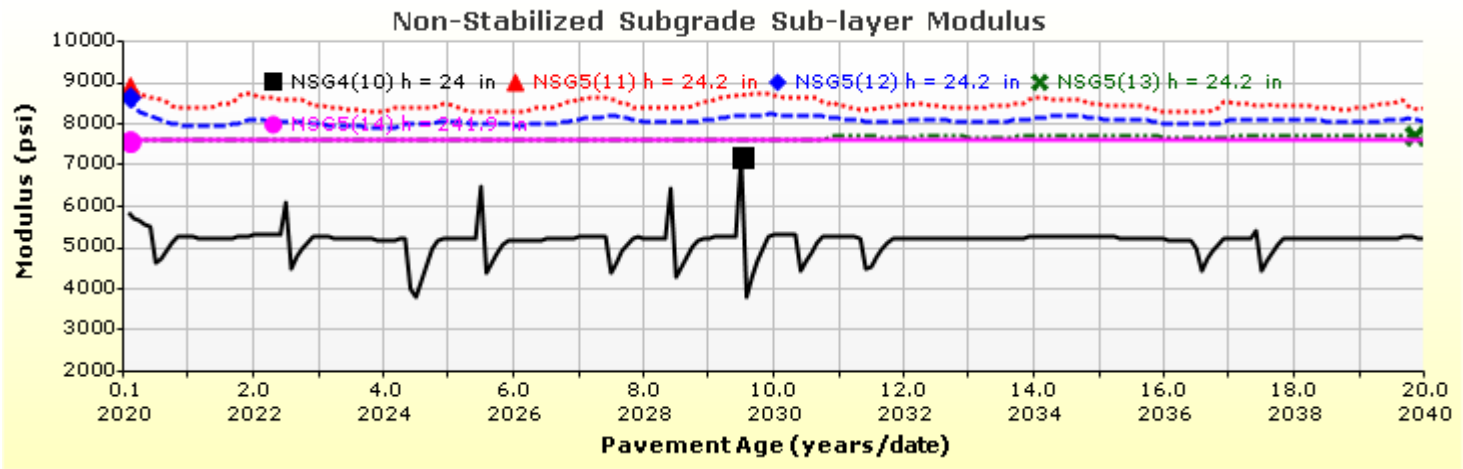

AC Top-Down Cracking (Longitudinal)
Top-Down Cracking (ft/mile
Threshold Value
@ 50% Reliability (Surface)
at 50% Reliability (Depth=.5in)
@Specified Reliability
3000
2500
2000
1500
1000
500
0
0.1 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0 18.0 20.0
2020 2022 2024 2026 2028 2030 2032 2034 2036 2038 2040
Pavement Age (years/date)


AC Bottom-Up Cracking (Alligator)
Bottom-Up Cracking (%)
Threshold Value
@ 50% Reliability
@ Specified Reliability
30
25
20
15
10
5
0
0.1 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0 18.0 20.0
2020 2022 2024 2026 2028 2030 2032 2034 2036 2038 2040
Pavement Age (years/date)


Rutting (Permanent Deformation) at 50% Reliability
Total
Subtotal AC
Subtotal Subgrade
Subtotal Base
Rut Depth (in)
0.25
0.2
0.15
0.1
0.05
0
0.1
2020
2.0
2022
4.0
2024
6.0
2026
8.0
2028
10.0
2030
12.0
2032
14.0
2034
16.0
2036
18.0
2038
20.0
2040
Pavement Age (years/date)


Asphalt Mid-Quintile Sub-layer Modulus
AC1(1) h = 0.5 in
AC1(2) h = 0.5 in
AC1(3) h = 1 in
AC2(4) h = 1 in
AC2(5) h = 1 in
AC2(6) h = 1.5 in
Modulus (psi)
4000000
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)


Granular Base Sub-layer Modulus
GB3(7) h = 2 in
GB3(8) h = 4 in
GB3(9) h = 4 in
Modulus (psi)
1400000
1200000
1000000
800000
600000
400000
200000
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)


Non-Stabilized Subgrade Sub-layer Modulus
NSG4(10) h = 24 in
NSG5(11) h = 24.2 in
NSG5(12) h = 24.2 in
NSG5(13) h = 24.2 in
NSG5(14) h = 241.9 in
Modulus (psi)
10000
9000
8000
7000
6000
5000
4000
3000
2000
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)

Layer Information

Layer 1 Flexible : R2 Level 1 SMA

Asphalt		
Thickness (in)	2.0	
Unit weight (pcf)	145.0	
Poisson's ratio	Is Calculated?	True
	Ratio	-
	Parameter A	-1.63
	Parameter B	3.84E-06

Asphalt Dynamic Modulus (Input Level: 1)

T (ºF)	0.5 Hz	1 Hz	10 Hz	25 Hz
14	1875400	2299039	2624309	2726019
40	846575	1309050	1799540	1983379
70	230100	427271	753122	918360
100	76296	127286	231357	296468
130	40803	55308	84229	102895

Asphalt Binder

Temperature (ºF)	Binder Gstar (Pa)	Phase angle (deg)
158	1233	64
168.8	673	66
179.6	383	68

General Info

Name	Value
Reference temperature (ºF)	70
Effective binder content (%)	12.2
Air voids (%)	4.7
Thermal conductivity (BTU/hr-ft-ºF)	0.67
Heat capacity (BTU/lb-ºF)	0.23

Identifiers

Field	Value
Display name/identifier	R2 Level 1 SMA
Description of object	Mix ID # FS1919
Author	CDOT
Date Created	4/3/2013 12:00:00 AM
Approver	CDOT
Date approved	4/3/2013 12:00:00 AM
State	Colorado
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	SMA
User defined field 2	
User defined field 3	
Revision Number	0

Layer 2 Flexible : R2 Level 1 SX(75) PG 64-22

Asphalt		
Thickness (in)	3.5	
Unit weight (pcf)	140.5	
Poisson's ratio	Is Calculated?	True
	Ratio	-
	Parameter A	-1.63
	Parameter B	3.84E-06

Asphalt Dynamic Modulus (Input Level: 1)

T (ºF)	0.5 Hz	1 Hz	10 Hz	25 Hz
14	2910500	2947100	3034800	3058600
40	2620500	2695700	2882400	2934800
70	2057300	2190500	2549800	2658300
100	1334300	1500400	2017600	2195500
130	697600	836500	1365200	1584000

Asphalt Binder

Temperature (ºF)	Binder Gstar (Pa)	Phase angle (deg)
168.8	451	85
147.2	1857	81.6
158	889	83.1

General Info

Name	Value
Reference temperature (ºF)	70
Effective binder content (%)	11.8
Air voids (%)	6.9
Thermal conductivity (BTU/hr-ft-ºF)	0.67
Heat capacity (BTU/lb-ºF)	0.23

Identifiers

Field	Value
Display name/identifier	R2 Level 1 SX(75) PG 64-22
Description of object	Mix ID # 19127A
Author	CDOT
Date Created	4/3/2013 12:00:00 AM
Approver	CDOT
Date approved	4/3/2013 12:00:00 AM
State	Colorado
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	SX
User defined field 2	
User defined field 3	
Revision Number	0

Layer 3 Non-stabilized Base : Class 6 ABC

Unbound	
Layer thickness (in)	10.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
22000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Class 6 ABC
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	20

Sieve

Liquid Limit	30.0
Plasticity Index	6.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	125.8
Saturated hydraulic conductivity (ft/hr)	False	2.257e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	8.3

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	12.2329
bf	1.1153
cf	0.8619
hr	244.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	12.0
#100	
#80	
#60	
#50	
#40	
#30	
#20	
#16	
#10	
#8	55.0
#4	65.0
3/8-in.	
1/2-in.	
3/4-in.	95.0
1-in.	100.0
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 4 Subgrade : Clayey Sand

Unbound	
Layer thickness (in)	24.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
7000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Clayey Sand
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	33

Sieve

Liquid Limit	37.0
Plasticity Index	18.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	112.9
Saturated hydraulic conductivity (ft/hr)	False	1.153e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	14.9

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	102.5522
bf	0.7198
cf	0.2545
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	47.0
#100	
#80	
#60	
#50	
#40	72.0
#30	
#20	
#16	
#10	
#8	
#4	98.0
3/8-in.	
1/2-in.	
3/4-in.	
1-in.	
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 5 Subgrade : A-6

Unbound	
Layer thickness (in)	Semi-infinite
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
14000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-6
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	33.0
Plasticity Index	16.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	107.9
Saturated hydraulic conductivity (ft/hr)	False	1.95e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	17.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	108.4091
bf	0.6801
cf	0.2161
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	63.2
#100	
#80	73.5
#60	
#50	
#40	82.4
#30	
#20	
#16	
#10	90.2
#8	
#4	93.5
3/8-in.	96.4
1/2-in.	97.4
3/4-in.	98.4
1-in.	99.0
1 1/2-in.	99.5
2-in.	99.8
2 1/2-in.	
3-in.	
3 1/2-in.	100.0

Calibration Coefficients

AC Fatigue

$$N_f = 0.00432 * C * \beta_{f1} k_1 \left(\frac{1}{\varepsilon_1}\right)^{k_2\beta_{f2}} \left(\frac{1}{E}\right)^{k_3\beta_{f3}}$$

$$C = 10^M$$

$$M = 4.84\left(\frac{V_b}{V_a + V_b} - 0.69\right)$$

k1: 0.007566
k2: 3.9492
k3: 1.281
Bf1: 130.3674
Bf2: 1
Bf3: 1.217799

AC Rutting

$$\frac{\varepsilon_p}{\varepsilon_r} = k_z \beta_{r1} 10^{k_1} T^{k_2\beta_{r2}} N^{k_3\beta_{r3}}$$

$$k_z = (C_1 + C_2 * depth) * 0.328196^{depth}$$

$$C_1 = -0.1039 * H_\alpha^2 + 2.4868 * H_\alpha - 17.342$$

$$C_2 = 0.0172 * H_\alpha^2 - 1.7331 * H_\alpha + 27.428$$

Where:

$$H_{ac} = total\ AC\ thickness(in)$$

$\varepsilon_p = plastic\ strain\left({}^{in}/_{in}\right)$
$\varepsilon_r = resilient\ strain\left({}^{in}/_{in}\right)$
$T = layer\ temperature(^{\circ}F)$
$N = number\ of\ load\ repetitions$

AC Rutting Standard Deviation	0.1414 * Pow(RUT,0.25) + 0.001	
AC Layer	K1:-3.35412 K2:1.5606 K3:0.3791	Br1:6.7 Br2:1 Br3:1

Thermal Fracture

$$C_f = 400 * N\left(\frac{\log C / h_{ac}}{\sigma}\right)$$

$$\Delta C = (k * \beta t)^{n+1} * A * \Delta K^n$$

$$A = 10^{(4.389 - 2.52 * \log(E * \sigma_m * n))}$$

$C_f = observed\ amount\ of\ thermal\ cracking(ft/500ft)$
$k = refression\ coefficient\ determined\ through\ field\ calibration$
$N() = standard\ normal\ distribution\ evaluated\ at()$
$\sigma = standard\ deviation\ of\ the\ \log\ of\ the\ depth\ of\ cracks\ in\ the\ pavments$
$C = crack\ depth(in)$
$h_{ac} = thickness\ of\ asphalt\ layer(in)$
$\Delta C = Change\ in\ the\ crack\ depth\ due\ to\ a\ cooling\ cycle$
$\Delta K = Change\ in\ the\ stress\ intensity\ factor\ due\ to\ a\ cooling\ cycle$
$A, n = Fracture\ parameters\ for\ the\ asphalt\ mixture$
$E = mixture\ stiffness$
$\sigma_M = Undamaged\ mixture\ tensile\ strength$
$\beta_t = Calibration\ parameter$

Level 1 K: 6.3	Level 1 Standard Deviation: 0.1468 * THERMAL + 65.027
Level 2 K: 0.5	Level 2 Standard Deviation: 0.2841 * THERMAL + 55.462
Level 3 K: 6.3	Level 3 Standard Deviation: 0.3972 * THERMAL + 20.422

CSM Fatigue

$$N_f = 10^{\left(\frac{k_1 \beta_{c1} \left(\frac{\sigma_s}{M_r}\right)}{k_2 \beta_{c2}}\right)}$$

$N_f = number\ of\ repetitions\ to\ fatigue\ cracking$
$\sigma_s = Tensile\ stress(psi)$
$M_r = modulus\ of\ rupture(psi)$

k1: 1	k2: 1	Bc1: 0.75	Bc2:1.1

Subgrade Rutting

$$\delta_a(N) = \beta_{s_1} k_1 \varepsilon_v h \left(\frac{\varepsilon_0}{\varepsilon_r}\right) \left| e^{-\left(\frac{\rho}{N}\right)^{\beta}} \right|$$

$\delta_a = permanent\ deformation\ for\ the\ layer$
$N = number\ of\ repetitions$
$\varepsilon_v = average\ veritcal\ strain(in/in)$
$\varepsilon_0, \beta, \rho = material\ properties$
$\varepsilon_r = resilient\ strain(in/in)$

Granular		Fine	
k1: 2.03	Bs1: 0.22	k1: 1.35	Bs1: 0.37
Standard Deviation (BASERUT) 0.0104 * Pow(BASERUT,0.67) + 0.001		Standard Deviation (BASERUT) 0.0663 * Pow(SUBRUT,0.5) + 0.001	

AC Cracking

AC Top Down Cracking

$$FC_{top} = \left(\frac{C_4}{1 + e^{(C_1 - C_2 * log_{10}(Damage))}}\right) * 10.56$$

c1: 7	c2: 3.5	c3: 0	c4: 1000

AC Cracking Top Standard Deviation

200 + 2300/(1+exp(1.072-2.1654*LOG10 (TOP+0.0001)))

AC Bottom Up Cracking

$$FC = \left(\frac{6000}{1 + e^{(C_1 * C_1' + C_2 * C_2' log_{10}(D * 100))}}\right) * \left(\frac{1}{60}\right)$$

$$C_2' = -2.40874 - 39.748 * (1 + h_{ac})^{-2.856}$$

$$C_1' = -2 * C_2'$$

c1: 0.021	c2: 2.35	c3: 6000

AC Cracking Bottom Standard Deviation

1 + 15/(1+exp(-3.1472-4.1349*LOG10 (BOTTOM+0.0001)))

CSM Cracking

$$FC_{ctb} = C_1 + \frac{C_2}{1 + e^{C_3 - C_4(Damage)}}$$

C1: 0	C2: 75	C3: 5	C4: 3

CSM Standard Deviation

CTB*1

IRI Flexible Pavements

C1 - Rutting
C2 - Fatigue Crack
C3 - Transverse Crack
C4 - Site Factors

C1: 50	C2: 0.55	C3: 0.0111	C4: 0.02

Ramp 2 (Powers SB on) composite 76-28 SMA over 64-22 sx75

File Name: C:\Users\darwinME\Desktop\AFK\Powers and Research\HMA\Ramp 2 (Powers SB on) composite 76-28 SMA over 64-22 sx75.dgpx

Design Inputs

Design Life: 20 years
Design Type: FLEXIBLE

Base construction: May, 2020
Pavement construction: June, 2020
Traffic opening: September, 2020

Climate Data Sources (Lat/Lon): 38.812, -104.711

Design Structure

Layer type	Material Type	Thickness (in)
Flexible	R2 Level 1 SMA	2.0
Flexible	R2 Level 1 SX(75) PG 64-22	4.5 (Optimized)
NonStabilized	Class 6 ABC	10.0
Subgrade	Clayey Sand	24.0
Subgrade	A-6	Semi-infinite

Volumetric at Construction:	
Effective binder content (%)	12.2
Air voids (%)	4.7

Traffic

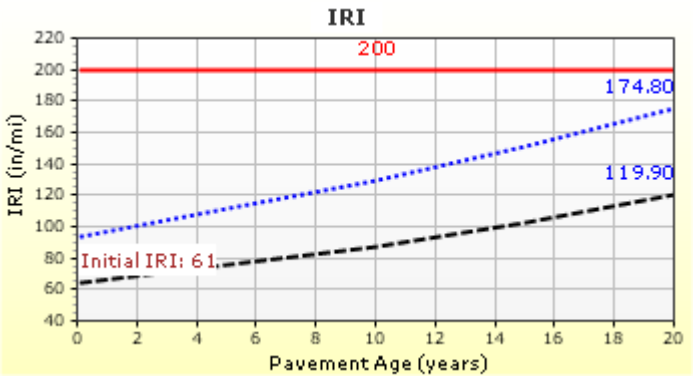
Age (year)	Heavy Trucks (cumulative)
2020 (initial)	581
2030 (10 years)	1,333,930
2040 (20 years)	2,811,800

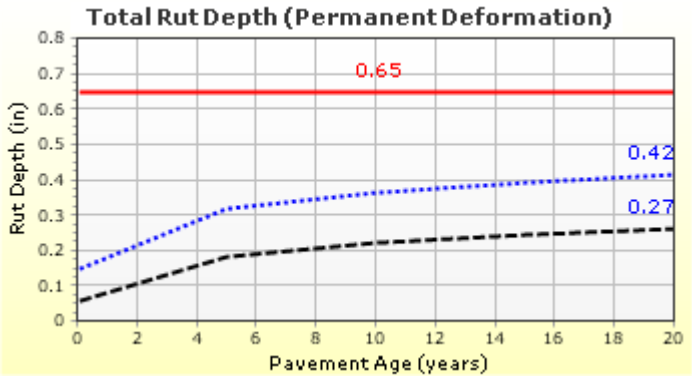
Design Outputs

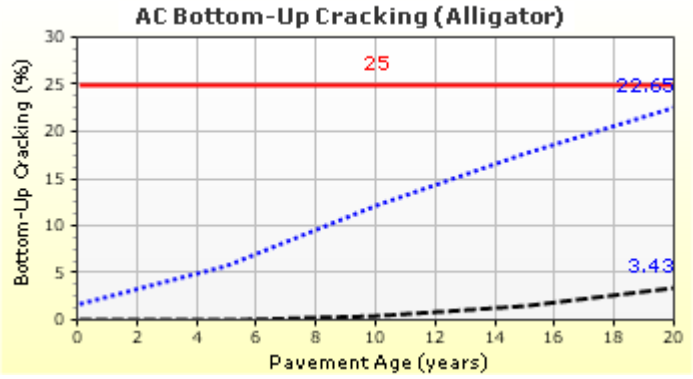
Distress Prediction Summary

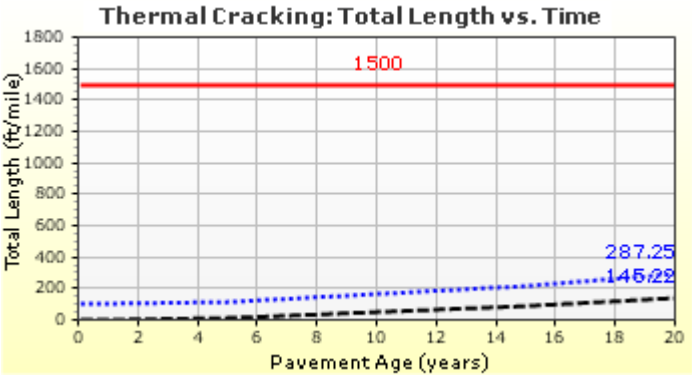
Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	200.00	174.78	95.00	99.18	Pass
Permanent deformation - total pavement (in)	0.65	0.42	95.00	100.00	Pass
AC bottom-up fatigue cracking (% lane area)	25.00	22.65	95.00	96.76	Pass
AC thermal cracking (ft/mile)	1500.00	287.25	95.00	100.00	Pass
AC top-down fatigue cracking (ft/mile)	2500.00	377.76	95.00	100.00	Pass
Permanent deformation - AC only (in)	0.50	0.31	95.00	99.99	Pass

Distress Charts





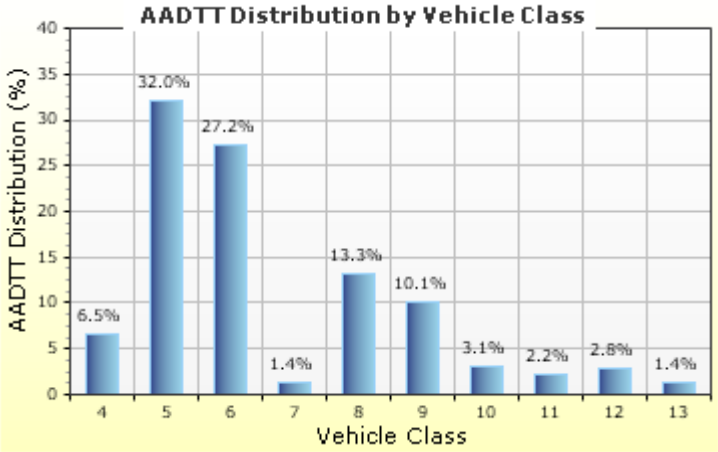


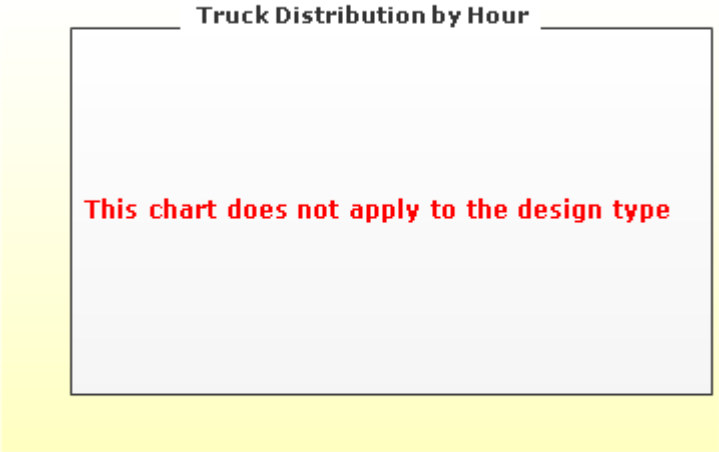


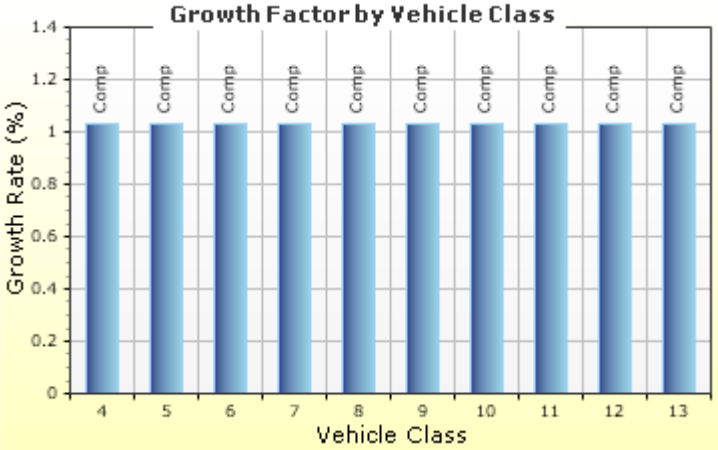
Traffic Inputs

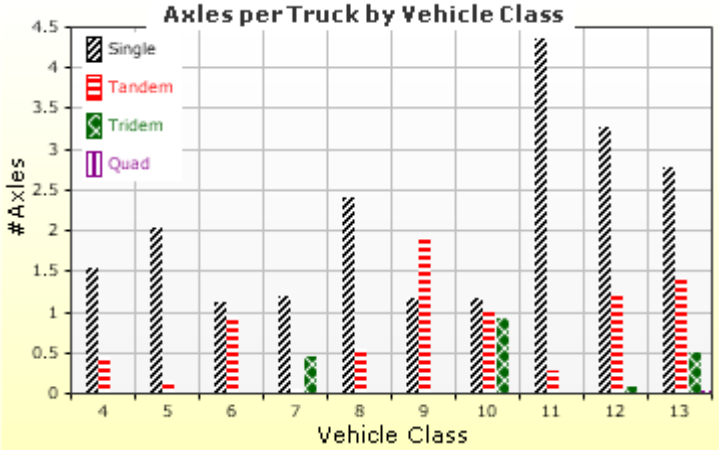
Graphical Representation of Traffic Inputs

Initial two-way AADTT:	581	Percent of trucks in design direction (%):	60.0
Number of lanes in design direction:	2	Percent of trucks in design lane (%):	100.0
		Operational speed (mph)	40.0

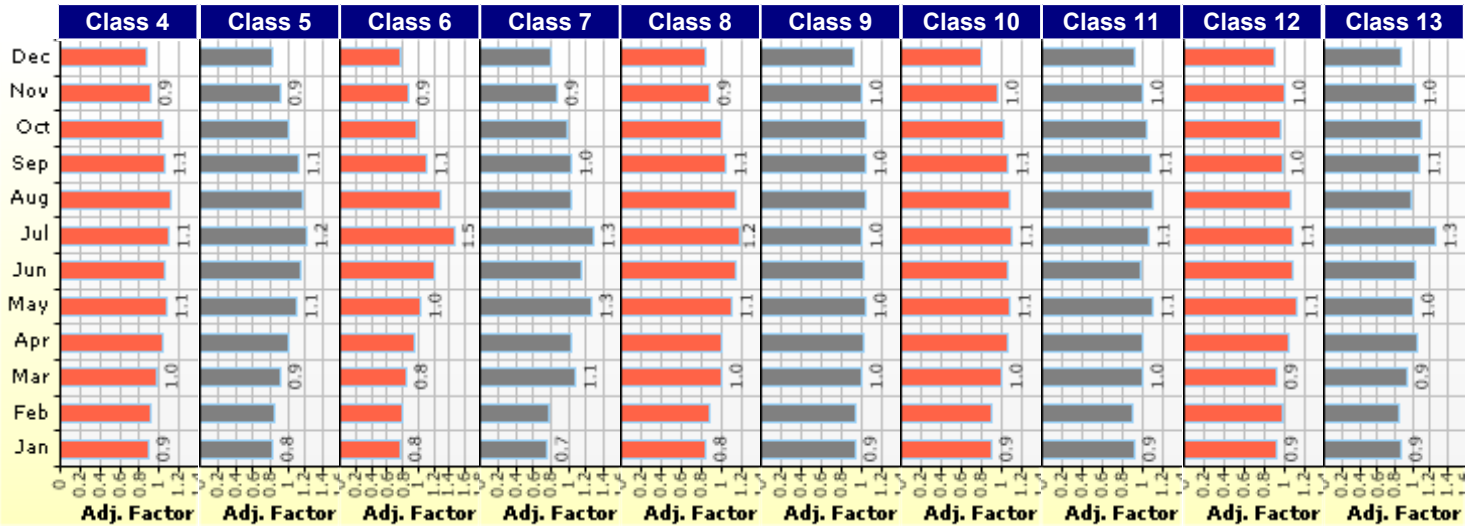








Traffic Volume Monthly Adjustment Factors



Tabular Representation of Traffic Inputs

Volume Monthly Adjustment Factors

Level 3: Default MAF

Month	Vehicle Class									
	4	5	6	7	8	9	10	11	12	13
January	0.9	0.8	0.8	0.7	0.8	0.9	0.9	0.9	0.9	0.9
February	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.8
March	1.0	0.9	0.8	1.1	1.0	1.0	1.0	1.0	0.9	0.9
April	1.0	1.0	0.9	1.0	1.0	1.0	1.1	1.0	1.0	1.1
May	1.1	1.1	1.0	1.3	1.1	1.0	1.1	1.1	1.1	1.0
June	1.1	1.1	1.2	1.1	1.1	1.0	1.1	1.0	1.1	1.0
July	1.1	1.2	1.5	1.3	1.2	1.0	1.1	1.1	1.1	1.3
August	1.1	1.2	1.3	1.0	1.1	1.0	1.1	1.1	1.1	1.0
September	1.1	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1
October	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.1
November	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0
December	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.9	0.9

Distributions by Vehicle Class

Truck Distribution by Hour does not apply

Vehicle Class	AADTT Distribution (%) (Level 3)	Growth Factor	
		Rate (%)	Function
Class 4	6.54%	1.03%	Compound
Class 5	32.02%	1.03%	Compound
Class 6	27.23%	1.03%	Compound
Class 7	1.38%	1.03%	Compound
Class 8	13.25%	1.03%	Compound
Class 9	10.07%	1.03%	Compound
Class 10	3.1%	1.03%	Compound
Class 11	2.19%	1.03%	Compound
Class 12	2.82%	1.03%	Compound
Class 13	1.4%	1.03%	Compound

Axle Configuration

Traffic Wander	
Mean wheel location (in)	18.0
Traffic wander standard deviation (in)	10.0
Design lane width (ft)	12.0

Axle Configuration	
Average axle width (ft)	8.5
Dual tire spacing (in)	12.0
Tire pressure (psi)	120.0

Average Axle Spacing	
Tandem axle spacing (in)	51.6
Tridem axle spacing (in)	49.2
Quad axle spacing (in)	49.2

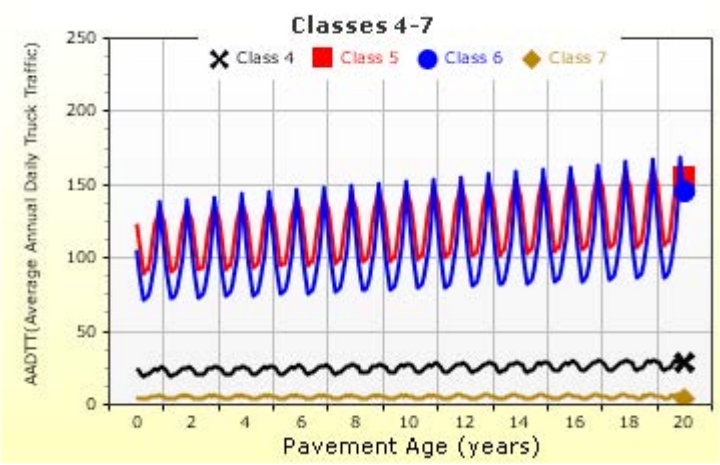
Wheelbase does not apply

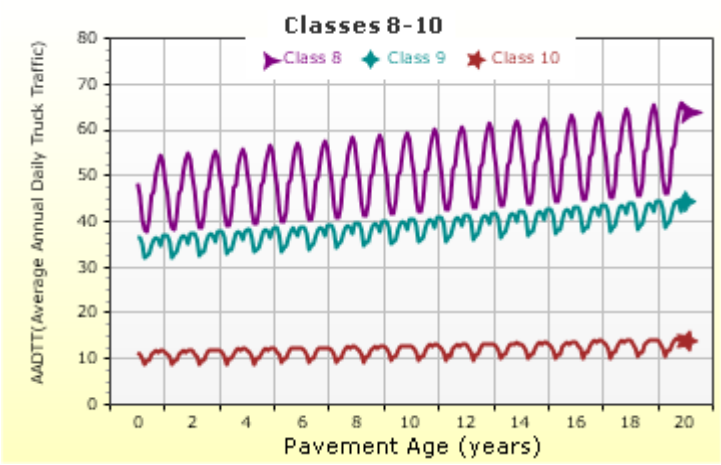
Number of Axles per Truck

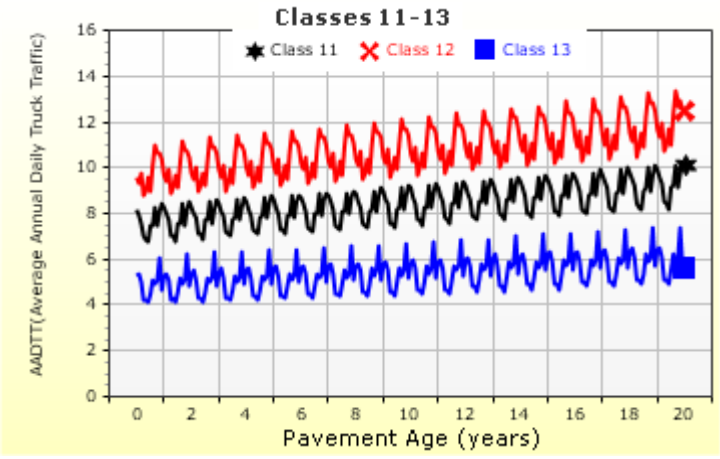
Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.53	0.45	0	0
Class 5	2.02	0.16	0.02	0
Class 6	1.12	0.94	0	0
Class 7	1.19	0.07	0.45	0.02
Class 8	2.41	0.56	0.02	0
Class 9	1.16	1.9	0.01	0
Class 10	1.15	1.01	0.93	0.02
Class 11	4.35	0.29	0.02	0
Class 12	3.27	1.22	0.09	0
Class 13	2.77	1.4	0.51	0.04

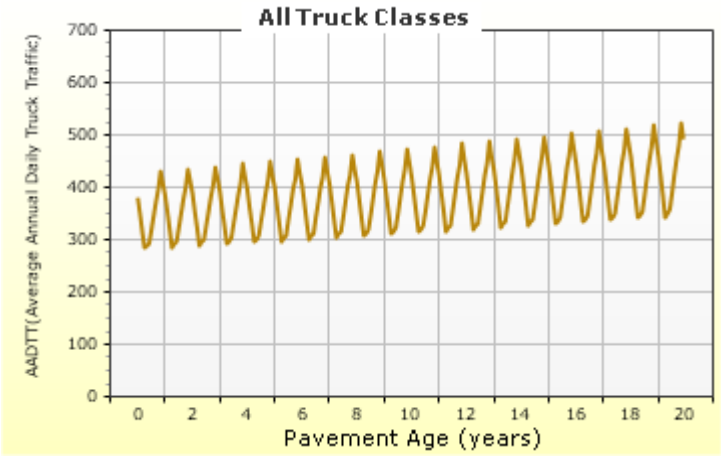
AADTT (Average Annual Daily Truck Traffic) Growth

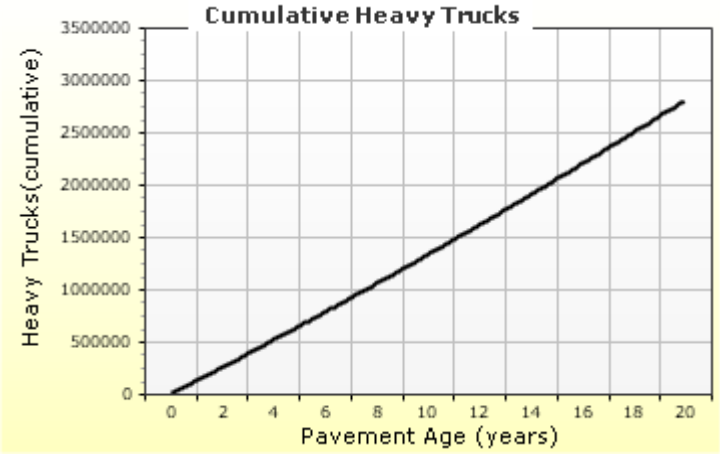
*** Traffic cap is not enforced**







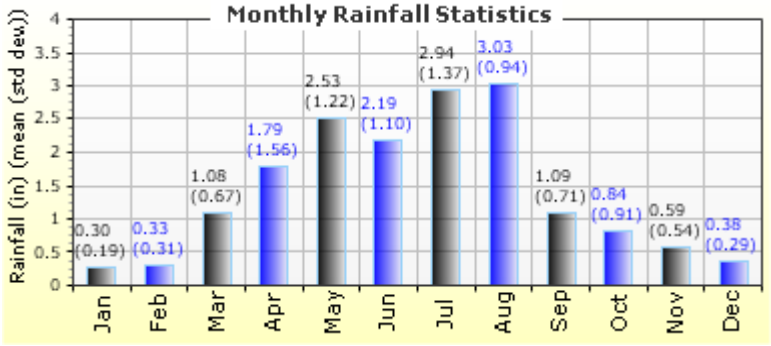




Climate Inputs

Climate Data Sources:

Climate Station Cities:	Location (lat lon elevation(ft))
COLORADO SPRINGS_	38.81200 -104.71100 6170

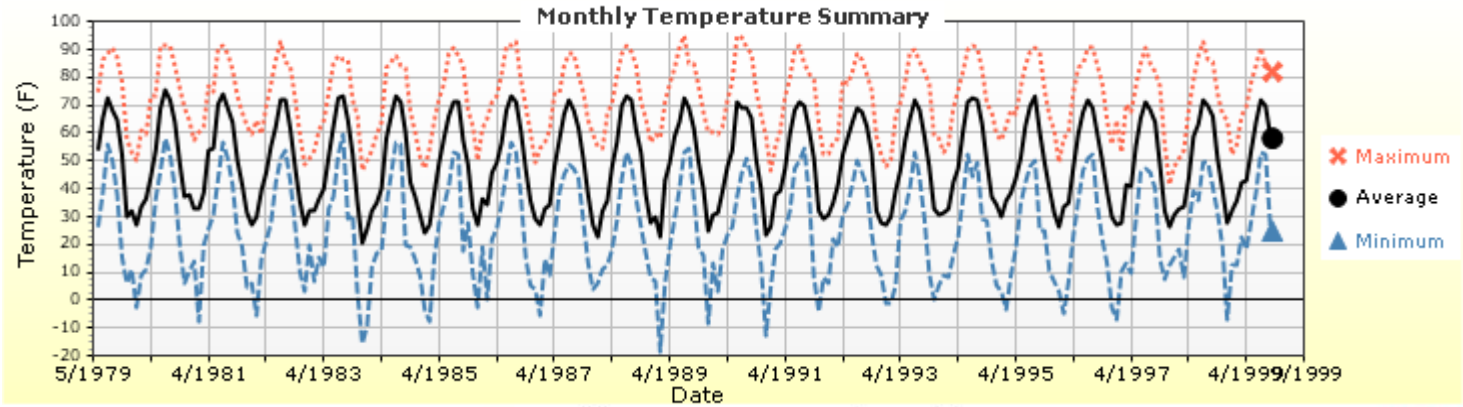


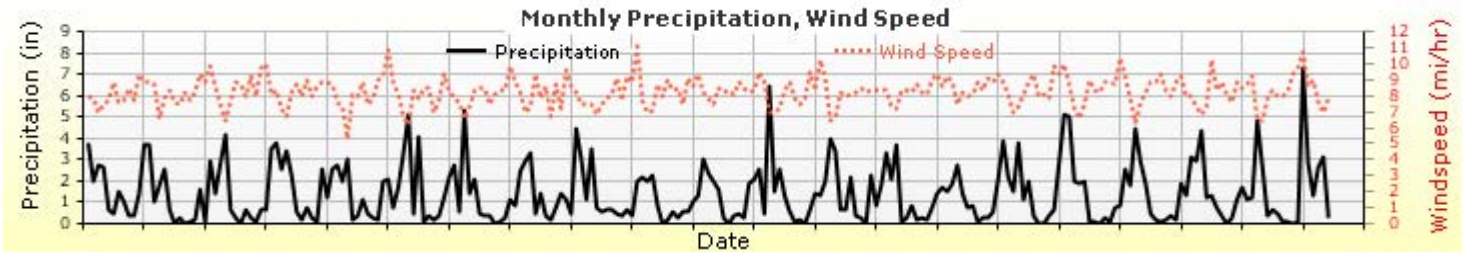
Annual Statistics:

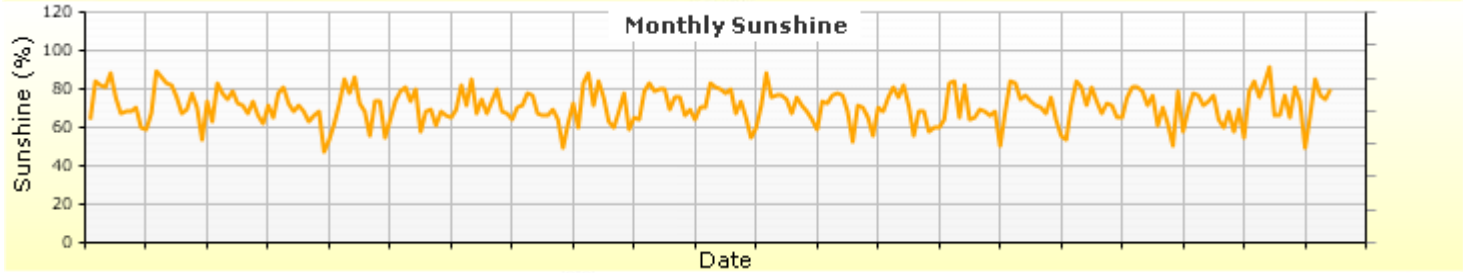
Mean annual air temperature (ºF)	49.11
Mean annual precipitation (in)	17.31
Freezing index (ºF - days)	555.60
Average annual number of freeze/thaw cycles:	83.33

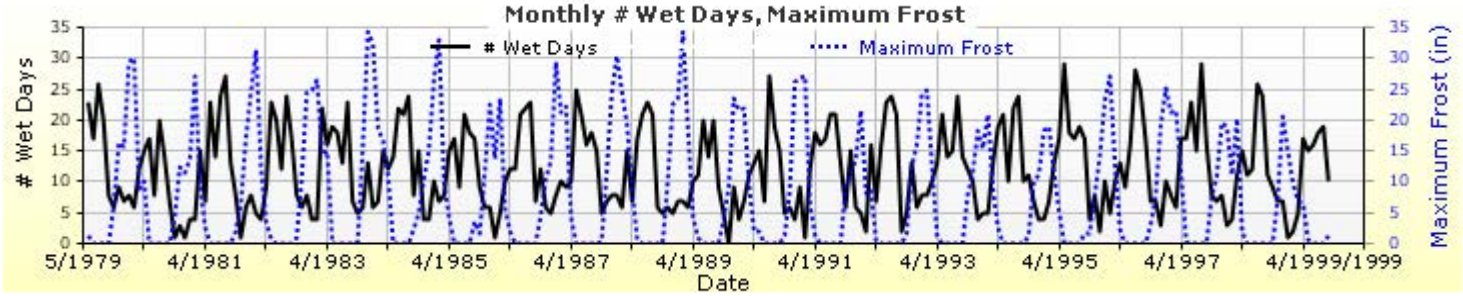
Water table depth (ft)	7.00

Monthly Climate Summary:

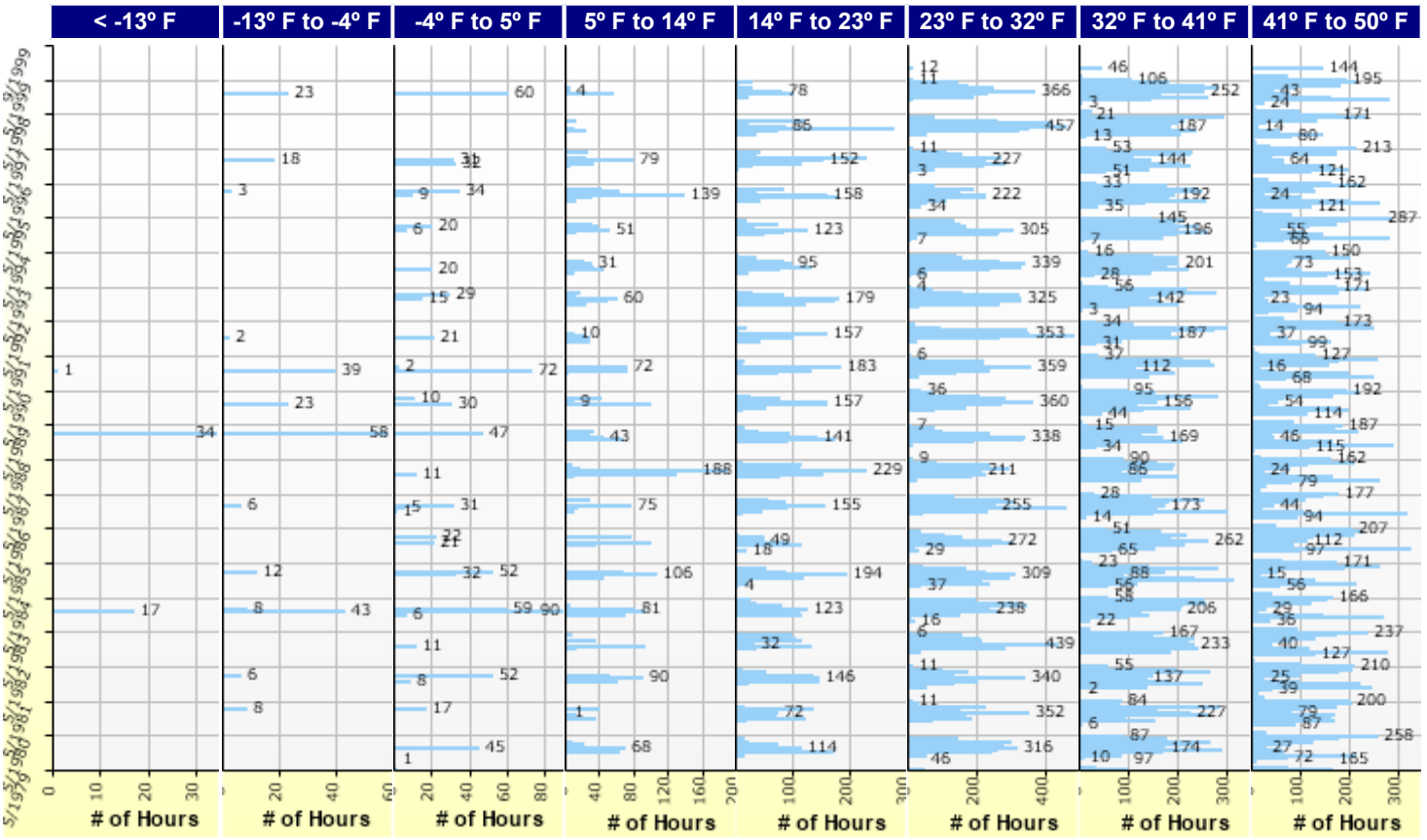


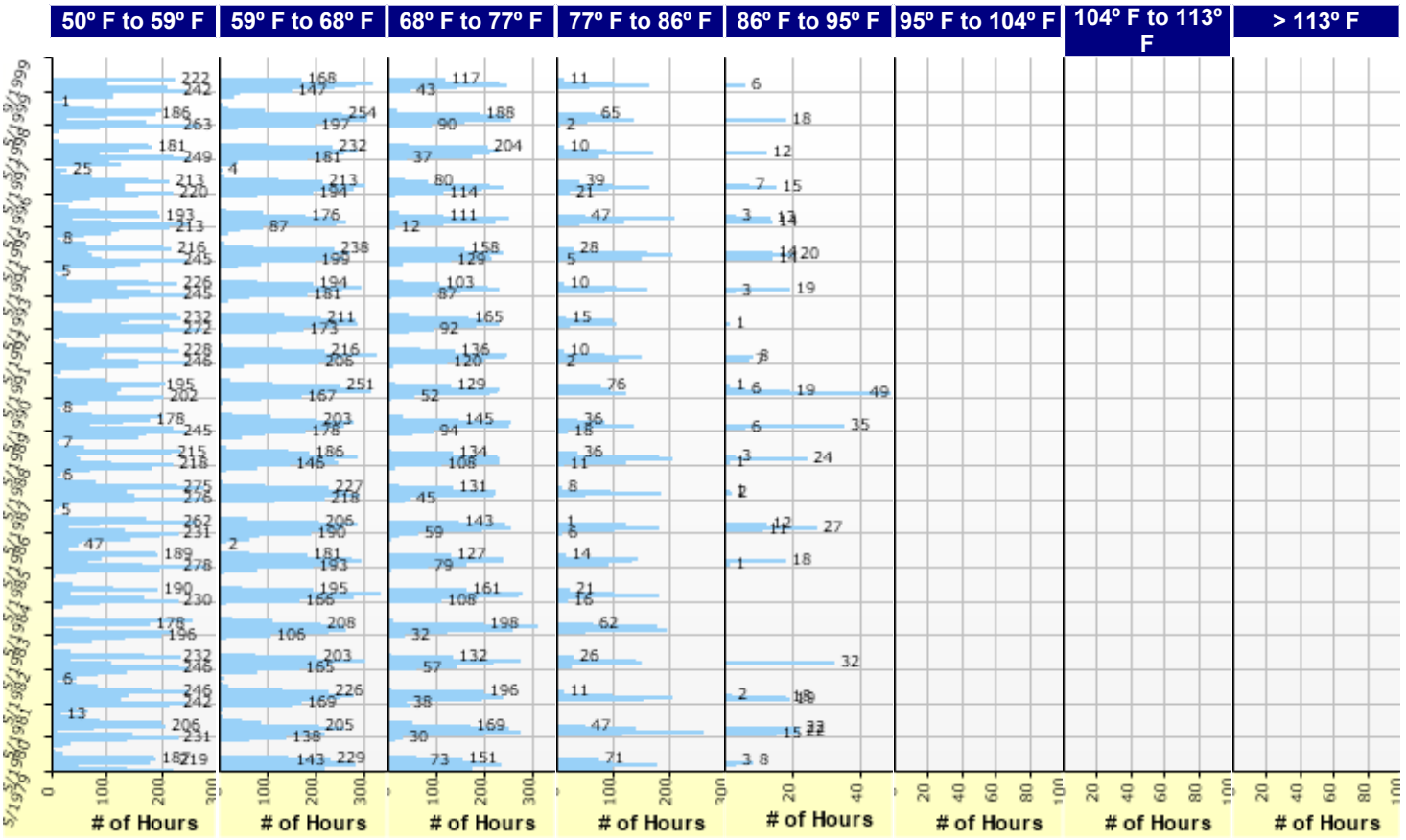






Hourly Air Temperature Distribution by Month:





Design Properties

HMA Design Properties

Use Multilayer Rutting Model	False
Using G* based model (not nationally calibrated)	False
Is NCHRP 1-37A HMA Rutting Model Coefficients	True
Endurance Limit	-
Use Reflective Cracking	True

Structure - ICM Properties	
AC surface shortwave absorptivity	0.85

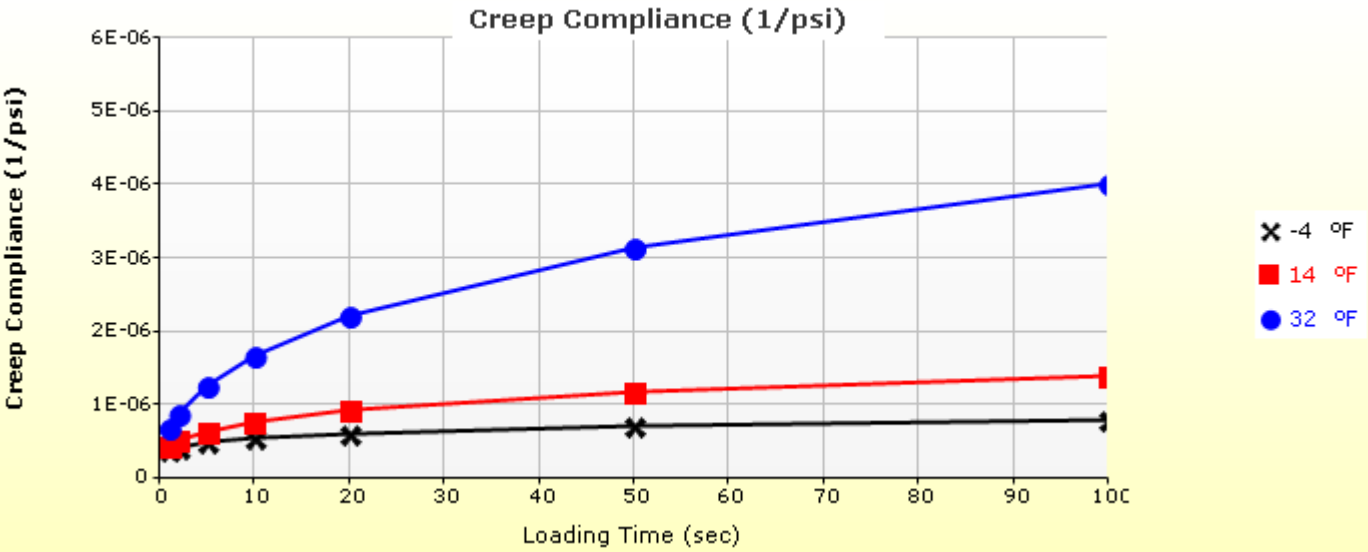
Layer Name	Layer Type	Interface Friction
Layer 1 Flexible : R2 Level 1 SMA	Flexible (1)	1.00
Layer 2 Flexible : R2 Level 1 SX (75) PG 64-22	Flexible (1)	1.00
Layer 3 Non-stabilized Base : Class 6 ABC	Non-stabilized Base (4)	1.00
Layer 4 Subgrade : Clayey Sand	Subgrade (5)	1.00
Layer 5 Subgrade : A-6	Subgrade (5)	-

Thermal Cracking (Input Level: 1)

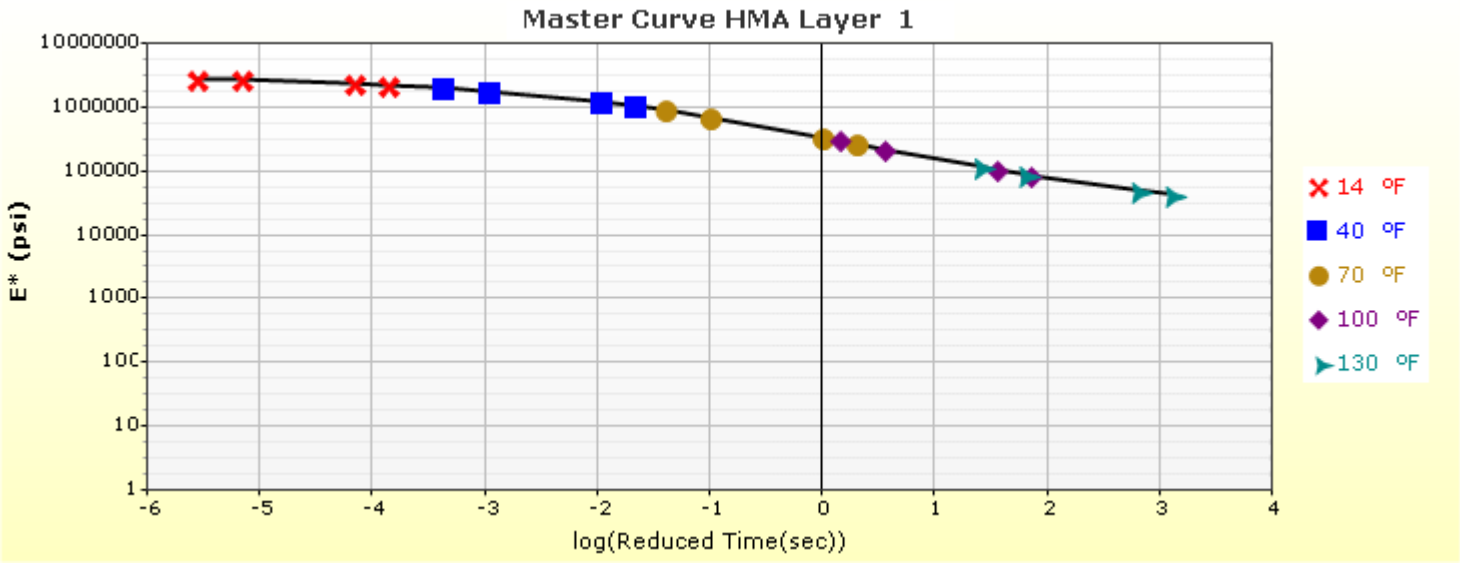
Indirect tensile strength at 14 ºF (psi)	515.00

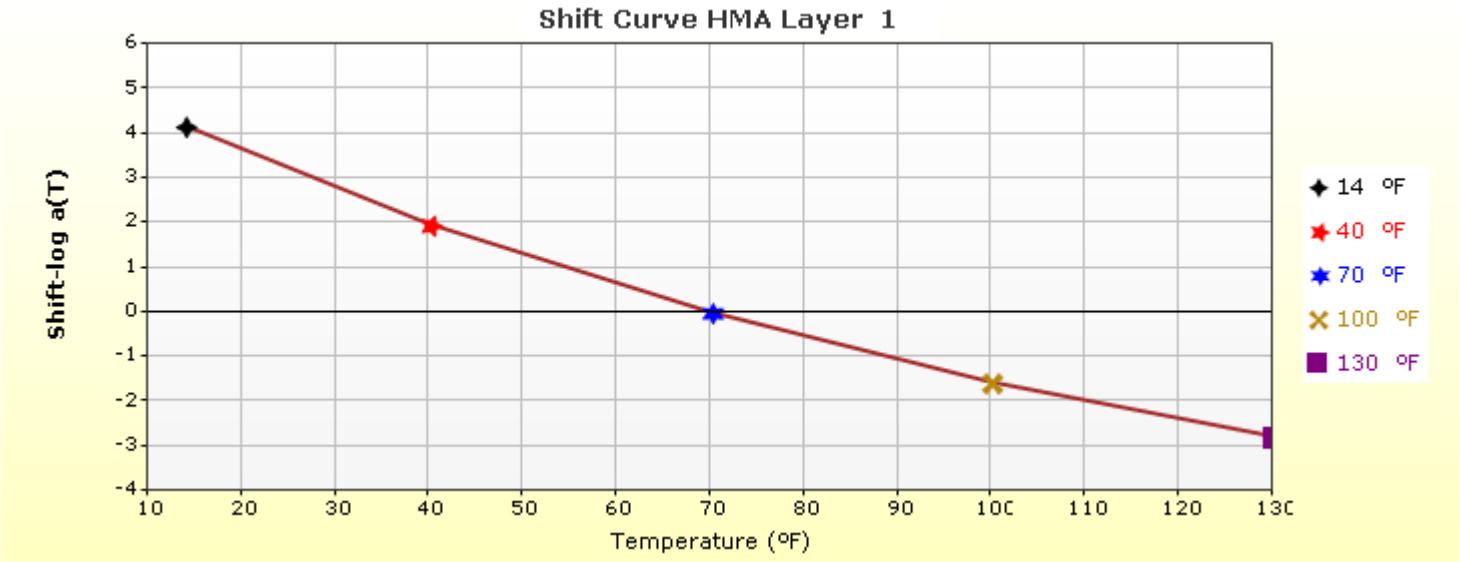
Thermal Contraction	
Is thermal contraction calculated?	True
Mix coefficient of thermal contraction (in/in/ºF)	-
Aggregate coefficient of thermal contraction (in/in/ºF)	5.0e-006
Voids in Mineral Aggregate (%)	16.9

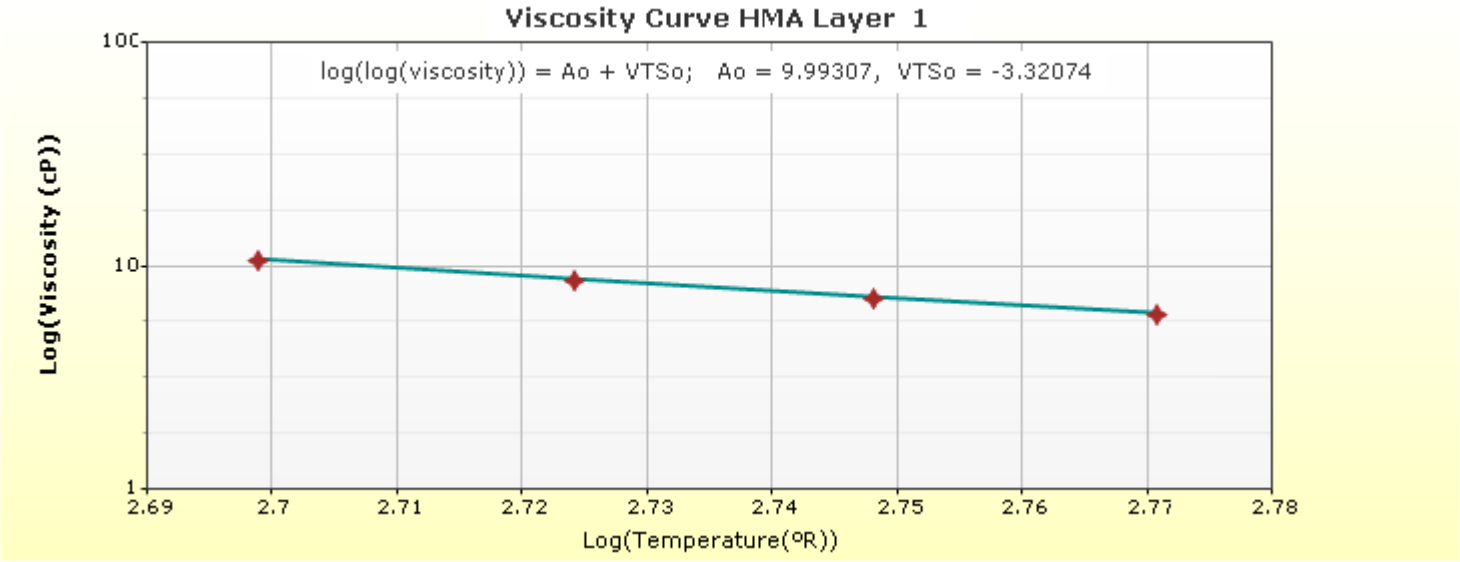
	Creep Compliance (1/psi)		
Loading time (sec)	-4 ºF	14 ºF	32 ºF
1	4.01e-007	4.45e-007	6.88e-007
2	4.28e-007	5.41e-007	8.96e-007
5	4.98e-007	6.37e-007	1.27e-006
10	5.51e-007	7.85e-007	1.69e-006
20	6.17e-007	9.33e-007	2.23e-006
50	7.19e-007	1.18e-006	3.14e-006
100	7.96e-007	1.39e-006	4.01e-006



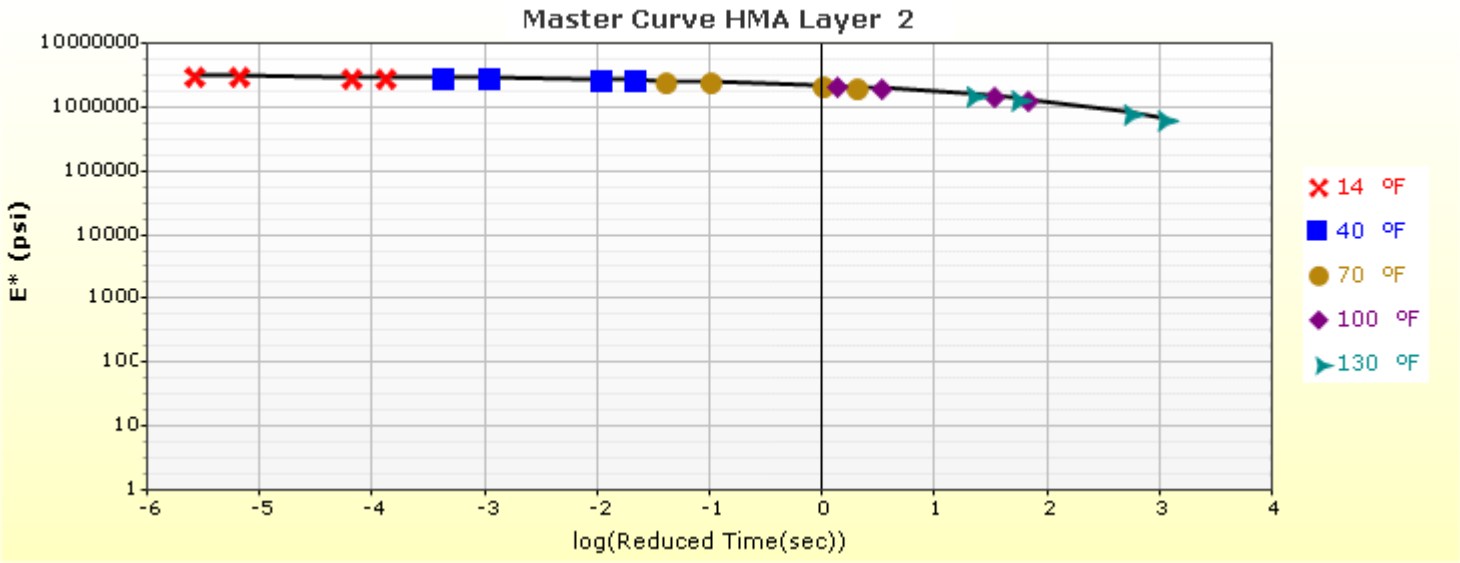
HMA Layer 1: Layer 1 Flexible : R2 Level 1 SMA

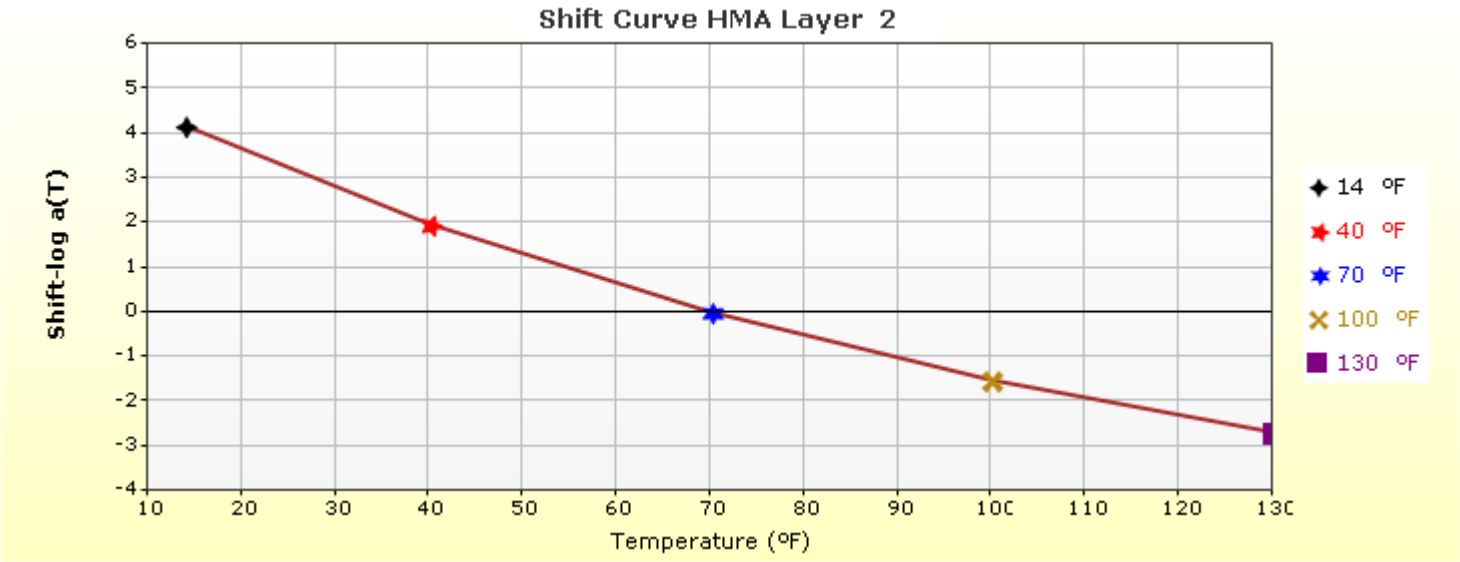


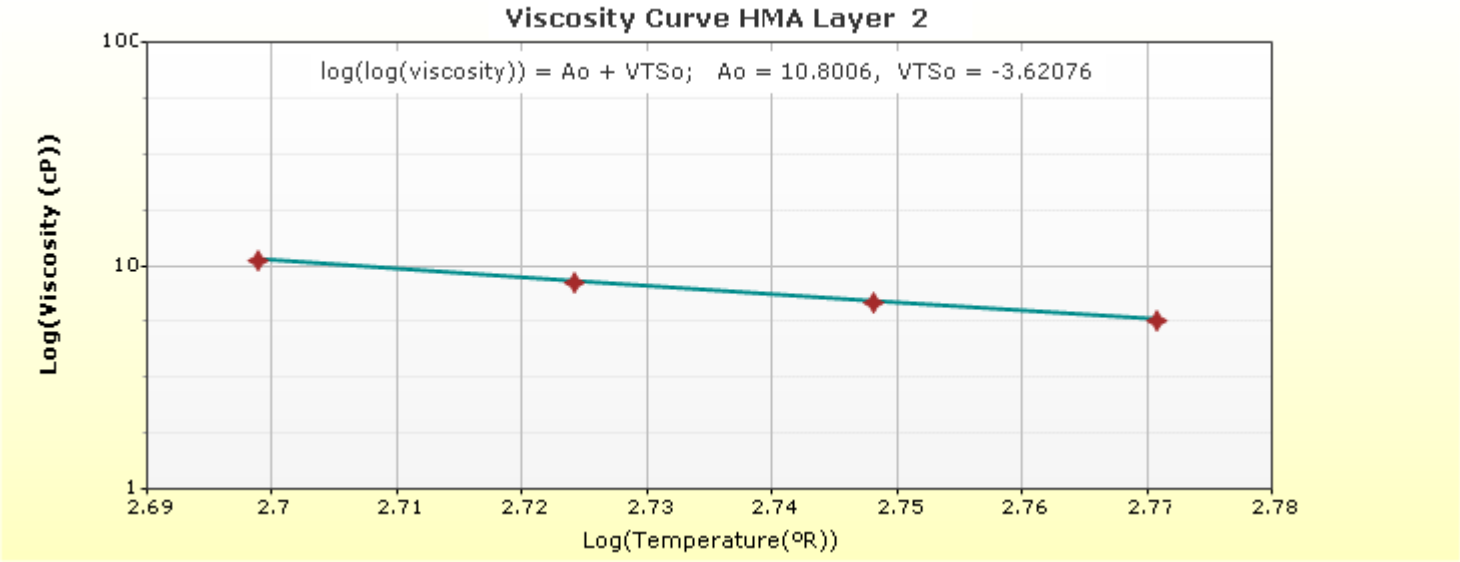




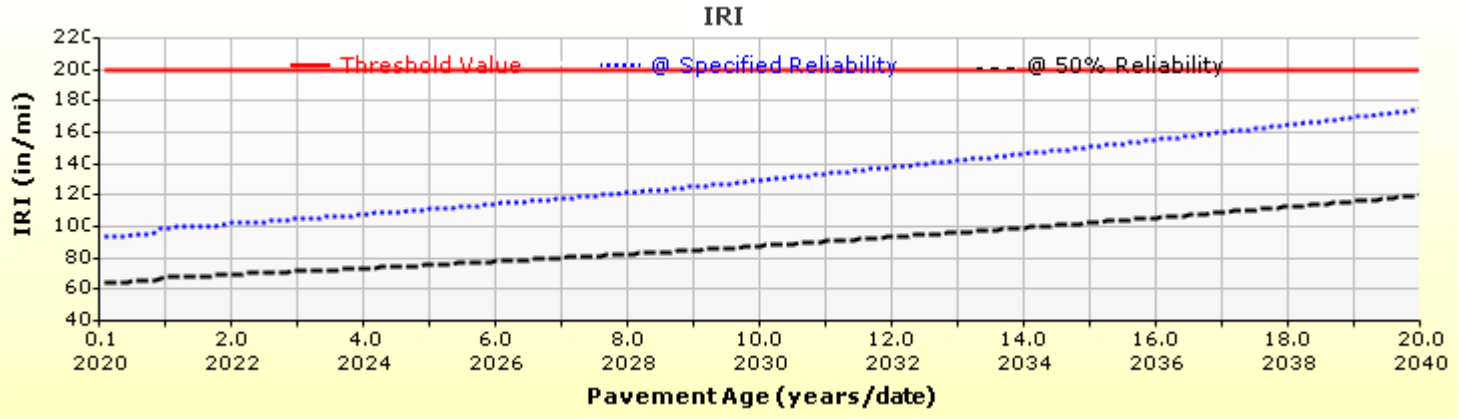
HMA Layer 2: Layer 2 Flexible : R2 Level 1 SX(75) PG 64-22

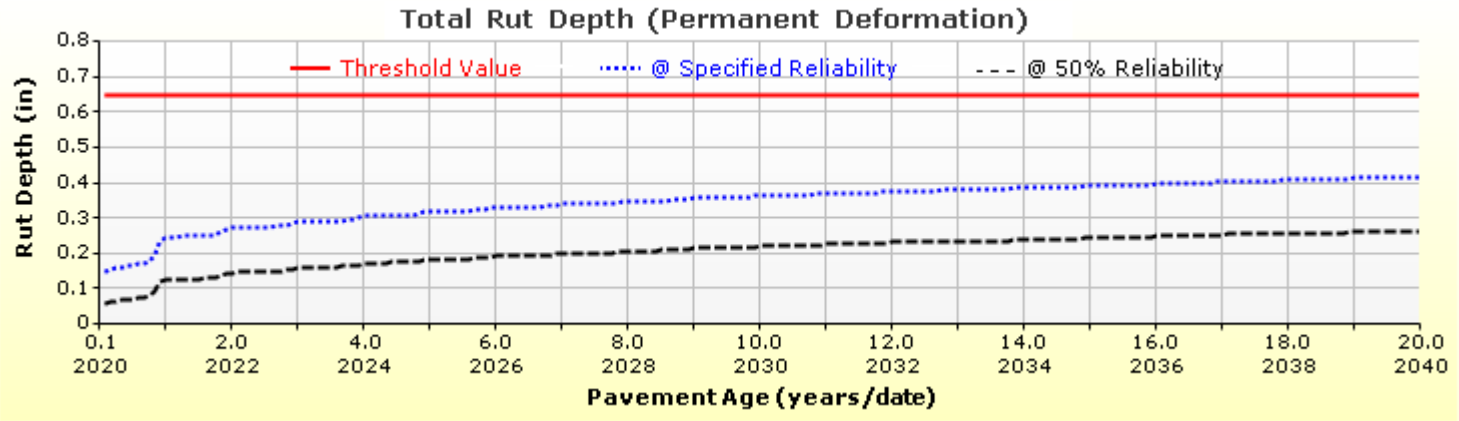


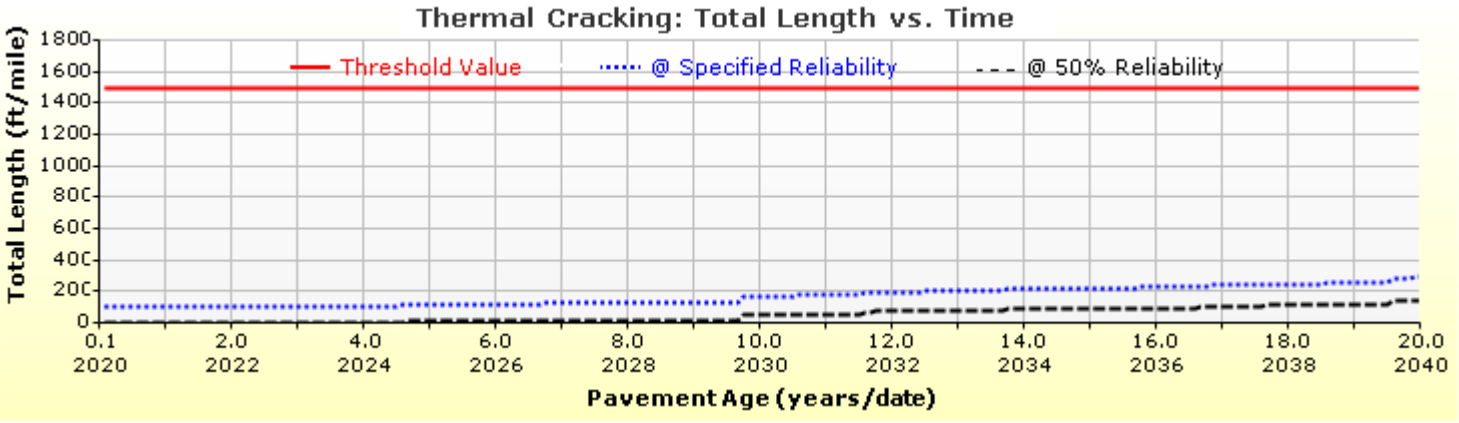


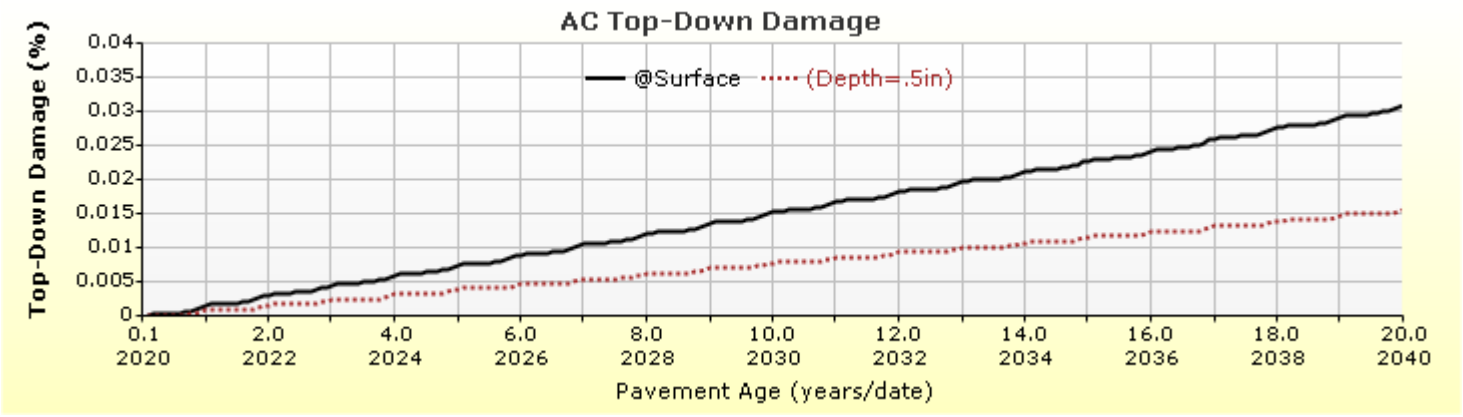


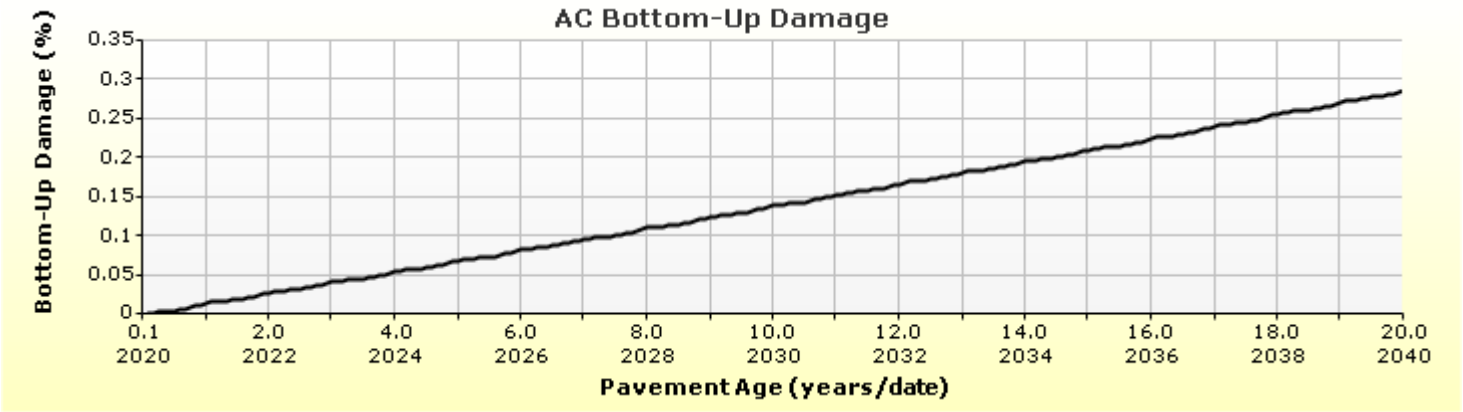
Analysis Output Charts

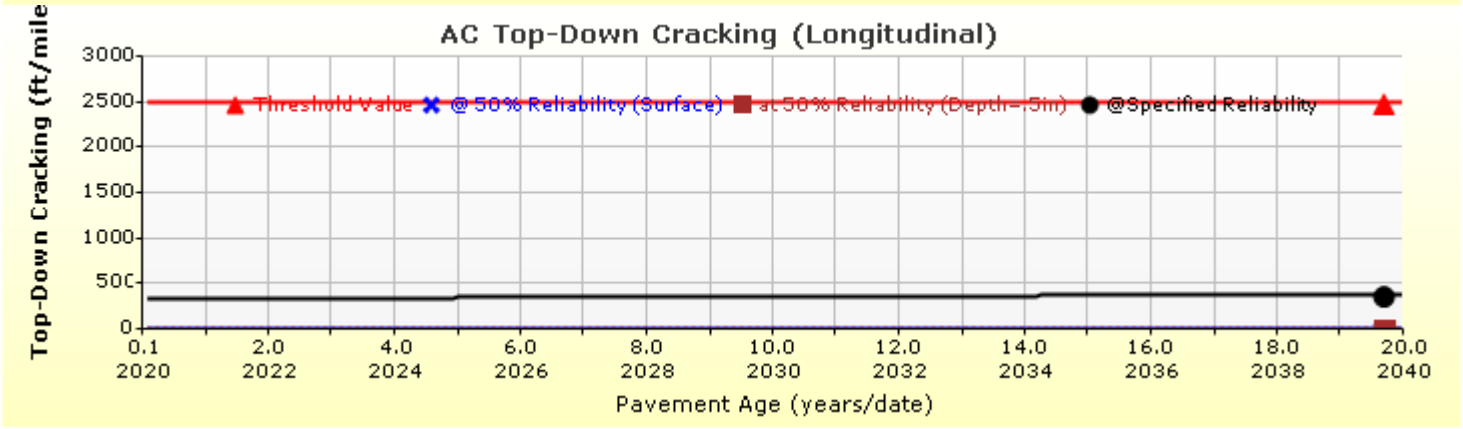


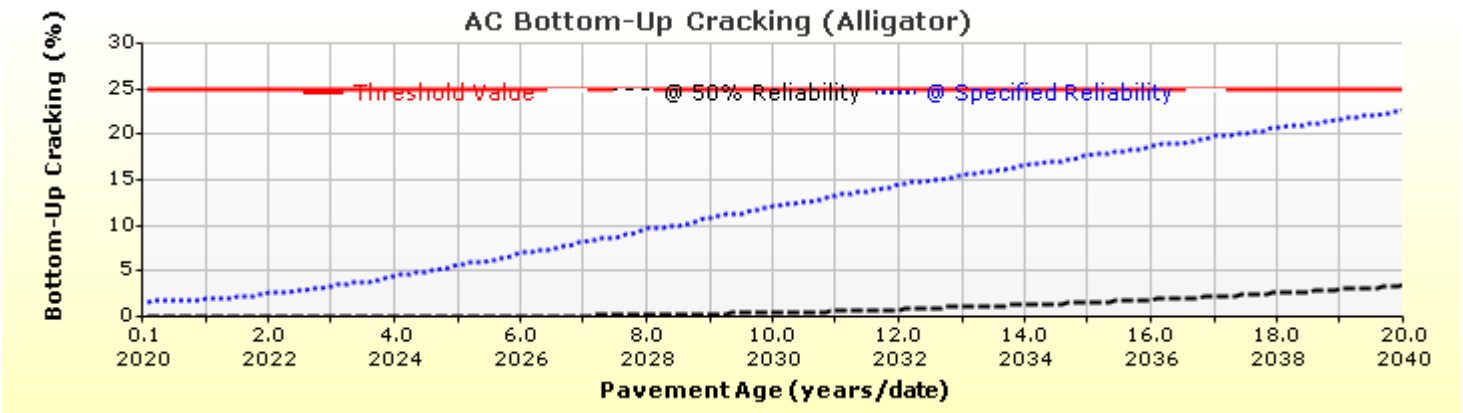


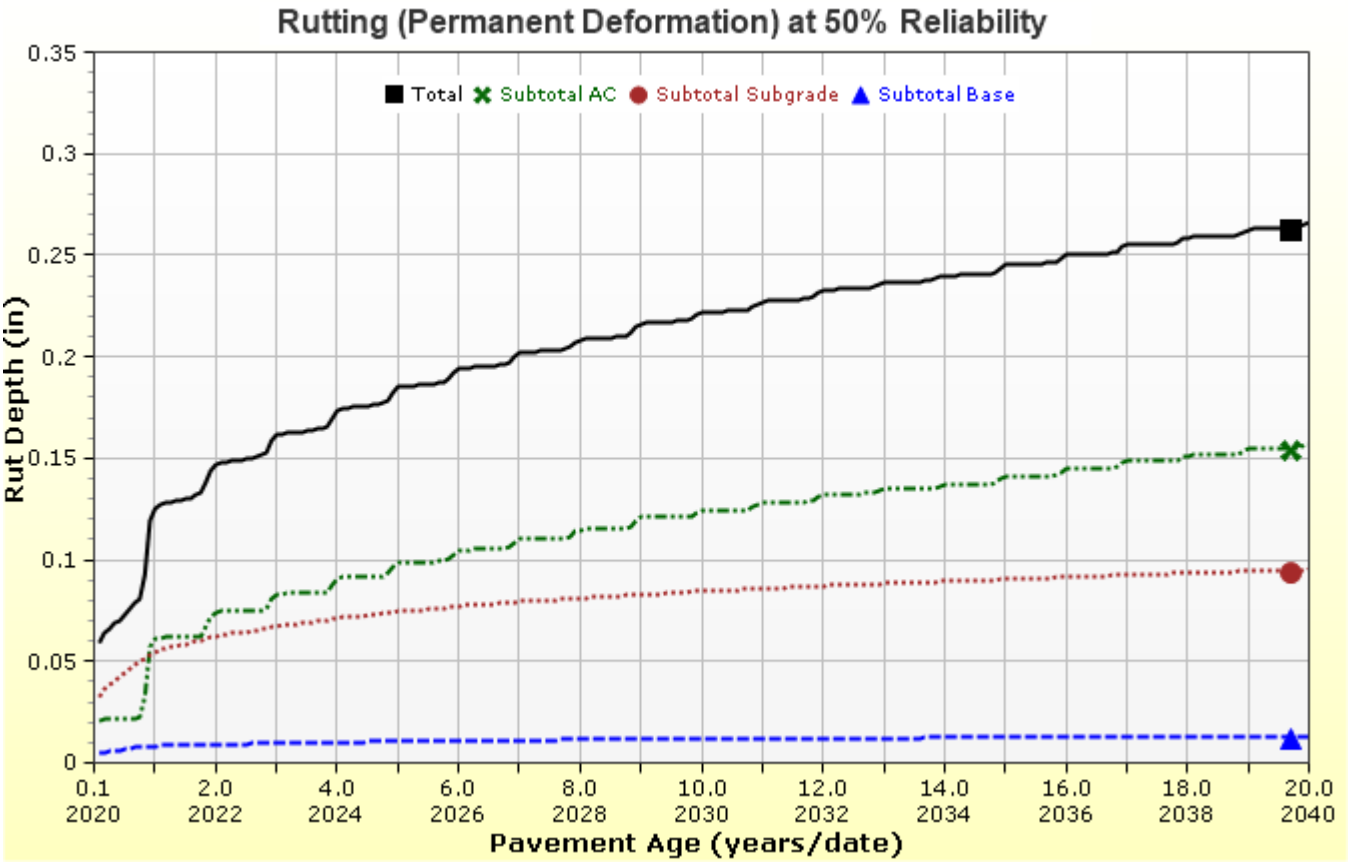


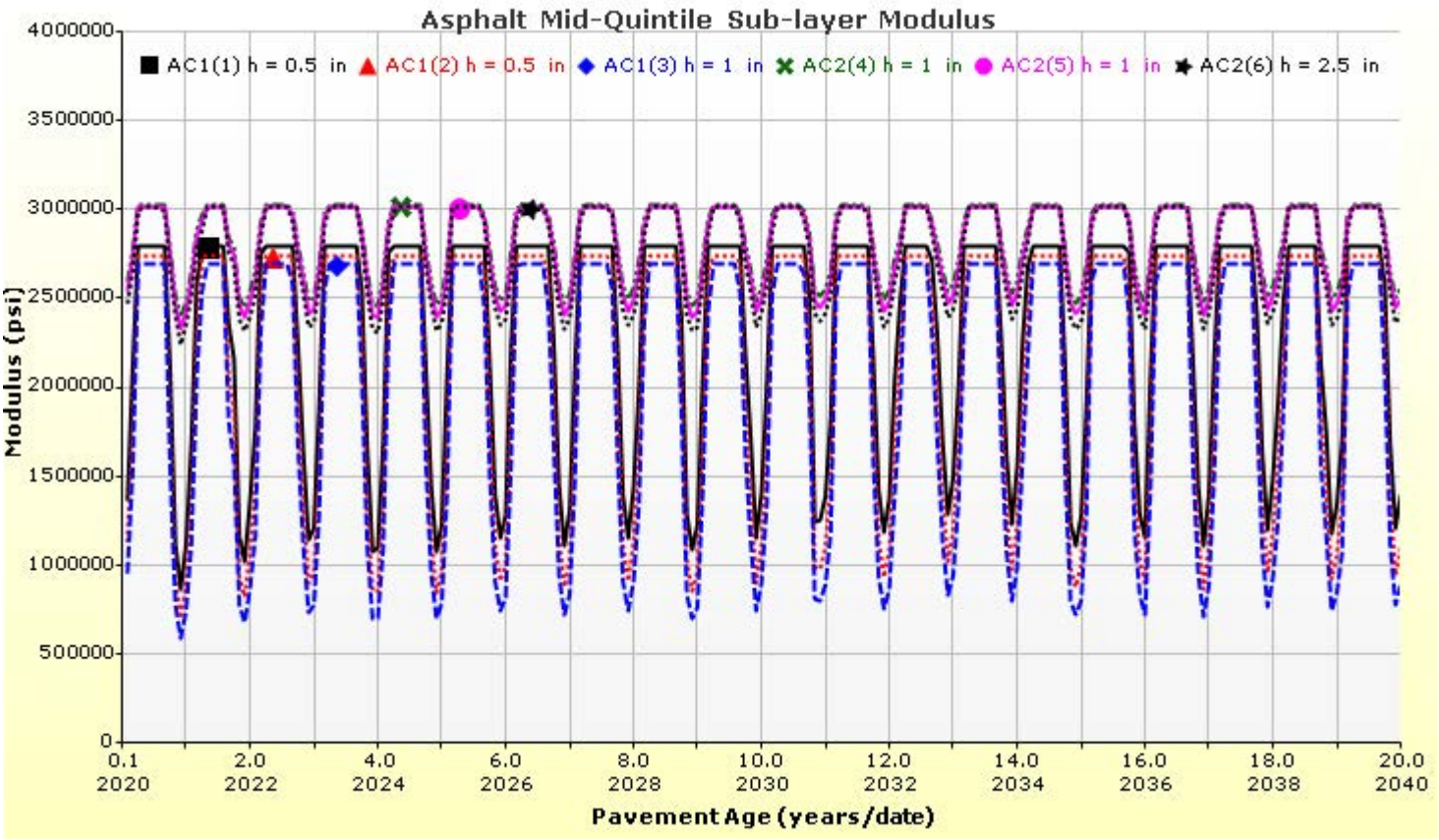

AC Top-Down Damage
Top-Down Damage (%)
@Surface
(Depth=.5in)
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)

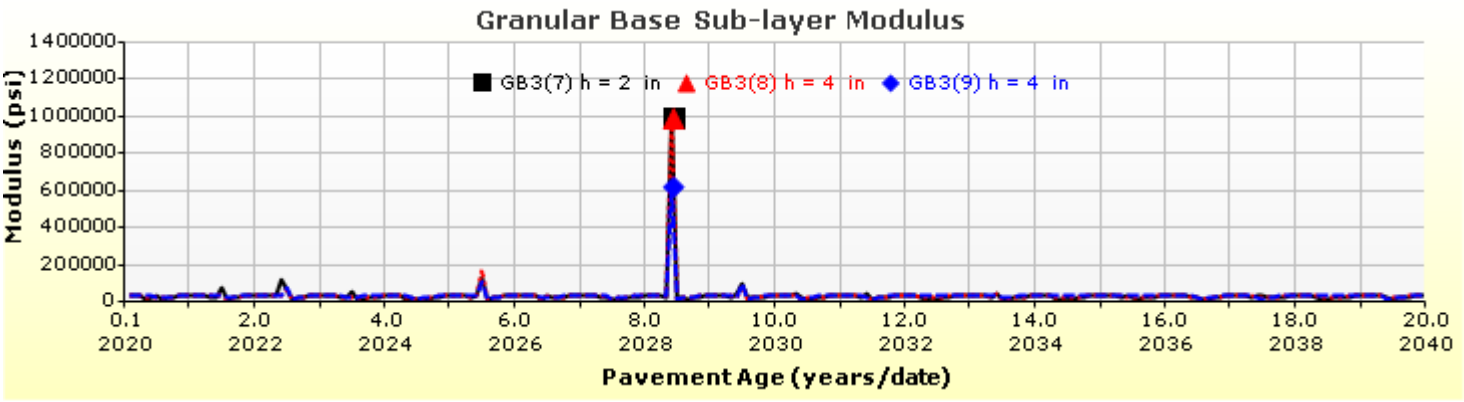

AC Bottom-Up Damage
Bottom-Up Damage (%)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)

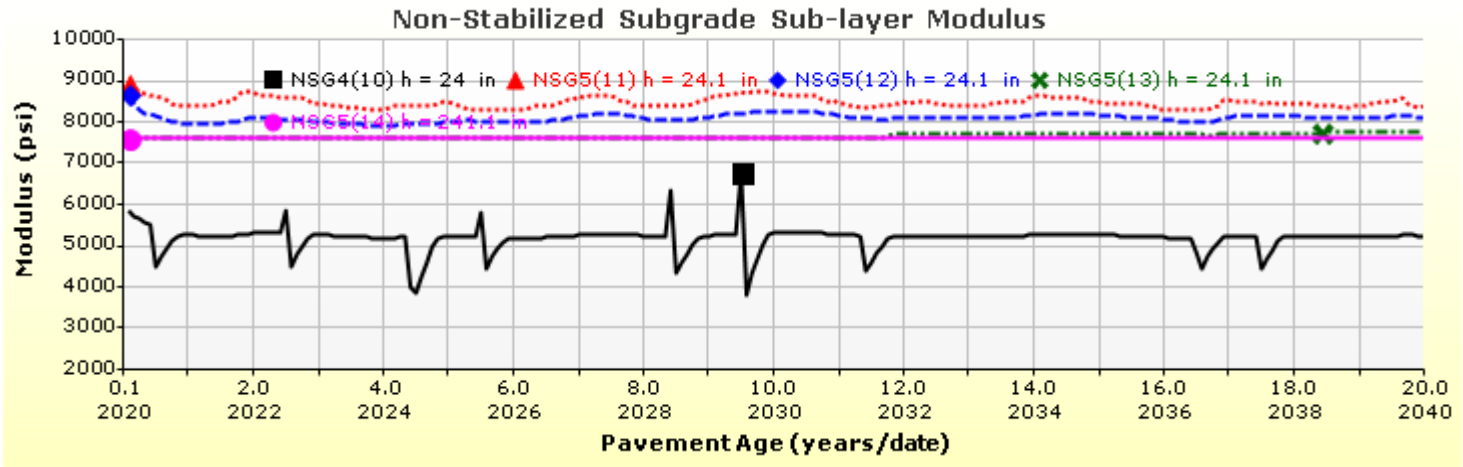

AC Top-Down Cracking (Longitudinal)
Top-Down Cracking (ft/mile
Threshold Value
@ 50% Reliability (Surface)
at 50% Reliability (Depth=.5in)
@Specified Reliability
3000
2500
2000
1500
1000
500
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)


AC Bottom-Up Cracking (Alligator)
Bottom-Up Cracking (%)
Threshold Value
@ 50% Reliability
@ Specified Reliability
30
25
20
15
10
5
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)


Rutting (Permanent Deformation) at 50% Reliability
Total
Subtotal AC
Subtotal Subgrade
Subtotal Base
Rut Depth (in)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1
2020
2.0
2022
4.0
2024
6.0
2026
8.0
2028
10.0
2030
12.0
2032
14.0
2034
16.0
2036
18.0
2038
20.0
2040
Pavement Age (years/date)


Asphalt Mid-Quintile Sub-layer Modulus
AC1(1) h = 0.5 in
AC1(2) h = 0.5 in
AC1(3) h = 1 in
AC2(4) h = 1 in
AC2(5) h = 1 in
AC2(6) h = 2.5 in
Modulus (psi)
Pavement Age (years/date)


Granular Base Sub-layer Modulus
GB3(7) h = 2 in
GB3(8) h = 4 in
GB3(9) h = 4 in
Modulus (psi)
Pavement Age (years/date)


Non-Stabilized Subgrade Sub-layer Modulus
NSG4(10) h = 24 in
NSG5(11) h = 24.1 in
NSG5(12) h = 24.1 in
NSG5(13) h = 24.1 in
NSG5(14) h = 24.1 in
Modulus (psi)
Pavement Age (years/date)

Layer Information

Layer 1 Flexible : R2 Level 1 SMA

Asphalt		
Thickness (in)	2.0	
Unit weight (pcf)	145.0	
Poisson's ratio	Is Calculated?	True
	Ratio	-
	Parameter A	-1.63
	Parameter B	3.84E-06

Asphalt Dynamic Modulus (Input Level: 1)

T (ºF)	0.5 Hz	1 Hz	10 Hz	25 Hz
14	1875400	2299039	2624309	2726019
40	846575	1309050	1799540	1983379
70	230100	427271	753122	918360
100	76296	127286	231357	296468
130	40803	55308	84229	102895

Asphalt Binder

Temperature (ºF)	Binder Gstar (Pa)	Phase angle (deg)
158	1233	64
168.8	673	66
179.6	383	68

General Info

Name	Value
Reference temperature (ºF)	70
Effective binder content (%)	12.2
Air voids (%)	4.7
Thermal conductivity (BTU/hr-ft-ºF)	0.67
Heat capacity (BTU/lb-ºF)	0.23

Identifiers

Field	Value
Display name/identifier	R2 Level 1 SMA
Description of object	Mix ID # FS1919
Author	CDOT
Date Created	4/3/2013 12:00:00 AM
Approver	CDOT
Date approved	4/3/2013 12:00:00 AM
State	Colorado
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	SMA
User defined field 2	
User defined field 3	
Revision Number	0

Layer 2 Flexible : R2 Level 1 SX(75) PG 64-22

Asphalt		
Thickness (in)	4.5	
Unit weight (pcf)	140.5	
Poisson's ratio	Is Calculated?	True
	Ratio	-
	Parameter A	-1.63
	Parameter B	3.84E-06

Asphalt Dynamic Modulus (Input Level: 1)

T (ºF)	0.5 Hz	1 Hz	10 Hz	25 Hz
14	2910500	2947100	3034800	3058600
40	2620500	2695700	2882400	2934800
70	2057300	2190500	2549800	2658300
100	1334300	1500400	2017600	2195500
130	697600	836500	1365200	1584000

Asphalt Binder

Temperature (ºF)	Binder Gstar (Pa)	Phase angle (deg)
168.8	451	85
147.2	1857	81.6
158	889	83.1

General Info

Name	Value
Reference temperature (ºF)	70
Effective binder content (%)	11.8
Air voids (%)	6.9
Thermal conductivity (BTU/hr-ft-ºF)	0.67
Heat capacity (BTU/lb-ºF)	0.23

Identifiers

Field	Value
Display name/identifier	R2 Level 1 SX(75) PG 64-22
Description of object	Mix ID # 19127A
Author	CDOT
Date Created	4/3/2013 12:00:00 AM
Approver	CDOT
Date approved	4/3/2013 12:00:00 AM
State	Colorado
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	SX
User defined field 2	
User defined field 3	
Revision Number	0

Layer 3 Non-stabilized Base : Class 6 ABC

Unbound	
Layer thickness (in)	10.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
22000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Class 6 ABC
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	20

Sieve

Liquid Limit	30.0
Plasticity Index	6.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	125.8
Saturated hydraulic conductivity (ft/hr)	False	2.257e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	8.3

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	12.2329
bf	1.1153
cf	0.8619
hr	244.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	12.0
#100	
#80	
#60	
#50	
#40	
#30	
#20	
#16	
#10	
#8	55.0
#4	65.0
3/8-in.	
1/2-in.	
3/4-in.	95.0
1-in.	100.0
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 4 Subgrade : Clayey Sand

Unbound	
Layer thickness (in)	24.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
7000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Clayey Sand
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	33

Sieve

Liquid Limit	37.0
Plasticity Index	18.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	112.9
Saturated hydraulic conductivity (ft/hr)	False	1.153e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	14.9

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	102.5522
bf	0.7198
cf	0.2545
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	47.0
#100	
#80	
#60	
#50	
#40	72.0
#30	
#20	
#16	
#10	
#8	
#4	98.0
3/8-in.	
1/2-in.	
3/4-in.	
1-in.	
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 5 Subgrade : A-6

Unbound	
Layer thickness (in)	Semi-infinite
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
14000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-6
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	33.0
Plasticity Index	16.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	107.9
Saturated hydraulic conductivity (ft/hr)	False	1.95e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	17.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	108.4091
bf	0.6801
cf	0.2161
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	63.2
#100	
#80	73.5
#60	
#50	
#40	82.4
#30	
#20	
#16	
#10	90.2
#8	
#4	93.5
3/8-in.	96.4
1/2-in.	97.4
3/4-in.	98.4
1-in.	99.0
1 1/2-in.	99.5
2-in.	99.8
2 1/2-in.	
3-in.	
3 1/2-in.	100.0

Calibration Coefficients

AC Fatigue

$$N_f = 0.00432 * C * \beta_{f1} k_1 \left(\frac{1}{\varepsilon_1}\right)^{k_2\beta_{f2}} \left(\frac{1}{E}\right)^{k_3\beta_{f3}}$$

$$C = 10^M$$

$$M = 4.84\left(\frac{V_b}{V_a + V_b} - 0.69\right)$$

k1: 0.007566
k2: 3.9492
k3: 1.281
Bf1: 130.3674
Bf2: 1
Bf3: 1.217799

AC Rutting

$$\frac{\varepsilon_p}{\varepsilon_r} = k_z \beta_{r1} 10^{k_1 T^{k_2 \beta_{r2}} N^{k_3 \beta_{r3}}}$$

$$k_z = (C_1 + C_2 * depth) * 0.328196^{depth}$$

$$C_1 = -0.1039 * H_\alpha^2 + 2.4868 * H_\alpha - 17.342$$

$$C_2 = 0.0172 * H_\alpha^2 - 1.7331 * H_\alpha + 27.428$$

Where:

$$H_{ac} = total\ AC\ thickness(in)$$

$\varepsilon_p = plastic\ strain\left(^{in}/_{in}\right)$
$\varepsilon_r = resilient\ strain\left(^{in}/_{in}\right)$
$T = layer\ temperature(^{\circ}F)$
$N = number\ of\ load\ repetitions$

AC Rutting Standard Deviation	0.1414 * Pow(RUT,0.25) + 0.001	
AC Layer	K1:-3.35412 K2:1.5606 K3:0.3791	Br1:6.7 Br2:1 Br3:1

Thermal Fracture

$$C_f = 400 * N\left(\frac{\log C / h_{ac}}{\sigma}\right)$$

$$\Delta C = (k * \beta t)^{n+1} * A * \Delta K^n$$

$$A = 10^{(4.389 - 2.52 * \log(E * \sigma_m * n))}$$

$C_f = observed\ amount\ of\ thermal\ cracking(ft/500ft)$
$k = refression\ coefficient\ determined\ through\ field\ calibration$
$N() = standard\ normal\ distribution\ evaluated\ at()$
$\sigma = standard\ deviation\ of\ the\ \log\ of\ the\ depth\ of\ cracks\ in\ the\ pavments$
$C = crack\ depth(in)$
$h_{ac} = thickness\ of\ asphalt\ layer(in)$
$\Delta C = Change\ in\ the\ crack\ depth\ due\ to\ a\ cooling\ cycle$
$\Delta K = Change\ in\ the\ stress\ intensity\ factor\ due\ to\ a\ cooling\ cycle$
$A, n = Fracture\ parameters\ for\ the\ asphalt\ mixture$
$E = mixture\ stiffness$
$\sigma_M = Undamaged\ mixture\ tensile\ strength$
$\beta_t = Calibration\ parameter$

Level 1 K: 6.3	Level 1 Standard Deviation: 0.1468 * THERMAL + 65.027
Level 2 K: 0.5	Level 2 Standard Deviation: 0.2841 * THERMAL + 55.462
Level 3 K: 6.3	Level 3 Standard Deviation: 0.3972 * THERMAL + 20.422

CSM Fatigue

$$N_f = 10^{\left(\frac{k_1 \beta_{c1} \left(\frac{\sigma_s}{M_r}\right)}{k_2 \beta_{c2}}\right)}$$

$N_f = number\ of\ repetitions\ to\ fatigue\ cracking$
$\sigma_s = Tensile\ stress(psi)$
$M_r = modulus\ of\ rupture(psi)$

k1: 1	k2: 1	Bc1: 0.75	Bc2:1.1

Subgrade Rutting

$$\delta_a(N) = \beta_{s_1} k_1 \varepsilon_v h \left(\frac{\varepsilon_0}{\varepsilon_r}\right) \left| e^{-\left(\frac{\rho}{N}\right)^{\beta}} \right|$$

$\delta_a = permanent\ deformation\ for\ the\ layer$
$N = number\ of\ repetitions$
$\varepsilon_v = average\ veritcal\ strain(in/in)$
$\varepsilon_0, \beta, \rho = material\ properties$
$\varepsilon_r = resilient\ strain(in/in)$

Granular		Fine	
k1: 2.03	Bs1: 0.22	k1: 1.35	Bs1: 0.37
Standard Deviation (BASERUT) 0.0104 * Pow(BASERUT,0.67) + 0.001		Standard Deviation (BASERUT) 0.0663 * Pow(SUBRUT,0.5) + 0.001	

AC Cracking

AC Top Down Cracking

$$FC_{top} = \left(\frac{C_4}{1 + e^{(C_1 - C_2 * log_{10}(Damage))}}\right) * 10.56$$

c1: 7	c2: 3.5	c3: 0	c4: 1000

AC Cracking Top Standard Deviation

200 + 2300/(1+exp(1.072-2.1654*LOG10 (TOP+0.0001)))

AC Bottom Up Cracking

$$FC = \left(\frac{6000}{1 + e^{(C_1 * C_1' + C_2 * C_2' log_{10}(D * 100))}}\right) * \left(\frac{1}{60}\right)$$

$$C_2' = -2.40874 - 39.748 * (1 + h_{ac})^{-2.856}$$

$$C_1' = -2 * C_2'$$

c1: 0.021	c2: 2.35	c3: 6000

AC Cracking Bottom Standard Deviation

1 + 15/(1+exp(-3.1472-4.1349*LOG10 (BOTTOM+0.0001)))

CSM Cracking

$$FC_{ctb} = C_1 + \frac{C_2}{1 + e^{C_3 - C_4(Damage)}}$$

C1: 0	C2: 75	C3: 5	C4: 3

CSM Standard Deviation

CTB*1

IRI Flexible Pavements

C1 - Rutting
C2 - Fatigue Crack
C3 - Transverse Crack
C4 - Site Factors

C1: 50	C2: 0.55	C3: 0.0111	C4: 0.02

Ramp 3 (Powers NB on) composite 76-28 SMA over 64-22 sx75

File Name: C:\Users\darwinME\Desktop\AFK\Powers and Research\HMA\Ramp 3 (Powers NB on) composite 76-28 SMA over 64-22 sx75.dgpx

Design Inputs

Design Life: 20 years
Design Type: FLEXIBLE

Base construction: May, 2020
Pavement construction: June, 2020
Traffic opening: September, 2020

Climate Data Sources (Lat/Lon): 38.812, -104.711

Design Structure

Layer type	Material Type	Thickness (in)
Flexible	R2 Level 1 SMA	2.0
Flexible	R2 Level 1 SX(75) PG 64-22	3.5 (Optimized)
NonStabilized	Class 6 ABC	10.0
Subgrade	Clayey Sand	24.0
Subgrade	A-6	Semi-infinite

Volumetric at Construction:	
Effective binder content (%)	12.2
Air voids (%)	4.7

Traffic

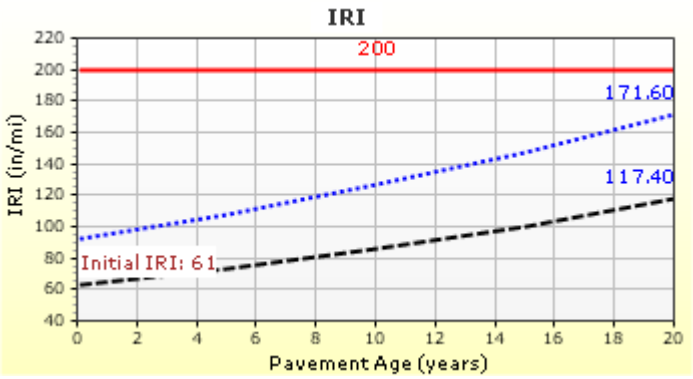
Age (year)	Heavy Trucks (cumulative)
2020 (initial)	282
2030 (10 years)	656,632
2040 (20 years)	1,406,750

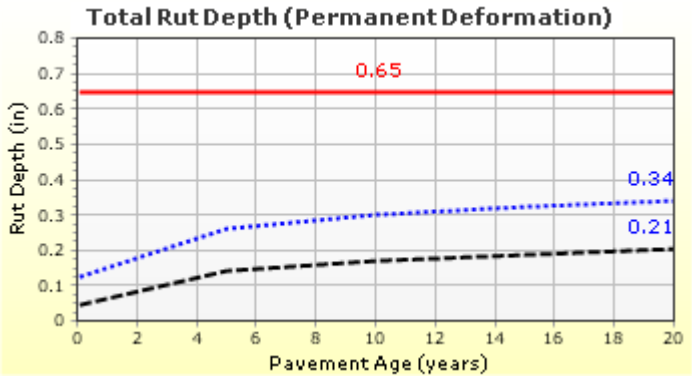
Design Outputs

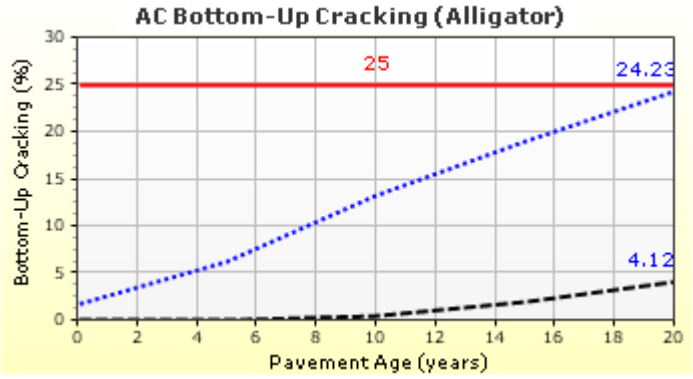
Distress Prediction Summary

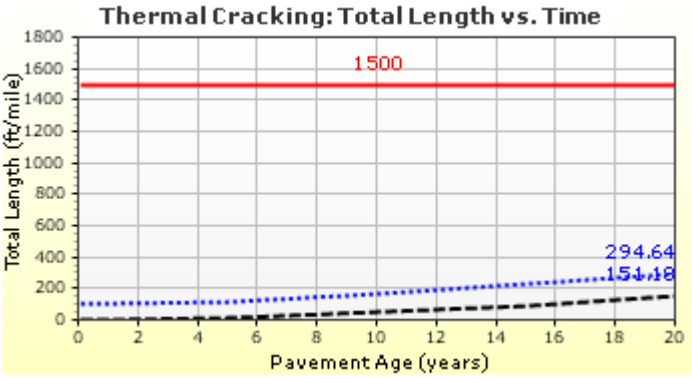
Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	200.00	171.56	95.00	99.39	Pass
Permanent deformation - total pavement (in)	0.65	0.34	95.00	100.00	Pass
AC bottom-up fatigue cracking (% lane area)	25.00	24.23	95.00	95.62	Pass
AC thermal cracking (ft/mile)	1500.00	294.64	95.00	100.00	Pass
AC top-down fatigue cracking (ft/mile)	2500.00	508.05	95.00	100.00	Pass
Permanent deformation - AC only (in)	0.50	0.23	95.00	100.00	Pass

Distress Charts





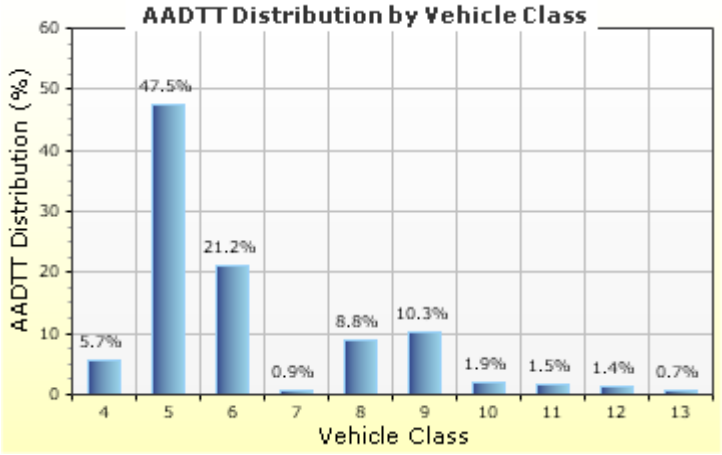


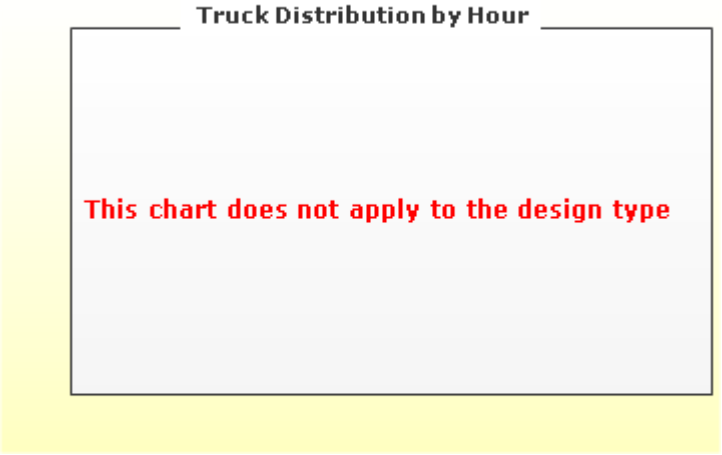


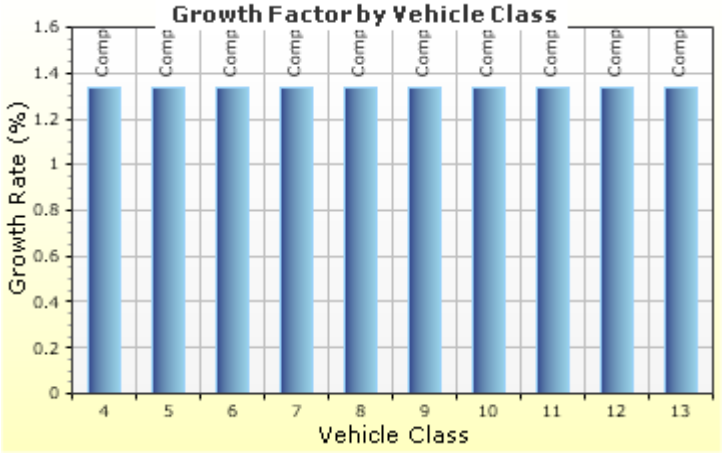
Traffic Inputs

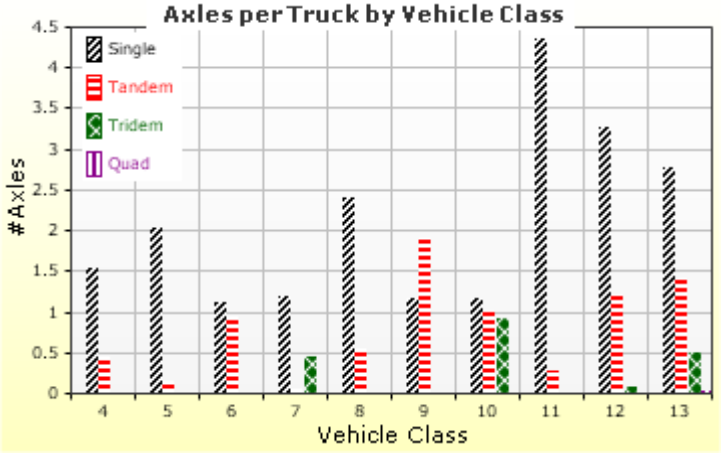
Graphical Representation of Traffic Inputs

Initial two-way AADTT:	282	Percent of trucks in design direction (%):	60.0
Number of lanes in design direction:	2	Percent of trucks in design lane (%):	100.0
		Operational speed (mph)	40.0

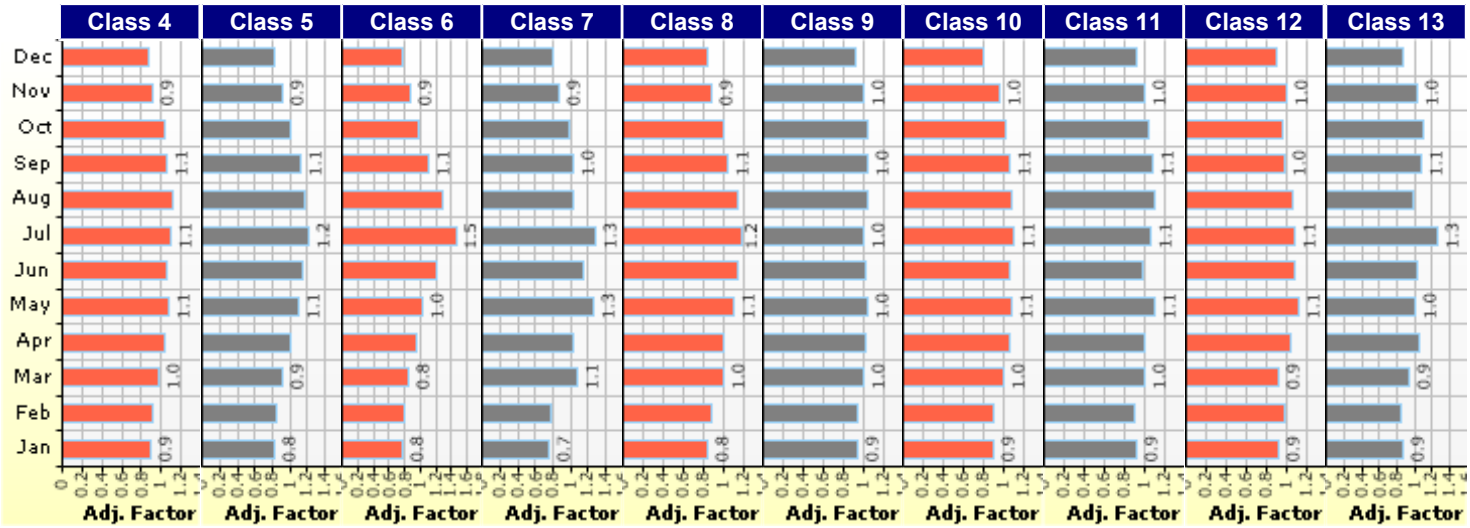








Traffic Volume Monthly Adjustment Factors



Tabular Representation of Traffic Inputs

Volume Monthly Adjustment Factors

Level 3: Default MAF

Month	Vehicle Class									
	4	5	6	7	8	9	10	11	12	13
January	0.9	0.8	0.8	0.7	0.8	0.9	0.9	0.9	0.9	0.9
February	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.8
March	1.0	0.9	0.8	1.1	1.0	1.0	1.0	1.0	0.9	0.9
April	1.0	1.0	0.9	1.0	1.0	1.0	1.1	1.0	1.0	1.1
May	1.1	1.1	1.0	1.3	1.1	1.0	1.1	1.1	1.1	1.0
June	1.1	1.1	1.2	1.1	1.1	1.0	1.1	1.0	1.1	1.0
July	1.1	1.2	1.5	1.3	1.2	1.0	1.1	1.1	1.1	1.3
August	1.1	1.2	1.3	1.0	1.1	1.0	1.1	1.1	1.1	1.0
September	1.1	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1
October	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.1
November	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0
December	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.9	0.9

Distributions by Vehicle Class

Truck Distribution by Hour does not apply

Vehicle Class	AADTT Distribution (%) (Level 3)	Growth Factor	
		Rate (%)	Function
Class 4	5.74%	1.34%	Compound
Class 5	47.46%	1.34%	Compound
Class 6	21.21%	1.34%	Compound
Class 7	0.94%	1.34%	Compound
Class 8	8.84%	1.34%	Compound
Class 9	10.31%	1.34%	Compound
Class 10	1.9%	1.34%	Compound
Class 11	1.51%	1.34%	Compound
Class 12	1.4%	1.34%	Compound
Class 13	0.69%	1.34%	Compound

Axle Configuration

Traffic Wander	
Mean wheel location (in)	18.0
Traffic wander standard deviation (in)	10.0
Design lane width (ft)	12.0

Axle Configuration	
Average axle width (ft)	8.5
Dual tire spacing (in)	12.0
Tire pressure (psi)	120.0

Average Axle Spacing	
Tandem axle spacing (in)	51.6
Tridem axle spacing (in)	49.2
Quad axle spacing (in)	49.2

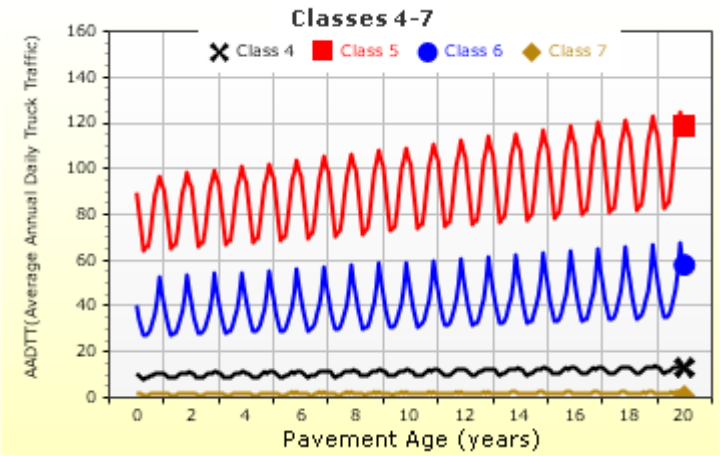
Wheelbase does not apply

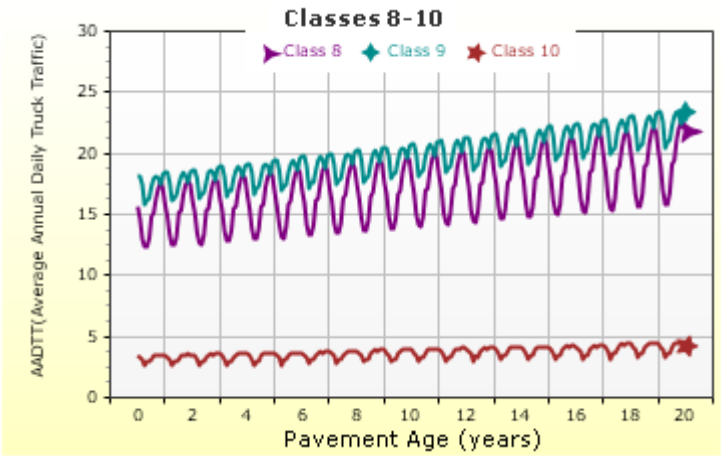
Number of Axles per Truck

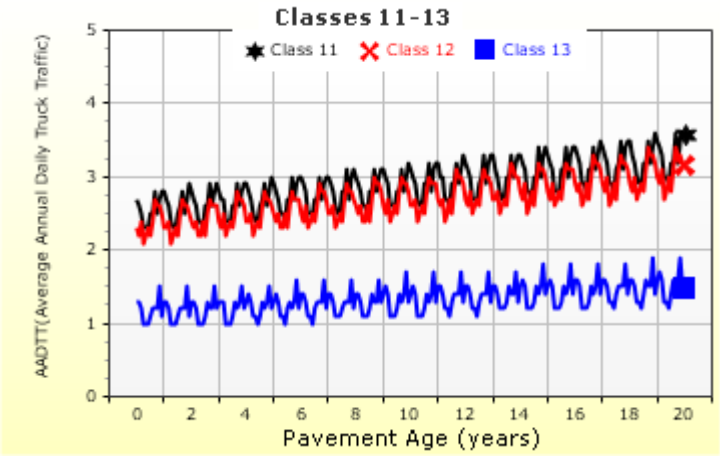
Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.53	0.45	0	0
Class 5	2.02	0.16	0.02	0
Class 6	1.12	0.94	0	0
Class 7	1.19	0.07	0.45	0.02
Class 8	2.41	0.56	0.02	0
Class 9	1.16	1.9	0.01	0
Class 10	1.15	1.01	0.93	0.02
Class 11	4.35	0.29	0.02	0
Class 12	3.27	1.22	0.09	0
Class 13	2.77	1.4	0.51	0.04

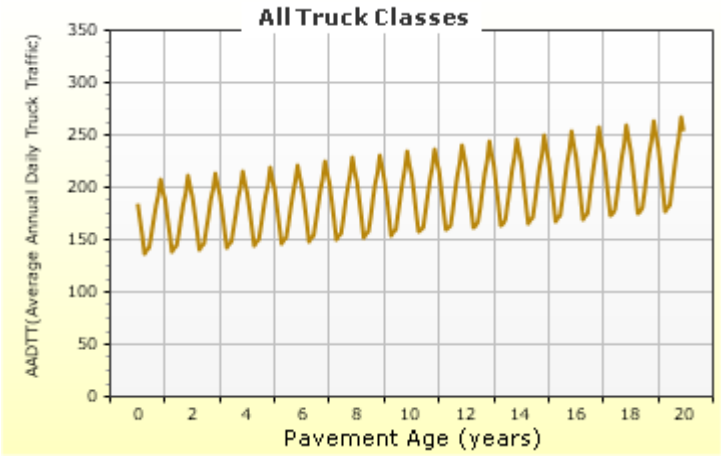
AADTT (Average Annual Daily Truck Traffic) Growth

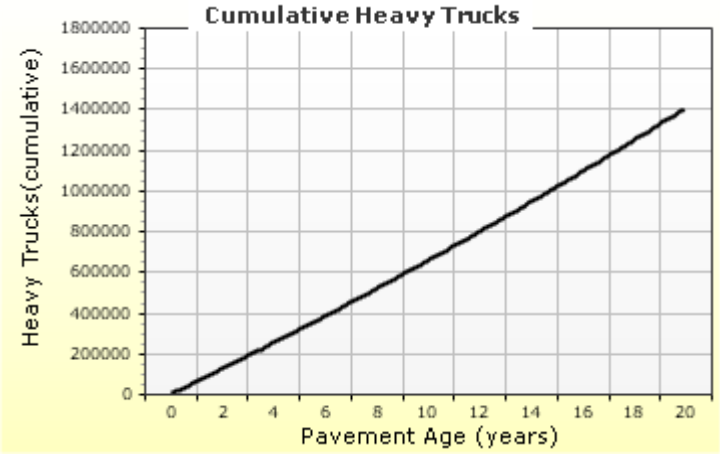
*** Traffic cap is not enforced**







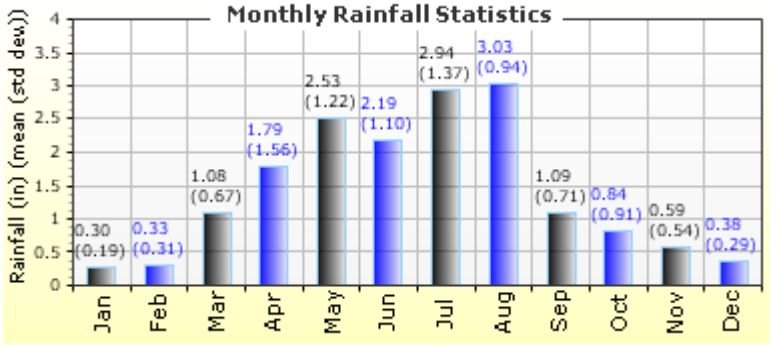




Climate Inputs

Climate Data Sources:

Climate Station Cities:	Location (lat lon elevation(ft))
COLORADO SPRINGS_	38.81200 -104.71100 6170

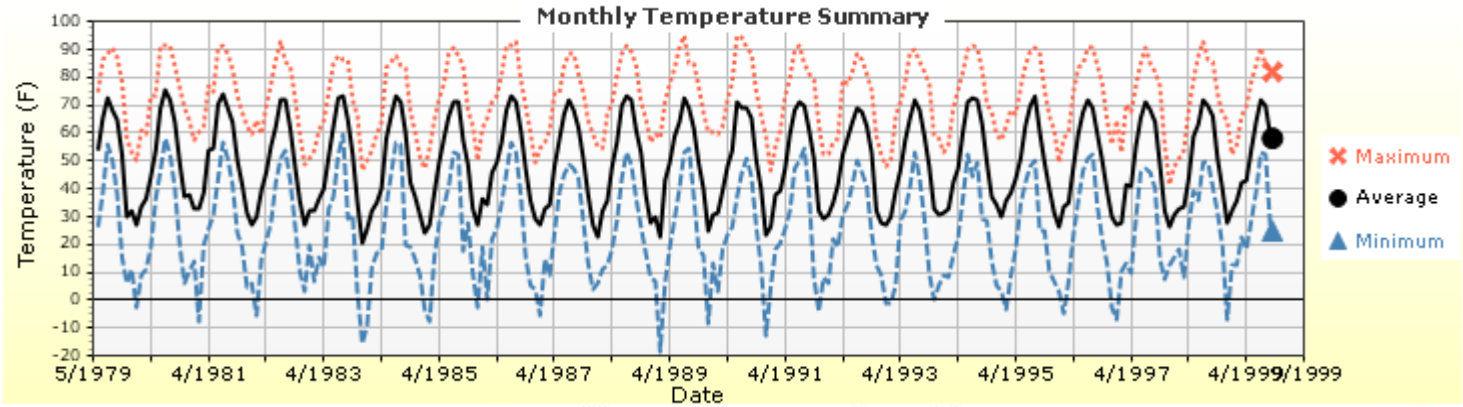


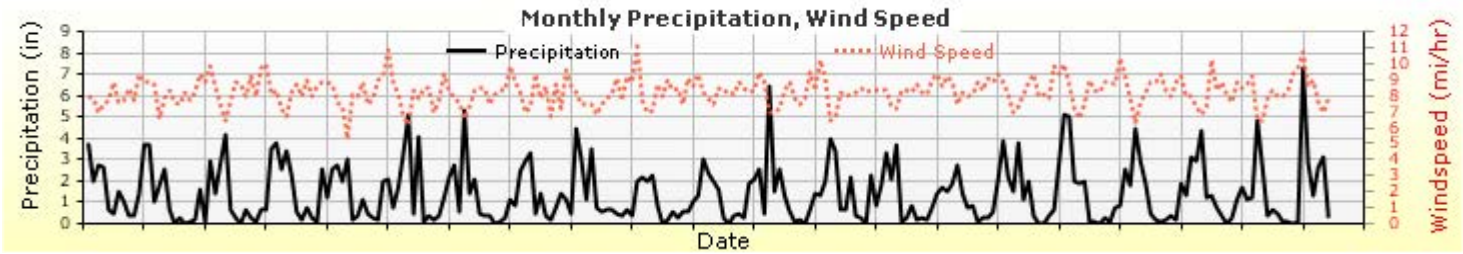
Annual Statistics:

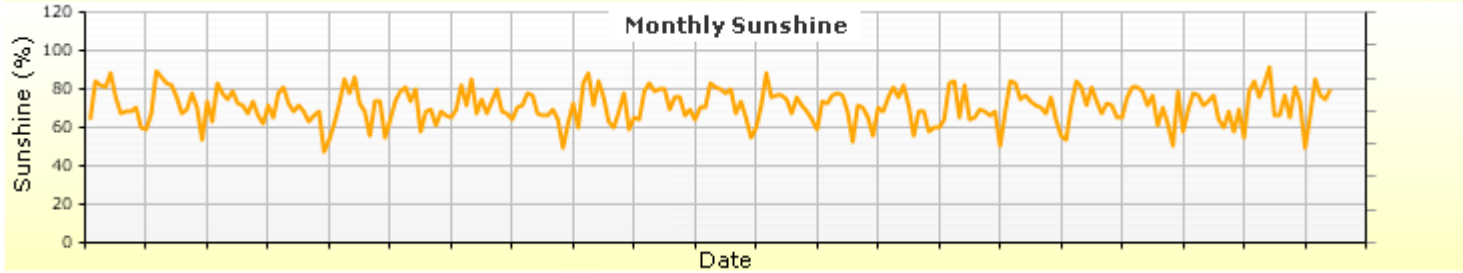
Mean annual air temperature (ºF)	49.11
Mean annual precipitation (in)	17.31
Freezing index (ºF - days)	555.60
Average annual number of freeze/thaw cycles:	83.33

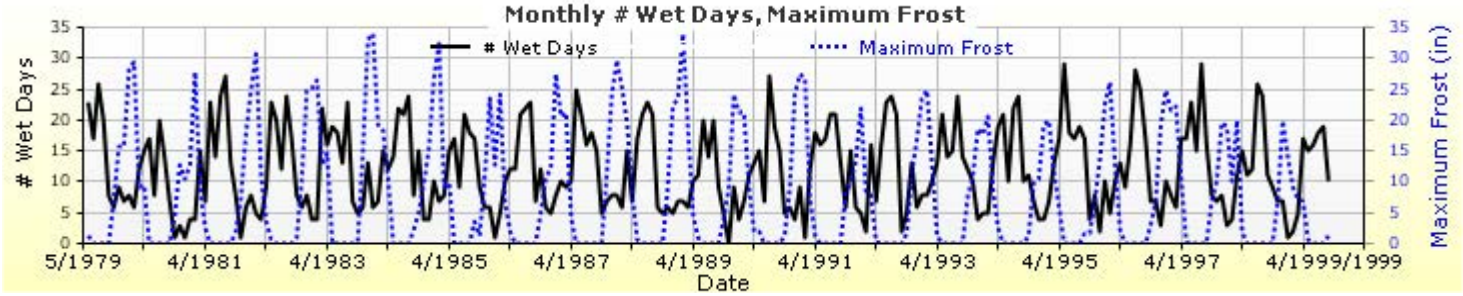
Water table depth (ft)	7.00

Monthly Climate Summary:

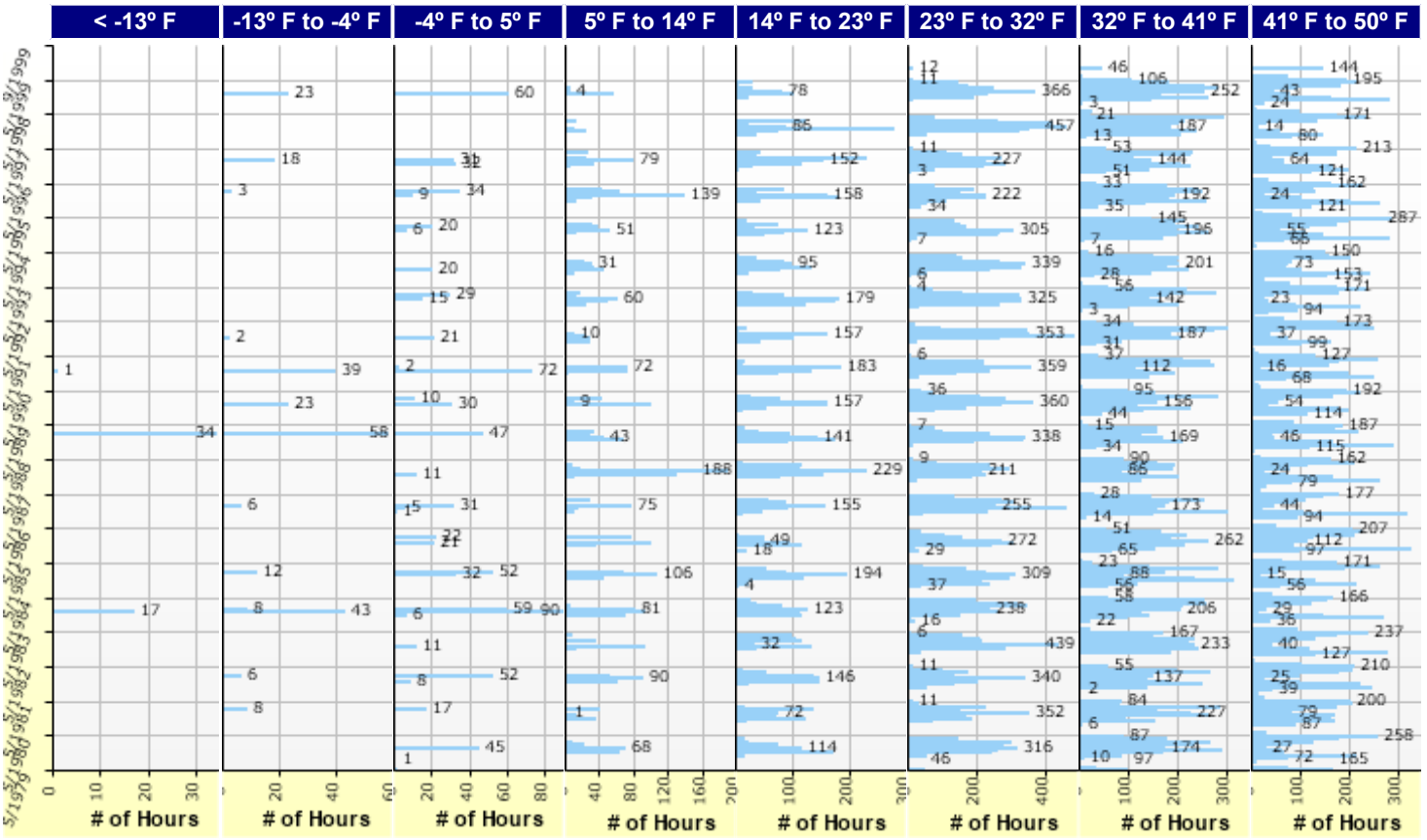


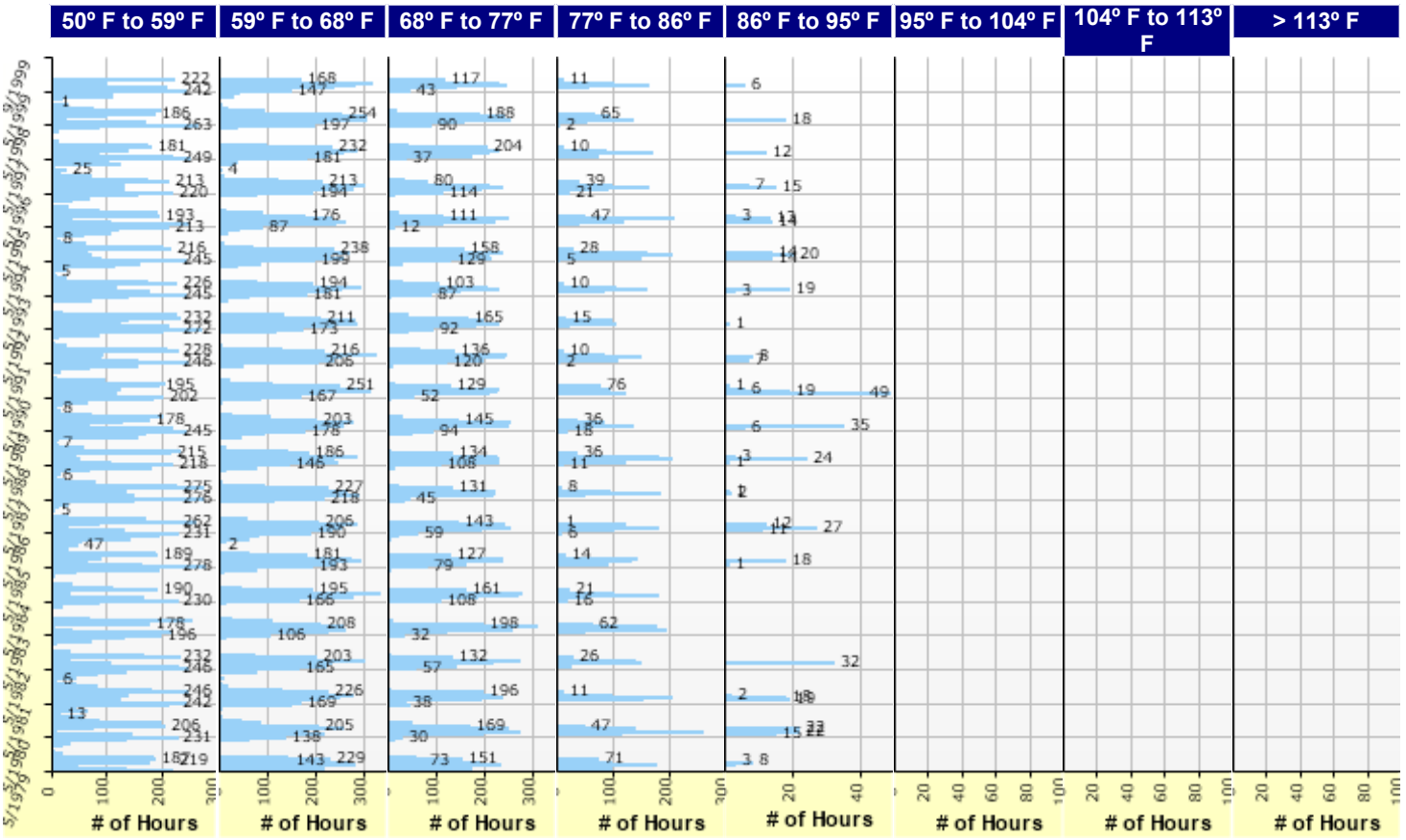






Hourly Air Temperature Distribution by Month:





Design Properties

HMA Design Properties

Use Multilayer Rutting Model	False
Using G* based model (not nationally calibrated)	False
Is NCHRP 1-37A HMA Rutting Model Coefficients	True
Endurance Limit	-
Use Reflective Cracking	True

Structure - ICM Properties	
AC surface shortwave absorptivity	0.85

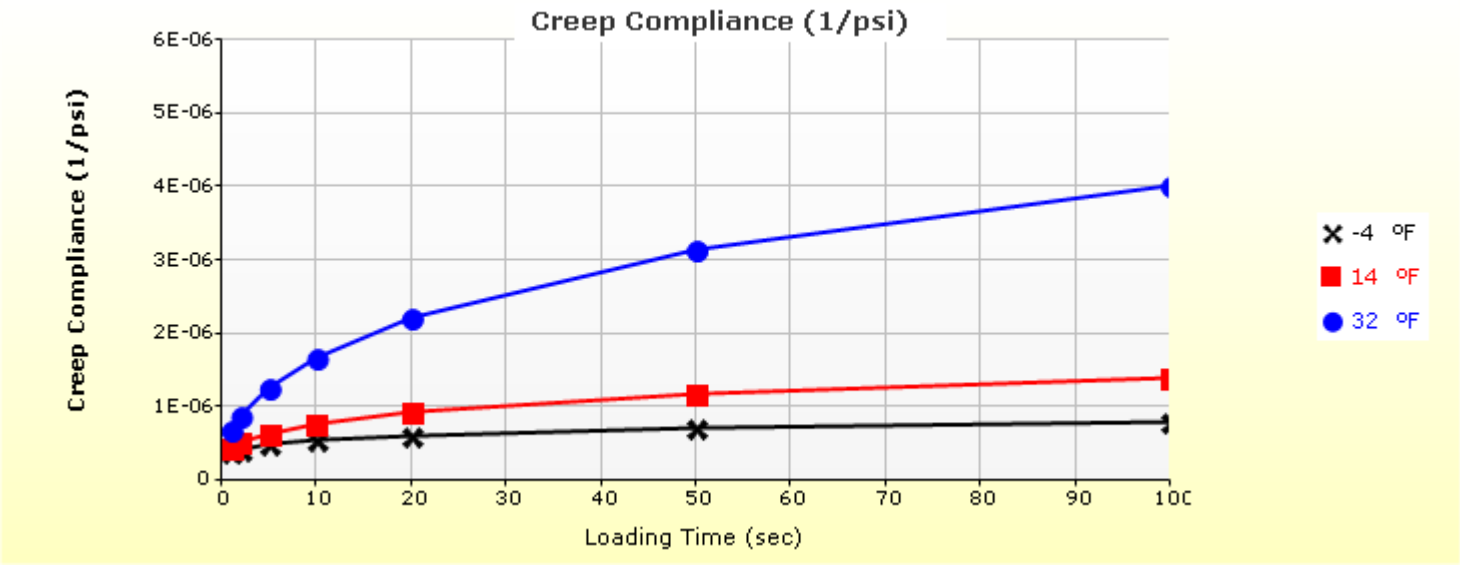
Layer Name	Layer Type	Interface Friction
Layer 1 Flexible : R2 Level 1 SMA	Flexible (1)	1.00
Layer 2 Flexible : R2 Level 1 SX (75) PG 64-22	Flexible (1)	1.00
Layer 3 Non-stabilized Base : Class 6 ABC	Non-stabilized Base (4)	1.00
Layer 4 Subgrade : Clayey Sand	Subgrade (5)	1.00
Layer 5 Subgrade : A-6	Subgrade (5)	-

Thermal Cracking (Input Level: 1)

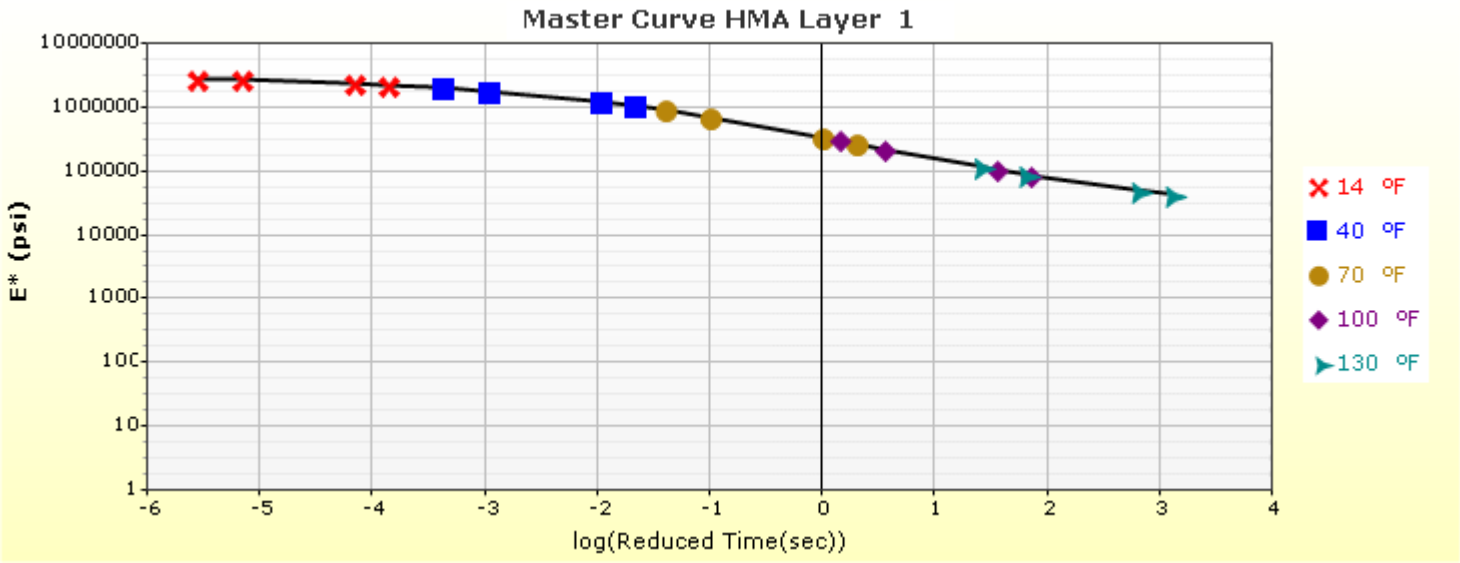
Indirect tensile strength at 14 ºF (psi)	515.00

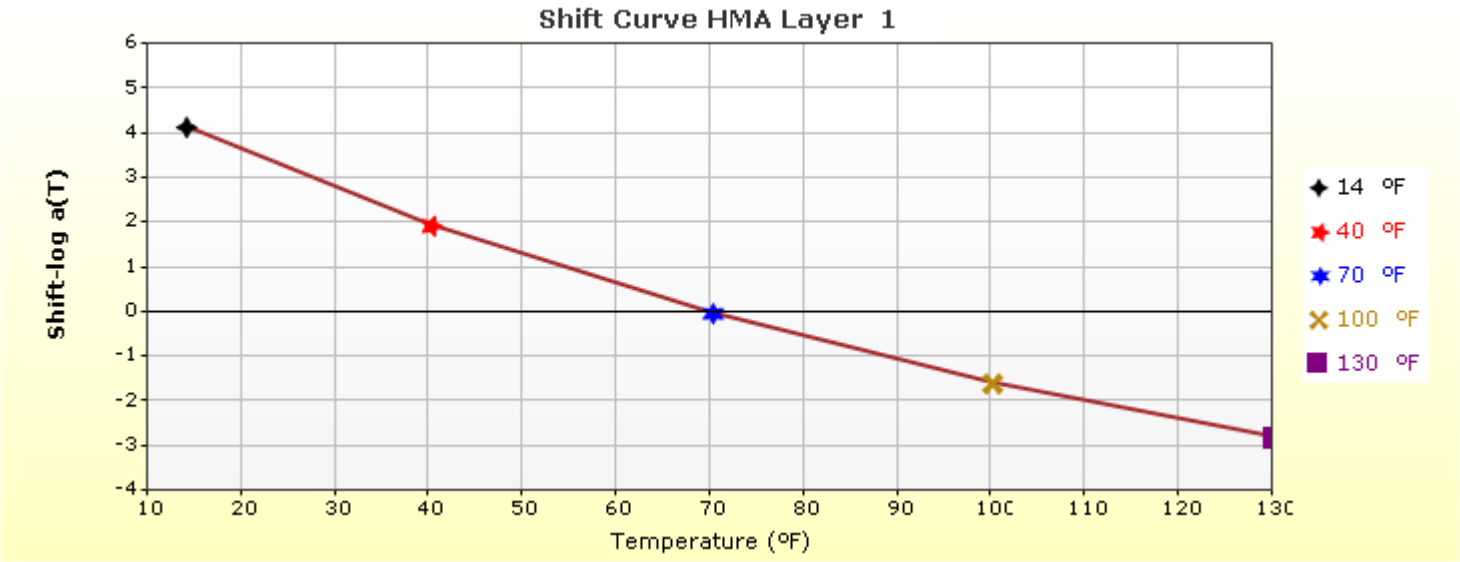
Thermal Contraction	
Is thermal contraction calculated?	True
Mix coefficient of thermal contraction (in/in/ºF)	-
Aggregate coefficient of thermal contraction (in/in/ºF)	5.0e-006
Voids in Mineral Aggregate (%)	16.9

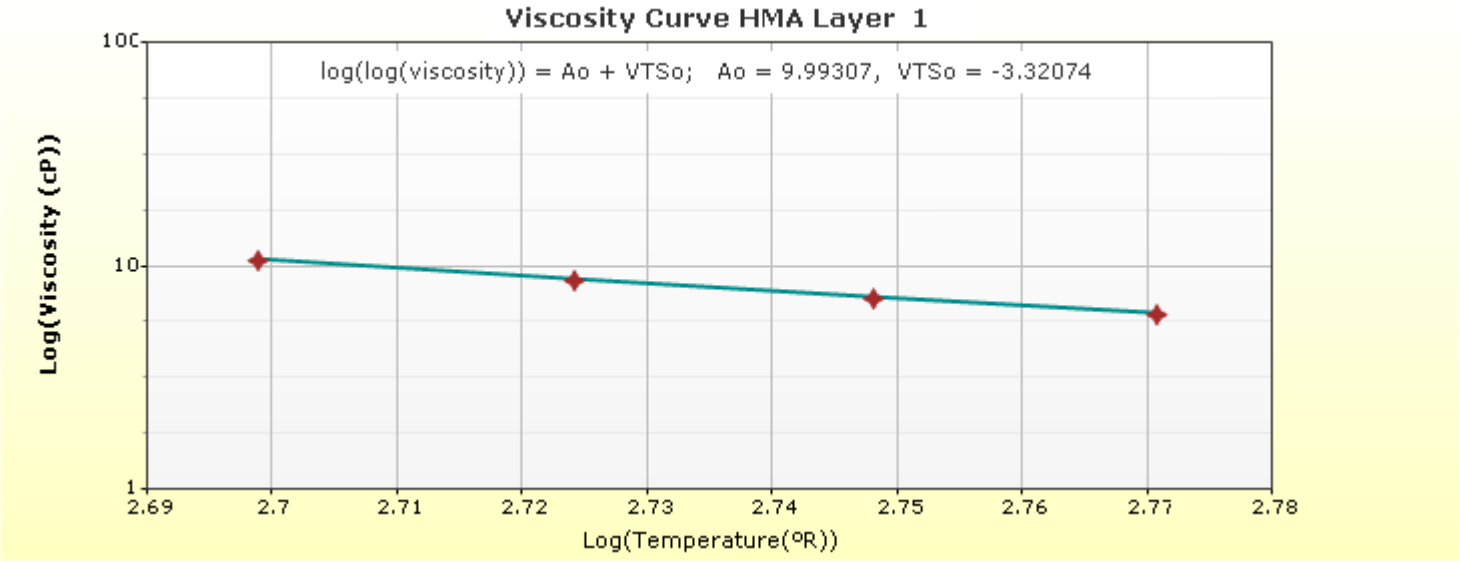
	Creep Compliance (1/psi)		
Loading time (sec)	-4 ºF	14 ºF	32 ºF
1	4.01e-007	4.45e-007	6.88e-007
2	4.28e-007	5.41e-007	8.96e-007
5	4.98e-007	6.37e-007	1.27e-006
10	5.51e-007	7.85e-007	1.69e-006
20	6.17e-007	9.33e-007	2.23e-006
50	7.19e-007	1.18e-006	3.14e-006
100	7.96e-007	1.39e-006	4.01e-006



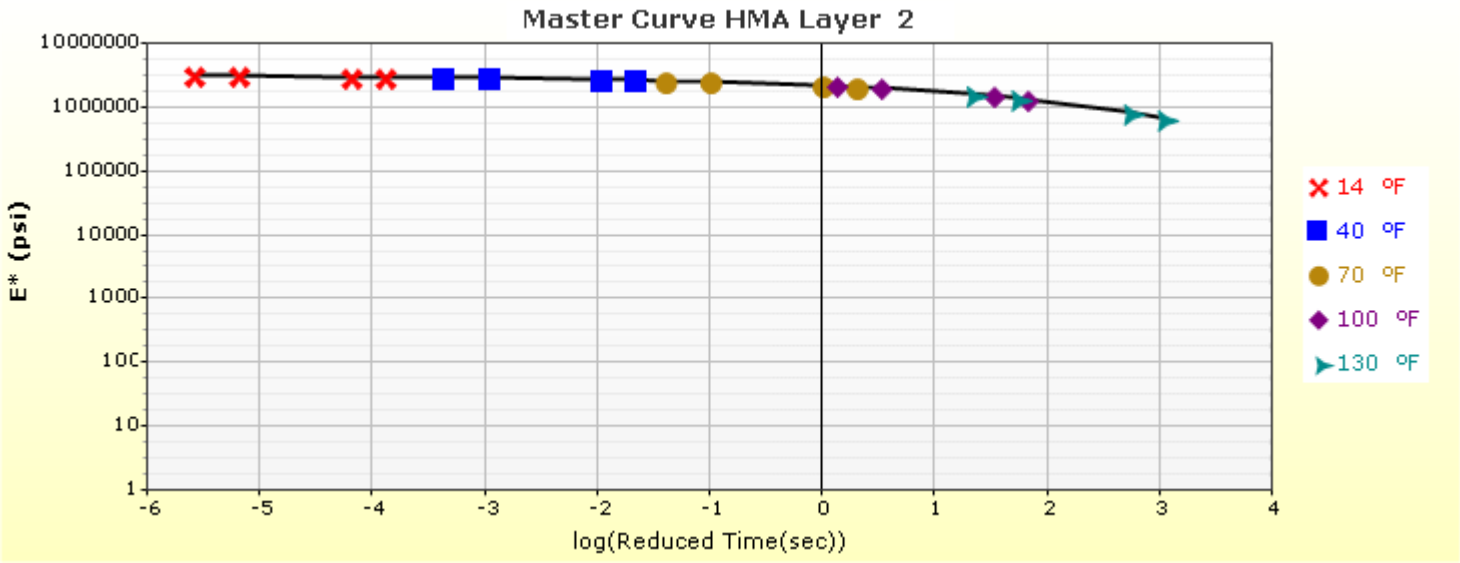
HMA Layer 1: Layer 1 Flexible : R2 Level 1 SMA

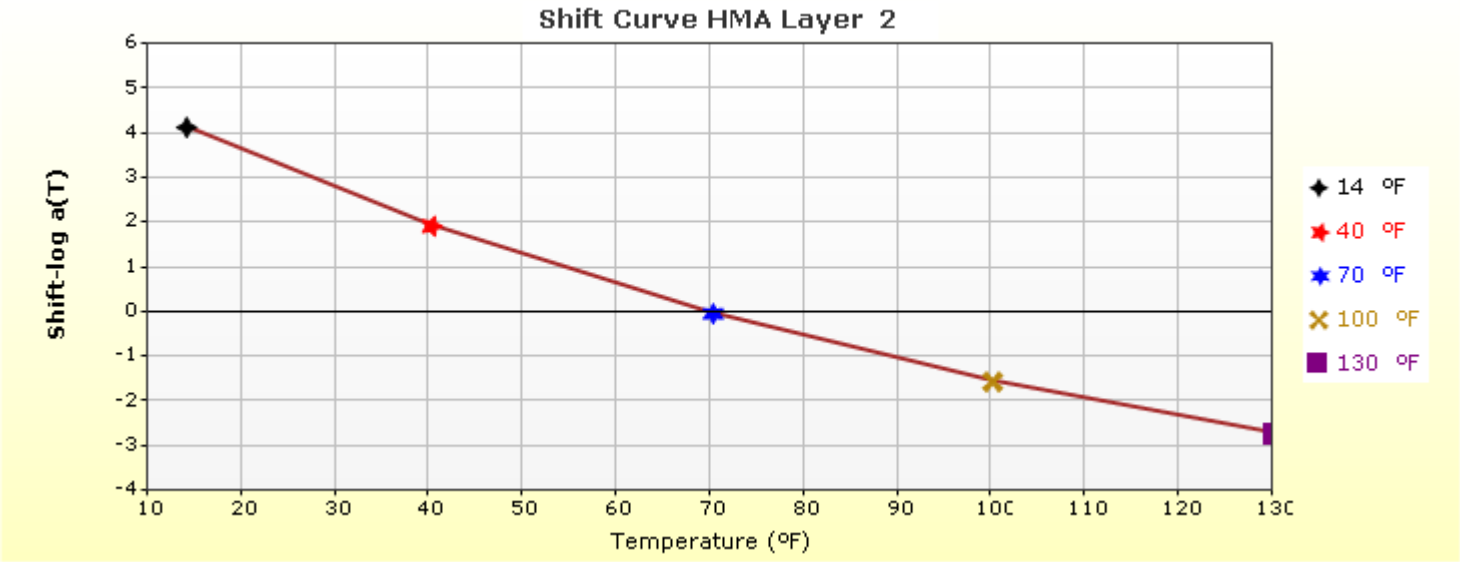


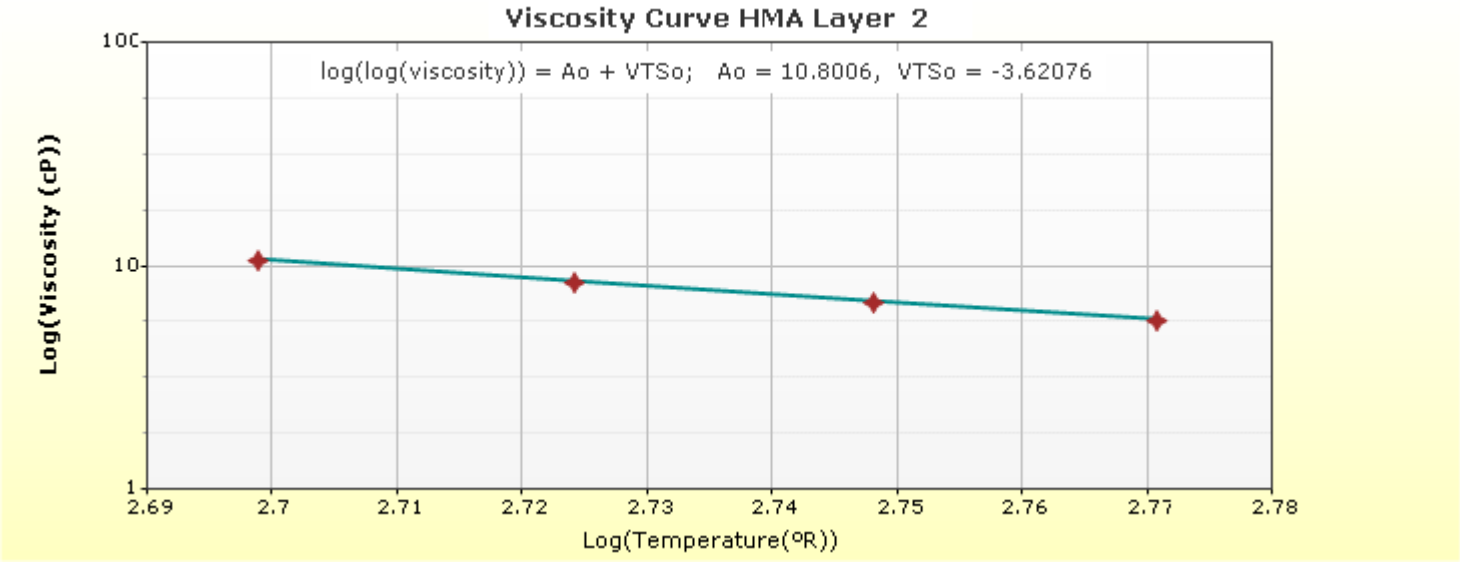




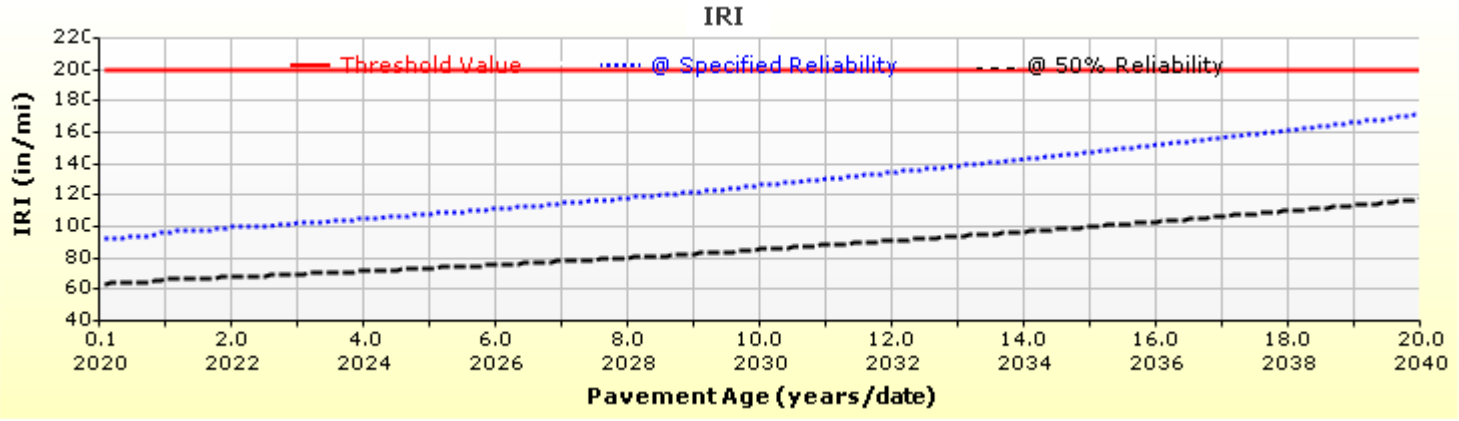
HMA Layer 2: Layer 2 Flexible : R2 Level 1 SX(75) PG 64-22

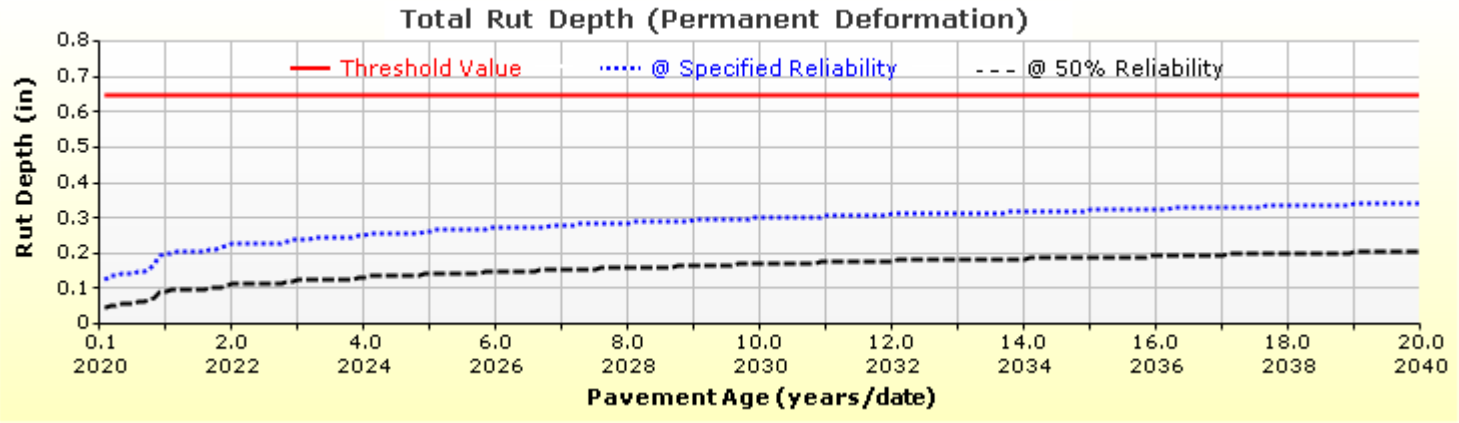


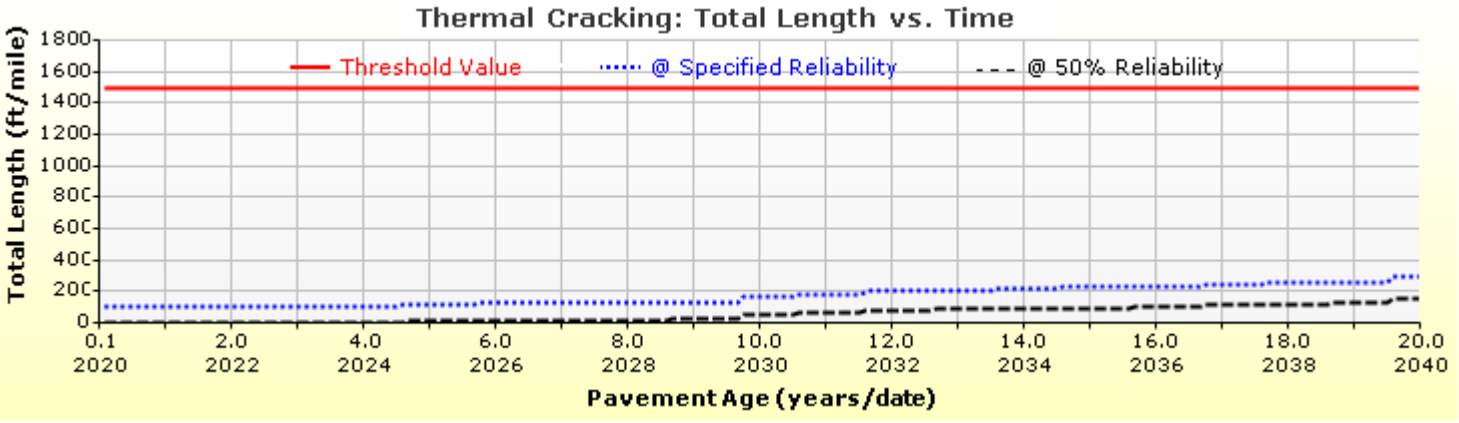


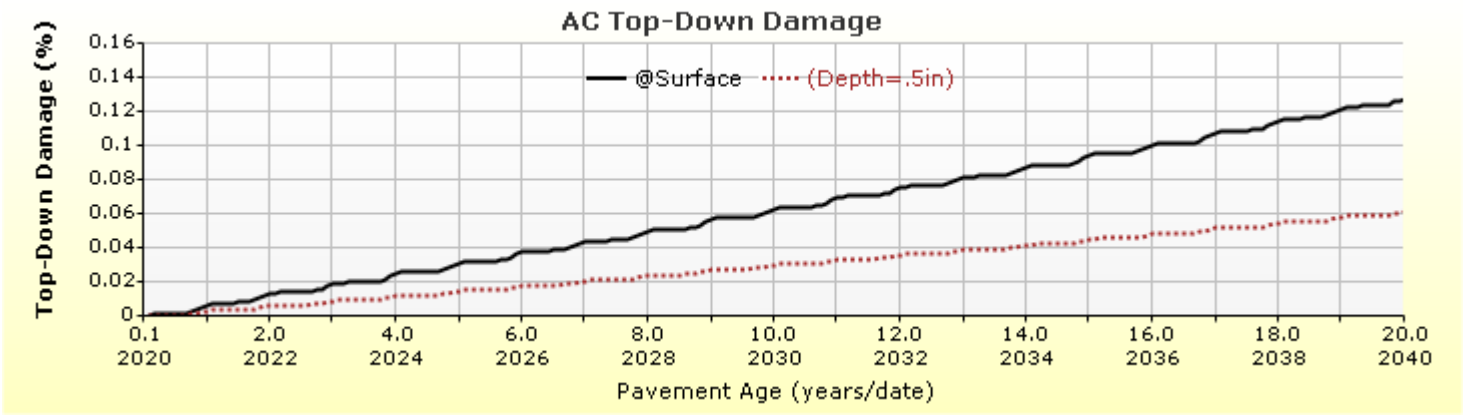


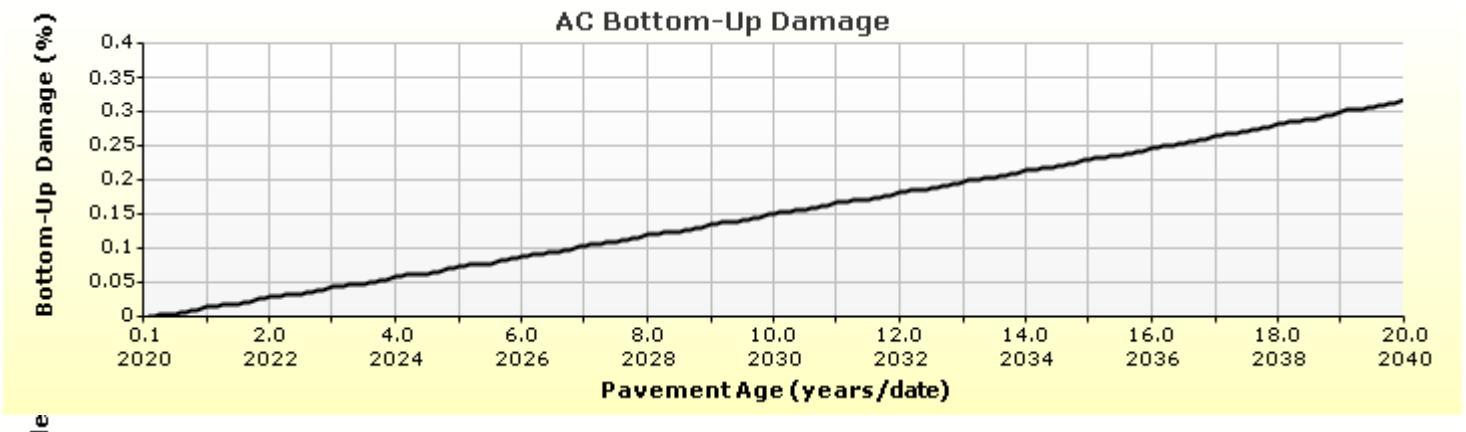
Analysis Output Charts

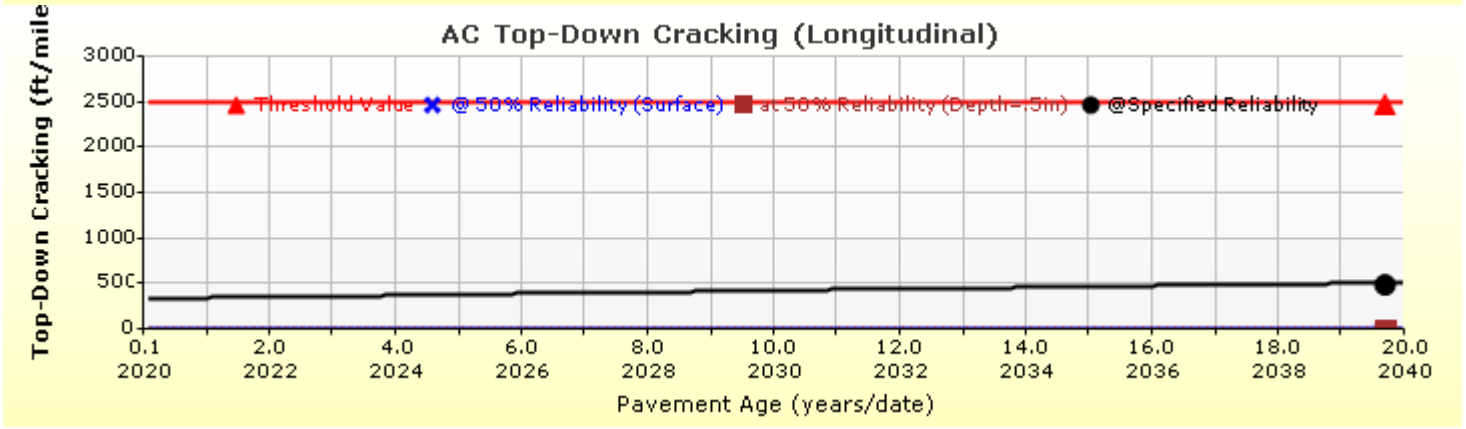


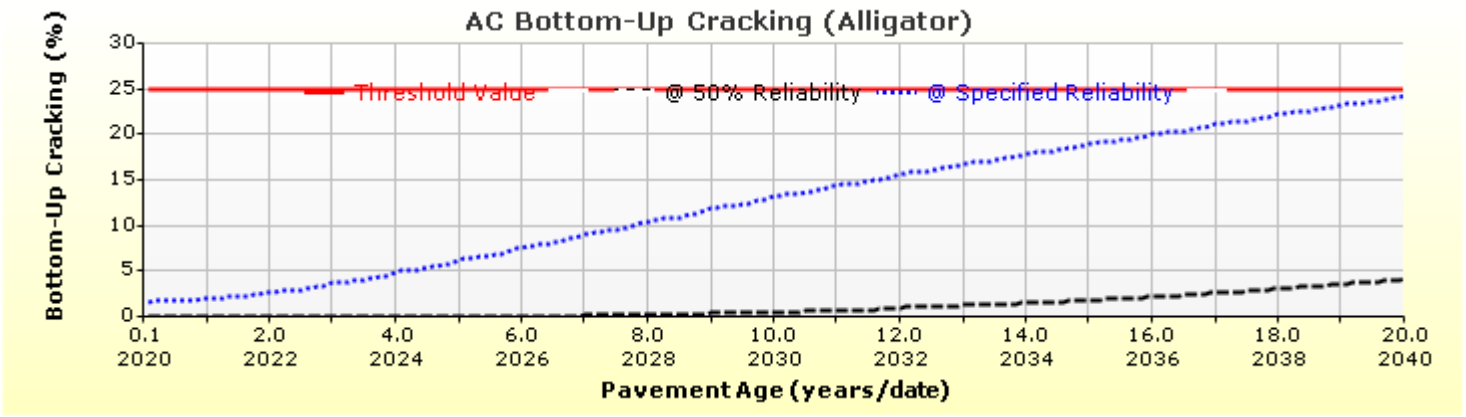


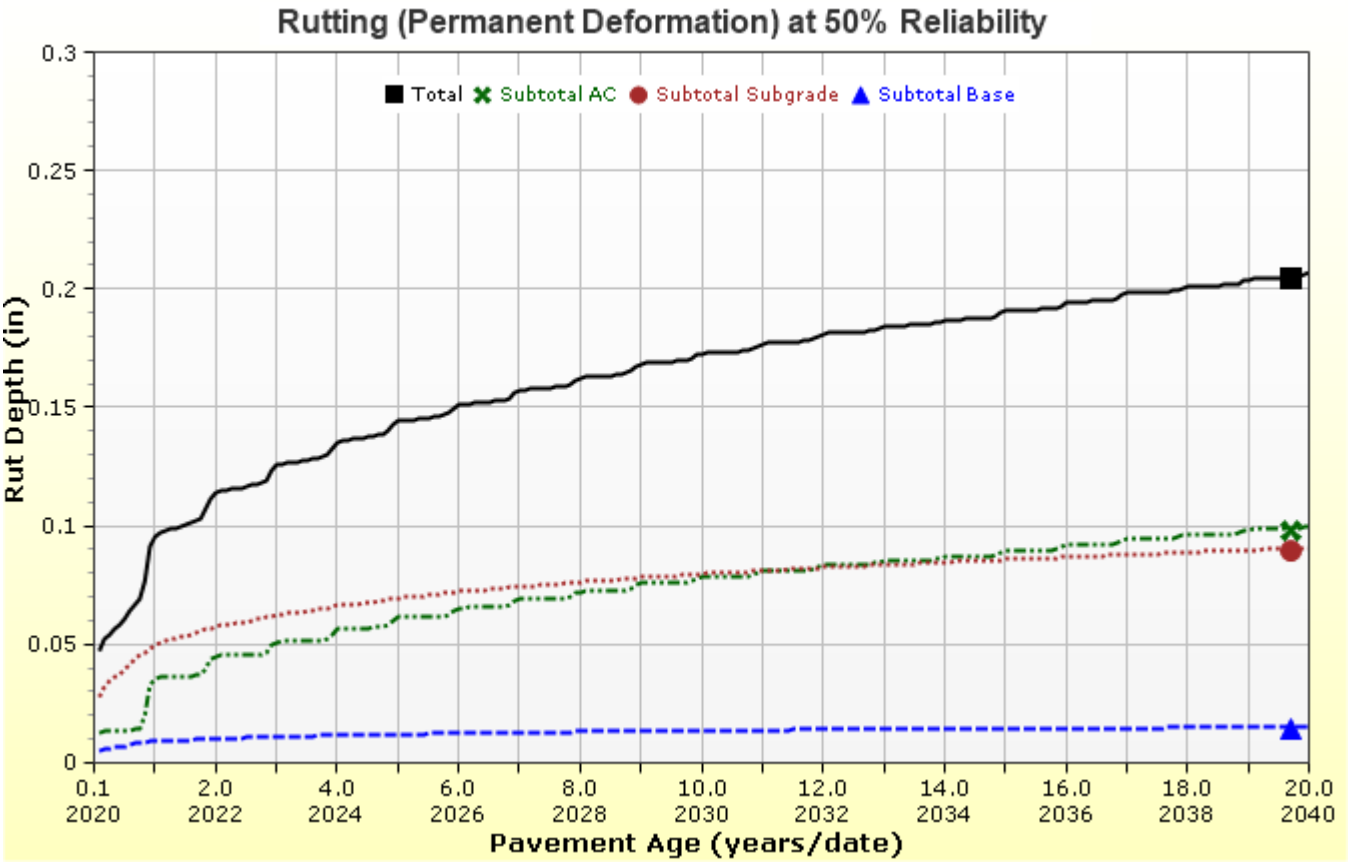


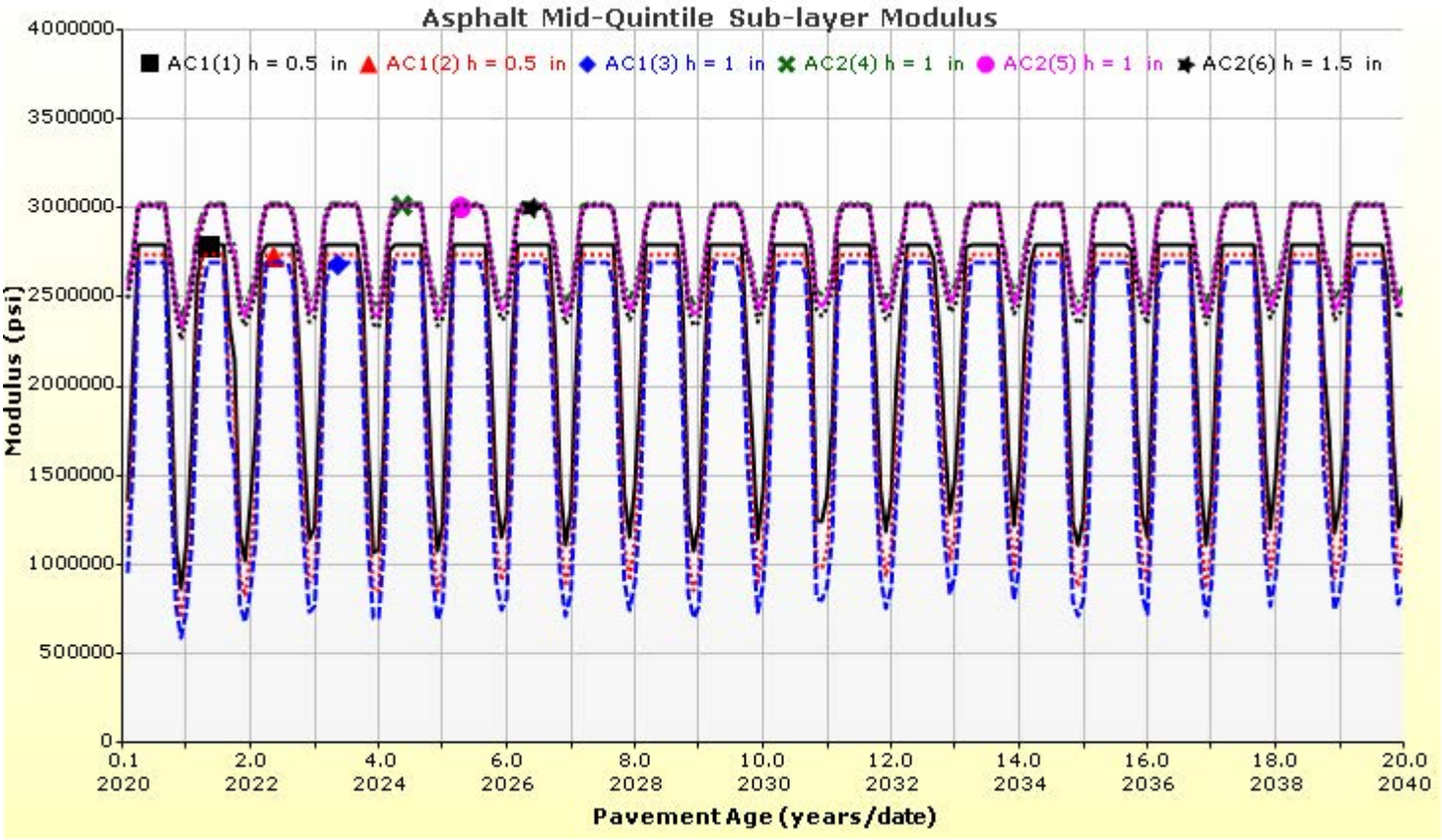

AC Top-Down Damage
Top-Down Damage (%)
@Surface
(Depth=.5in)
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)

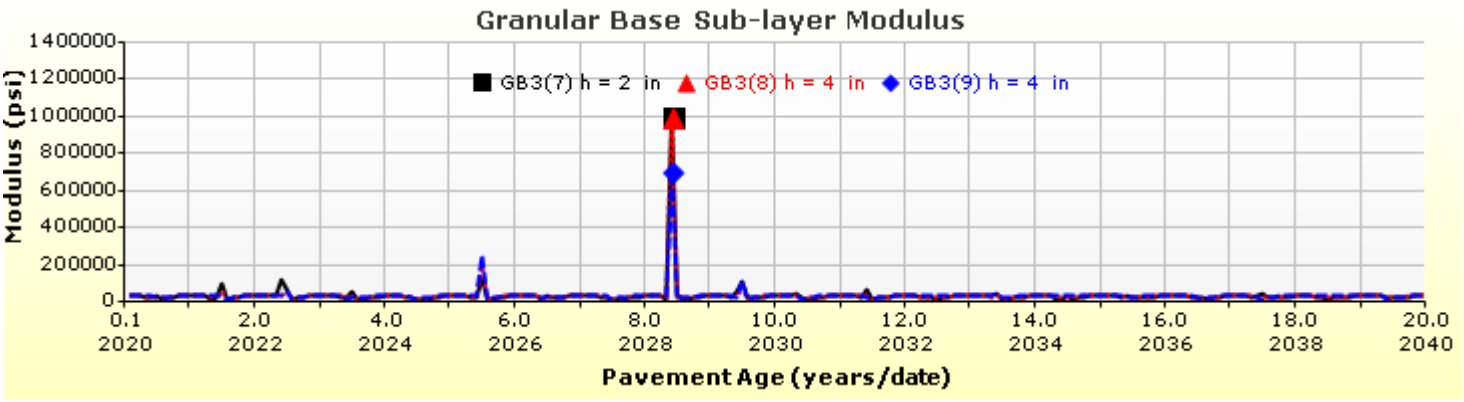

AC Bottom-Up Damage
Bottom-Up Damage (%)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)

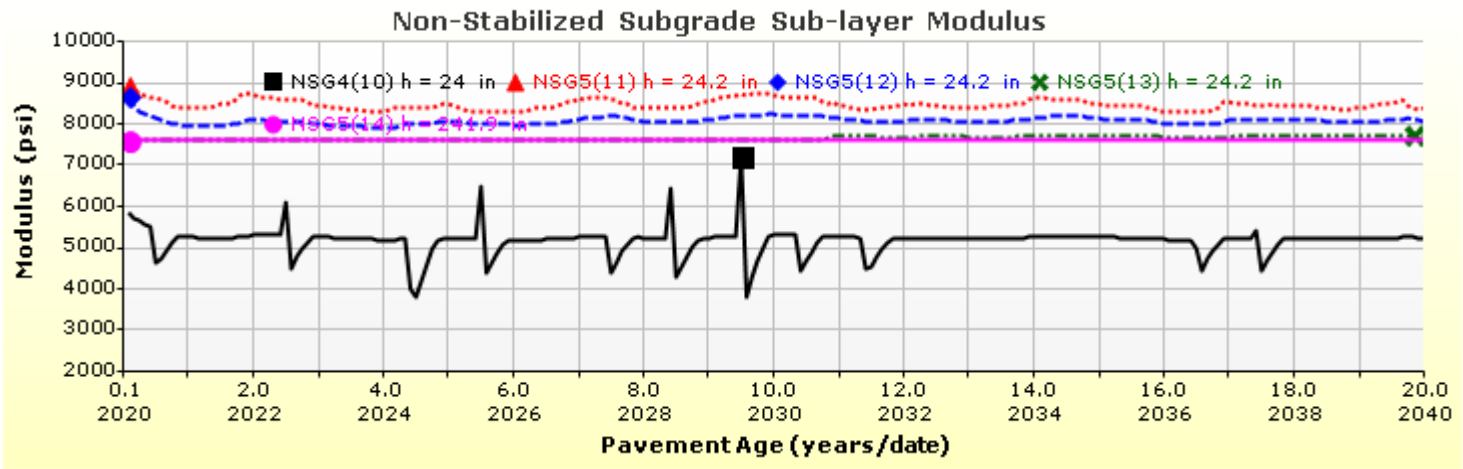

AC Top-Down Cracking (Longitudinal)
Top-Down Cracking (ft/mile
Threshold Value
@ 50% Reliability (Surface)
at 50% Reliability (Depth=.5in)
@Specified Reliability
3000
2500
2000
1500
1000
500
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)


AC Bottom-Up Cracking (Alligator)
Bottom-Up Cracking (%)
Threshold Value
@ 50% Reliability
@ Specified Reliability
30
25
20
15
10
5
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)


Rutting (Permanent Deformation) at 50% Reliability
Total
Subtotal AC
Subtotal Subgrade
Subtotal Base
Rut Depth (in)
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1
2020
2.0
2022
4.0
2024
6.0
2026
8.0
2028
10.0
2030
12.0
2032
14.0
2034
16.0
2036
18.0
2038
20.0
2040
Pavement Age (years/date)


Asphalt Mid-Quintile Sub-layer Modulus
AC1(1) h = 0.5 in
AC1(2) h = 0.5 in
AC1(3) h = 1 in
AC2(4) h = 1 in
AC2(5) h = 1 in
AC2(6) h = 1.5 in
Modulus (psi)
Pavement Age (years/date)


Granular Base Sub-layer Modulus
GB3(7) h = 2 in
GB3(8) h = 4 in
GB3(9) h = 4 in
Modulus (psi)
Pavement Age (years/date)


Non-Stabilized Subgrade Sub-layer Modulus
NSG4(10) h = 24 in
NSG5(11) h = 24.2 in
NSG5(12) h = 24.2 in
NSG5(13) h = 24.2 in
NSG5(14) h = 241.9 in
Modulus (psi)
Pavement Age (years/date)

Layer Information

Layer 1 Flexible : R2 Level 1 SMA

Asphalt		
Thickness (in)	2.0	
Unit weight (pcf)	145.0	
Poisson's ratio	Is Calculated?	True
	Ratio	-
	Parameter A	-1.63
	Parameter B	3.84E-06

Asphalt Dynamic Modulus (Input Level: 1)

T (ºF)	0.5 Hz	1 Hz	10 Hz	25 Hz
14	1875400	2299039	2624309	2726019
40	846575	1309050	1799540	1983379
70	230100	427271	753122	918360
100	76296	127286	231357	296468
130	40803	55308	84229	102895

Asphalt Binder

Temperature (ºF)	Binder Gstar (Pa)	Phase angle (deg)
158	1233	64
168.8	673	66
179.6	383	68

General Info

Name	Value
Reference temperature (ºF)	70
Effective binder content (%)	12.2
Air voids (%)	4.7
Thermal conductivity (BTU/hr-ft-ºF)	0.67
Heat capacity (BTU/lb-ºF)	0.23

Identifiers

Field	Value
Display name/identifier	R2 Level 1 SMA
Description of object	Mix ID # FS1919
Author	CDOT
Date Created	4/3/2013 12:00:00 AM
Approver	CDOT
Date approved	4/3/2013 12:00:00 AM
State	Colorado
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	SMA
User defined field 2	
User defined field 3	
Revision Number	0

Layer 2 Flexible : R2 Level 1 SX(75) PG 64-22

Asphalt		
Thickness (in)	3.5	
Unit weight (pcf)	140.5	
Poisson's ratio	Is Calculated?	True
	Ratio	-
	Parameter A	-1.63
	Parameter B	3.84E-06

Asphalt Dynamic Modulus (Input Level: 1)

T (ºF)	0.5 Hz	1 Hz	10 Hz	25 Hz
14	2910500	2947100	3034800	3058600
40	2620500	2695700	2882400	2934800
70	2057300	2190500	2549800	2658300
100	1334300	1500400	2017600	2195500
130	697600	836500	1365200	1584000

Asphalt Binder

Temperature (ºF)	Binder Gstar (Pa)	Phase angle (deg)
168.8	451	85
147.2	1857	81.6
158	889	83.1

General Info

Name	Value
Reference temperature (ºF)	70
Effective binder content (%)	11.8
Air voids (%)	6.9
Thermal conductivity (BTU/hr-ft-ºF)	0.67
Heat capacity (BTU/lb-ºF)	0.23

Identifiers

Field	Value
Display name/identifier	R2 Level 1 SX(75) PG 64-22
Description of object	Mix ID # 19127A
Author	CDOT
Date Created	4/3/2013 12:00:00 AM
Approver	CDOT
Date approved	4/3/2013 12:00:00 AM
State	Colorado
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	SX
User defined field 2	
User defined field 3	
Revision Number	0

Layer 3 Non-stabilized Base : Class 6 ABC

Unbound	
Layer thickness (in)	10.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
22000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Class 6 ABC
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	20

Sieve

Liquid Limit	30.0
Plasticity Index	6.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	125.8
Saturated hydraulic conductivity (ft/hr)	False	2.257e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	8.3

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	12.2329
bf	1.1153
cf	0.8619
hr	244.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	12.0
#100	
#80	
#60	
#50	
#40	
#30	
#20	
#16	
#10	
#8	55.0
#4	65.0
3/8-in.	
1/2-in.	
3/4-in.	95.0
1-in.	100.0
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 4 Subgrade : Clayey Sand

Unbound	
Layer thickness (in)	24.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
7000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Clayey Sand
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	33

Sieve

Liquid Limit	37.0
Plasticity Index	18.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	112.9
Saturated hydraulic conductivity (ft/hr)	False	1.153e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	14.9

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	102.5522
bf	0.7198
cf	0.2545
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	47.0
#100	
#80	
#60	
#50	
#40	72.0
#30	
#20	
#16	
#10	
#8	
#4	98.0
3/8-in.	
1/2-in.	
3/4-in.	
1-in.	
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 5 Subgrade : A-6

Unbound	
Layer thickness (in)	Semi-infinite
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
14000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-6
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	33.0
Plasticity Index	16.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	107.9
Saturated hydraulic conductivity (ft/hr)	False	1.95e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	17.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	108.4091
bf	0.6801
cf	0.2161
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	63.2
#100	
#80	73.5
#60	
#50	
#40	82.4
#30	
#20	
#16	
#10	90.2
#8	
#4	93.5
3/8-in.	96.4
1/2-in.	97.4
3/4-in.	98.4
1-in.	99.0
1 1/2-in.	99.5
2-in.	99.8
2 1/2-in.	
3-in.	
3 1/2-in.	100.0

Calibration Coefficients

AC Fatigue

$$N_f = 0.00432 * C * \beta_{f1} k_1 \left(\frac{1}{\varepsilon_1}\right)^{k_2\beta_{f2}} \left(\frac{1}{E}\right)^{k_3\beta_{f3}}$$

$$C = 10^M$$

$$M = 4.84\left(\frac{V_b}{V_a + V_b} - 0.69\right)$$

k1: 0.007566
k2: 3.9492
k3: 1.281
Bf1: 130.3674
Bf2: 1
Bf3: 1.217799

AC Rutting

$$\frac{\varepsilon_p}{\varepsilon_r} = k_z \beta_{r1} 10^{k_1} T^{k_2\beta_{r2}} N^{k_3 B_{r3}}$$

$$k_z = (C_1 + C_2 * depth) * 0.328196^{depth}$$

$$C_1 = -0.1039 * H_\alpha^2 + 2.4868 * H_\alpha - 17.342$$

$$C_2 = 0.0172 * H_\alpha^2 - 1.7331 * H_\alpha + 27.428$$

Where:

$$H_{ac} = total\ AC\ thickness(in)$$

$\varepsilon_p = plastic\ strain\left({}^{in}/_{in}\right)$
$\varepsilon_r = resilient\ strain\left({}^{in}/_{in}\right)$
$T = layer\ temperature(^{\circ}F)$
$N = number\ of\ load\ repetitions$

AC Rutting Standard Deviation	0.1414 * Pow(RUT,0.25) + 0.001	
AC Layer	K1:-3.35412 K2:1.5606 K3:0.3791	Br1:6.7 Br2:1 Br3:1

Thermal Fracture

$$C_f = 400 * N\left(\frac{\log C / h_{ac}}{\sigma}\right)$$

$$\Delta C = (k * \beta t)^{n+1} * A * \Delta K^n$$

$$A = 10^{(4.389 - 2.52 * \log(E * \sigma_m * n))}$$

$C_f = observed\ amount\ of\ thermal\ cracking(ft/500ft)$
$k = refression\ coefficient\ determined\ through\ field\ calibration$
$N() = standard\ normal\ distribution\ evaluated\ at()$
$\sigma = standard\ deviation\ of\ the\ \log\ of\ the\ depth\ of\ cracks\ in\ the\ pavments$
$C = crack\ depth(in)$
$h_{ac} = thickness\ of\ asphalt\ layer(in)$
$\Delta C = Change\ in\ the\ crack\ depth\ due\ to\ a\ cooling\ cycle$
$\Delta K = Change\ in\ the\ stress\ intensity\ factor\ due\ to\ a\ cooling\ cycle$
$A, n = Fracture\ parameters\ for\ the\ asphalt\ mixture$
$E = mixture\ stiffness$
$\sigma_M = Undamaged\ mixture\ tensile\ strength$
$\beta_t = Calibration\ parameter$

Level 1 K: 6.3	Level 1 Standard Deviation: 0.1468 * THERMAL + 65.027
Level 2 K: 0.5	Level 2 Standard Deviation: 0.2841 * THERMAL + 55.462
Level 3 K: 6.3	Level 3 Standard Deviation: 0.3972 * THERMAL + 20.422

CSM Fatigue

$$N_f = 10^{\left(\frac{k_1 \beta_{c1} \left(\frac{\sigma_s}{M_r}\right)}{k_2 \beta_{c2}}\right)}$$

$N_f = number\ of\ repetitions\ to\ fatigue\ cracking$
$\sigma_s = Tensile\ stress(psi)$
$M_r = modulus\ of\ rupture(psi)$

k1: 1	k2: 1	Bc1: 0.75	Bc2:1.1

Subgrade Rutting

$$\delta_a(N) = \beta_{s_1} k_1 \varepsilon_v h \left(\frac{\varepsilon_0}{\varepsilon_r}\right) \left| e^{-\left(\frac{\rho}{N}\right)^{\beta}} \right|$$

$\delta_a = permanent\ deformation\ for\ the\ layer$
$N = number\ of\ repetitions$
$\varepsilon_v = average\ veritcal\ strain(in/in)$
$\varepsilon_0, \beta, \rho = material\ properties$
$\varepsilon_r = resilient\ strain(in/in)$

Granular		Fine	
k1: 2.03	Bs1: 0.22	k1: 1.35	Bs1: 0.37
Standard Deviation (BASERUT) 0.0104 * Pow(BASERUT,0.67) + 0.001		Standard Deviation (BASERUT) 0.0663 * Pow(SUBRUT,0.5) + 0.001	

AC Cracking

AC Top Down Cracking

$$FC_{top} = \left(\frac{C_4}{1 + e^{(C_1 - C_2 * log_{10}(Damage))}}\right) * 10.56$$

c1: 7	c2: 3.5	c3: 0	c4: 1000

AC Cracking Top Standard Deviation

200 + 2300/(1+exp(1.072-2.1654*LOG10 (TOP+0.0001)))

AC Bottom Up Cracking

$$FC = \left(\frac{6000}{1 + e^{(C_1 * C_1' + C_2 * C_2' log_{10}(D * 100))}}\right) * \left(\frac{1}{60}\right)$$

$$C_2' = -2.40874 - 39.748 * (1 + h_{ac})^{-2.856}$$

$$C_1' = -2 * C_2'$$

c1: 0.021	c2: 2.35	c3: 6000

AC Cracking Bottom Standard Deviation

1 + 15/(1+exp(-3.1472-4.1349*LOG10 (BOTTOM+0.0001)))

CSM Cracking

$$FC_{ctb} = C_1 + \frac{C_2}{1 + e^{C_3 - C_4(Damage)}}$$

C1: 0	C2: 75	C3: 5	C4: 3

CSM Standard Deviation

CTB*1

IRI Flexible Pavements

C1 - Rutting
C2 - Fatigue Crack
C3 - Transverse Crack
C4 - Site Factors

C1: 50	C2: 0.55	C3: 0.0111	C4: 0.02

Ramp 4 (Powers NB off) composite 76-28 SMA over 64-22 sx75

File Name: C:\Users\darwinME\Desktop\AFK\Powers and Research\HMA\Ramp 4 (Powers NB off) composite 76-28 SMA over 64-22 sx75.dgpx

Design Inputs

Design Life: 20 years
Design Type: FLEXIBLE

Base construction: May, 2020
Pavement construction: June, 2020
Traffic opening: September, 2020

Climate Data Sources (Lat/Lon): 38.812, -104.711

Design Structure

Layer type	Material Type	Thickness (in)
Flexible	R2 Level 1 SMA	2.0
Flexible	R2 Level 1 SX(75) PG 64-22	3.5 (Optimized)
NonStabilized	Class 6 ABC	10.0
Subgrade	Clayey Sand	24.0
Subgrade	A-6	Semi-infinite

Volumetric at Construction:	
Effective binder content (%)	12.2
Air voids (%)	4.7

Traffic

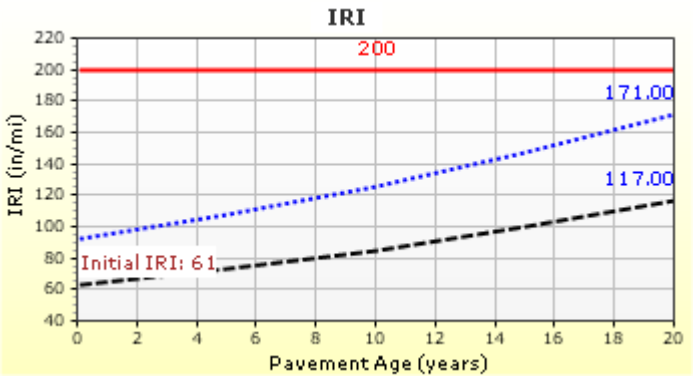
Age (year)	Heavy Trucks (cumulative)
2020 (initial)	189
2030 (10 years)	479,444
2040 (20 years)	1,137,040

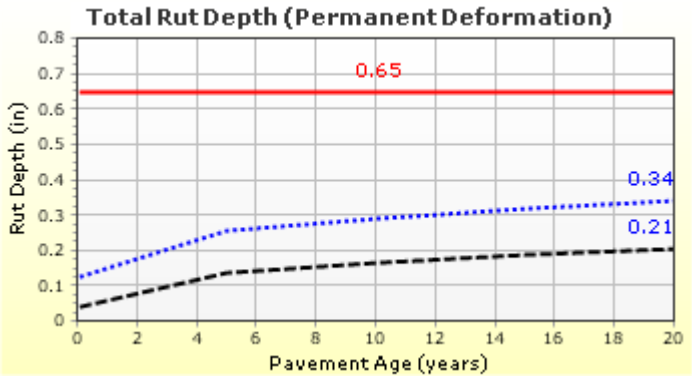
Design Outputs

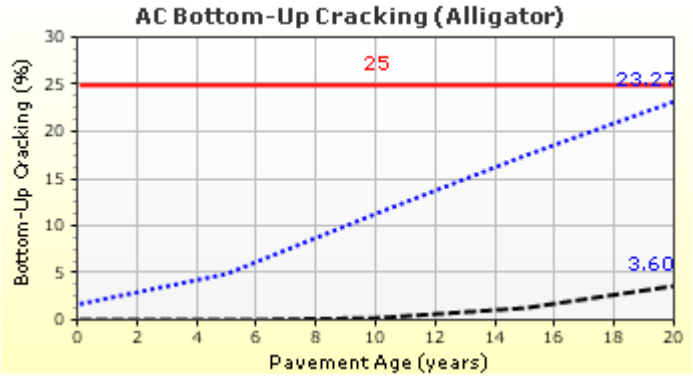
Distress Prediction Summary

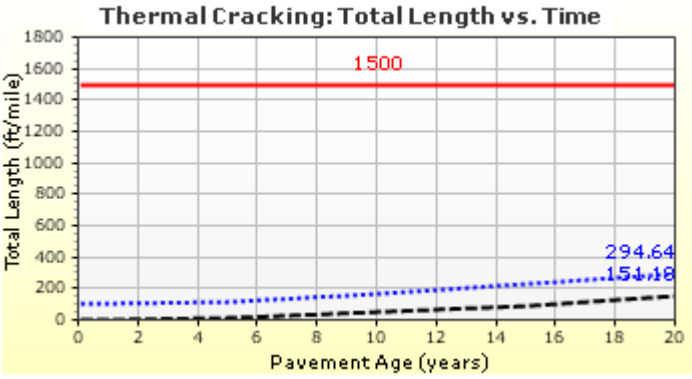
Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	200.00	171.04	95.00	99.42	Pass
Permanent deformation - total pavement (in)	0.65	0.34	95.00	100.00	Pass
AC bottom-up fatigue cracking (% lane area)	25.00	23.27	95.00	96.32	Pass
AC thermal cracking (ft/mile)	1500.00	294.64	95.00	100.00	Pass
AC top-down fatigue cracking (ft/mile)	2500.00	515.55	95.00	100.00	Pass
Permanent deformation - AC only (in)	0.50	0.23	95.00	100.00	Pass

Distress Charts





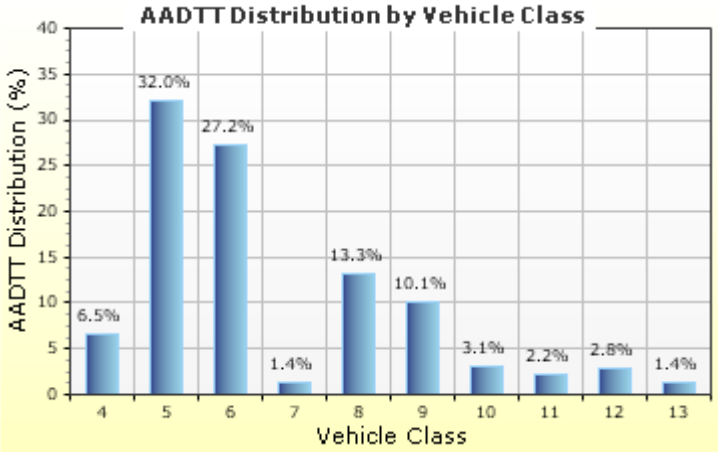


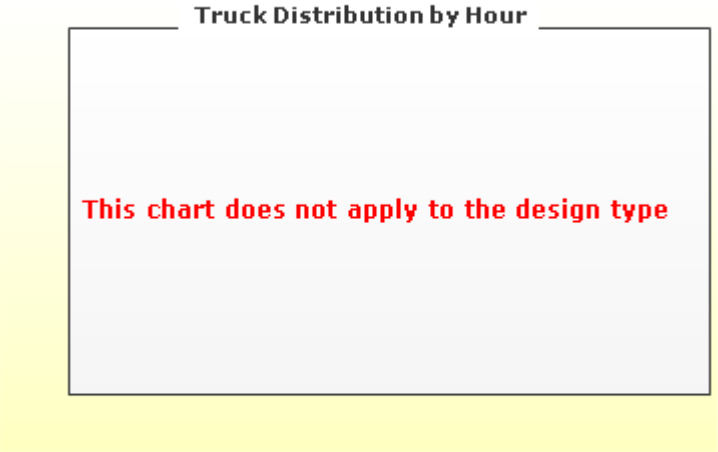


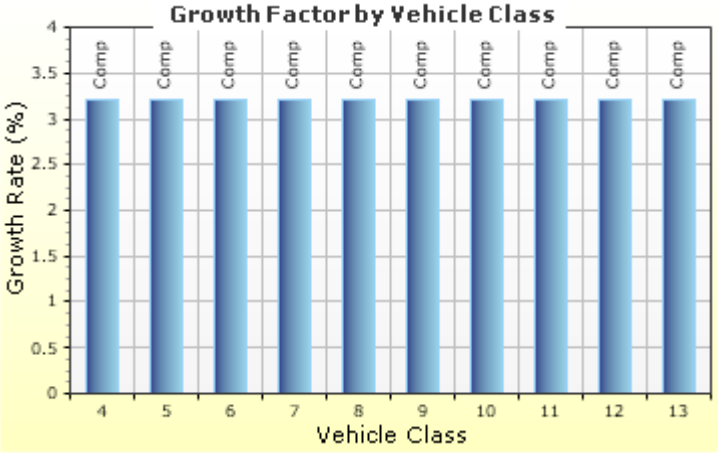
Traffic Inputs

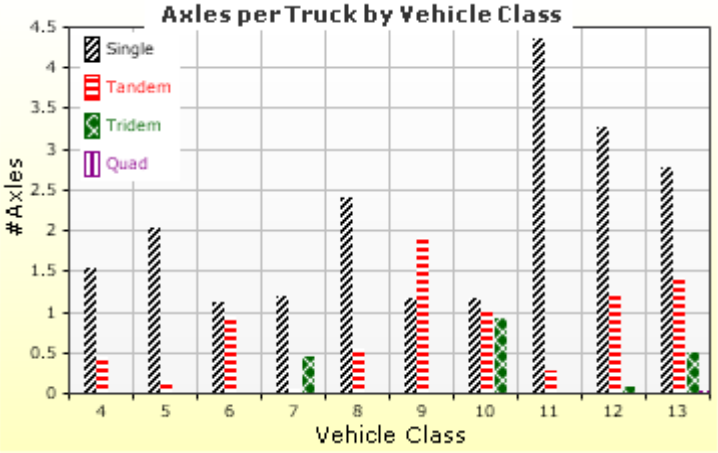
Graphical Representation of Traffic Inputs

Initial two-way AADTT:	189	Percent of trucks in design direction (%):	60.0
Number of lanes in design direction:	2	Percent of trucks in design lane (%):	100.0
		Operational speed (mph)	40.0

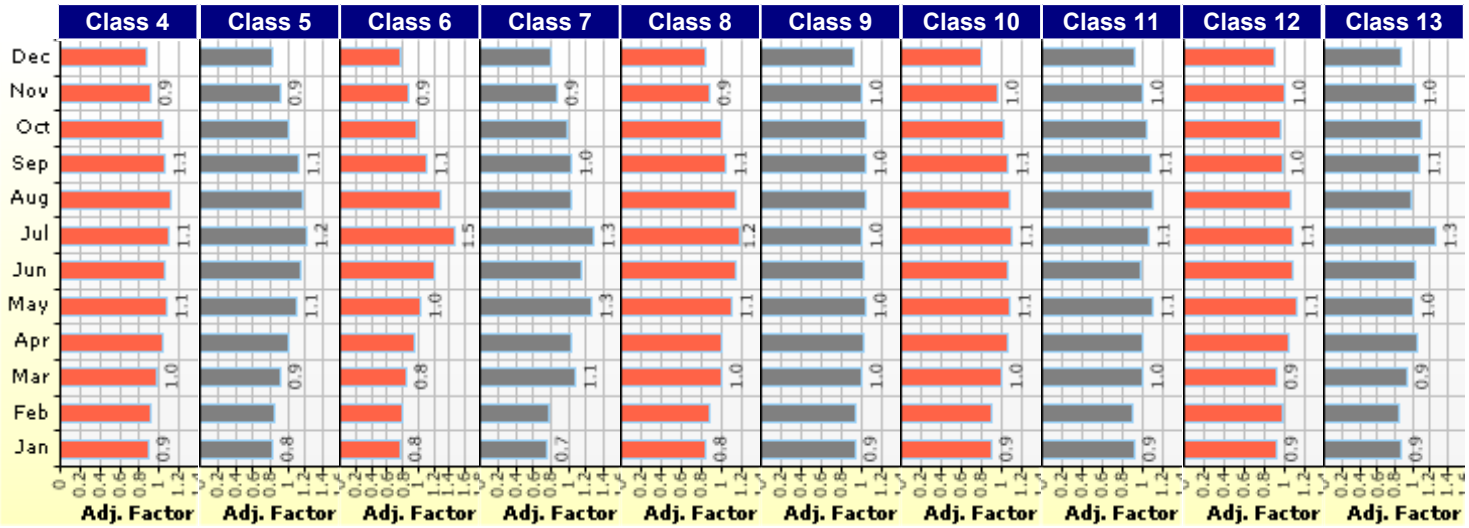








Traffic Volume Monthly Adjustment Factors



Tabular Representation of Traffic Inputs

Volume Monthly Adjustment Factors

Level 3: Default MAF

Month	Vehicle Class									
	4	5	6	7	8	9	10	11	12	13
January	0.9	0.8	0.8	0.7	0.8	0.9	0.9	0.9	0.9	0.9
February	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.8
March	1.0	0.9	0.8	1.1	1.0	1.0	1.0	1.0	0.9	0.9
April	1.0	1.0	0.9	1.0	1.0	1.0	1.1	1.0	1.0	1.1
May	1.1	1.1	1.0	1.3	1.1	1.0	1.1	1.1	1.1	1.0
June	1.1	1.1	1.2	1.1	1.1	1.0	1.1	1.0	1.1	1.0
July	1.1	1.2	1.5	1.3	1.2	1.0	1.1	1.1	1.1	1.3
August	1.1	1.2	1.3	1.0	1.1	1.0	1.1	1.1	1.1	1.0
September	1.1	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1
October	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.1
November	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0
December	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.9	0.9

Distributions by Vehicle Class

Truck Distribution by Hour does not apply

Vehicle Class	AADTT Distribution (%) (Level 3)	Growth Factor	
		Rate (%)	Function
Class 4	6.54%	3.21%	Compound
Class 5	32.02%	3.21%	Compound
Class 6	27.23%	3.21%	Compound
Class 7	1.38%	3.21%	Compound
Class 8	13.25%	3.21%	Compound
Class 9	10.07%	3.21%	Compound
Class 10	3.1%	3.21%	Compound
Class 11	2.19%	3.21%	Compound
Class 12	2.82%	3.21%	Compound
Class 13	1.4%	3.21%	Compound

Axle Configuration

Traffic Wander	
Mean wheel location (in)	18.0
Traffic wander standard deviation (in)	10.0
Design lane width (ft)	12.0

Axle Configuration	
Average axle width (ft)	8.5
Dual tire spacing (in)	12.0
Tire pressure (psi)	120.0

Average Axle Spacing	
Tandem axle spacing (in)	51.6
Tridem axle spacing (in)	49.2
Quad axle spacing (in)	49.2

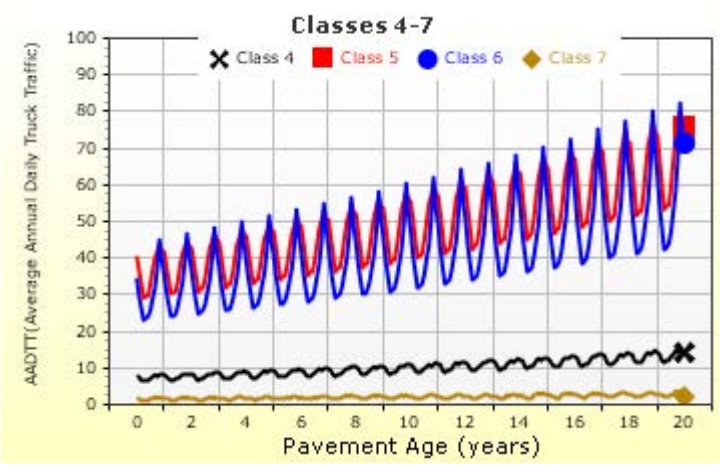
Wheelbase does not apply

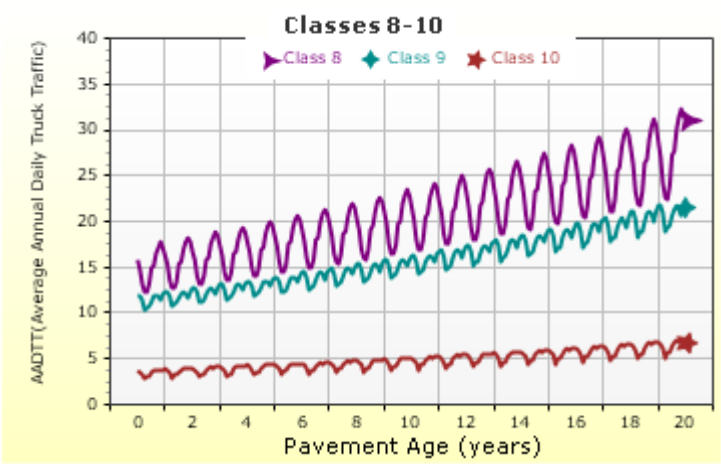
Number of Axles per Truck

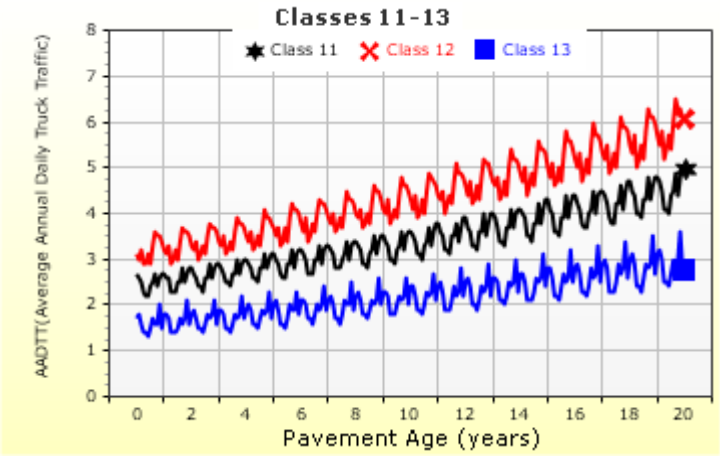
Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.53	0.45	0	0
Class 5	2.02	0.16	0.02	0
Class 6	1.12	0.94	0	0
Class 7	1.19	0.07	0.45	0.02
Class 8	2.41	0.56	0.02	0
Class 9	1.16	1.9	0.01	0
Class 10	1.15	1.01	0.93	0.02
Class 11	4.35	0.29	0.02	0
Class 12	3.27	1.22	0.09	0
Class 13	2.77	1.4	0.51	0.04

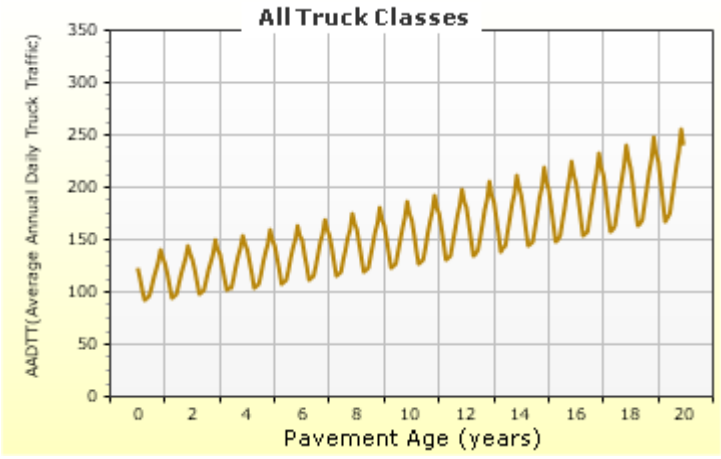
AADTT (Average Annual Daily Truck Traffic) Growth

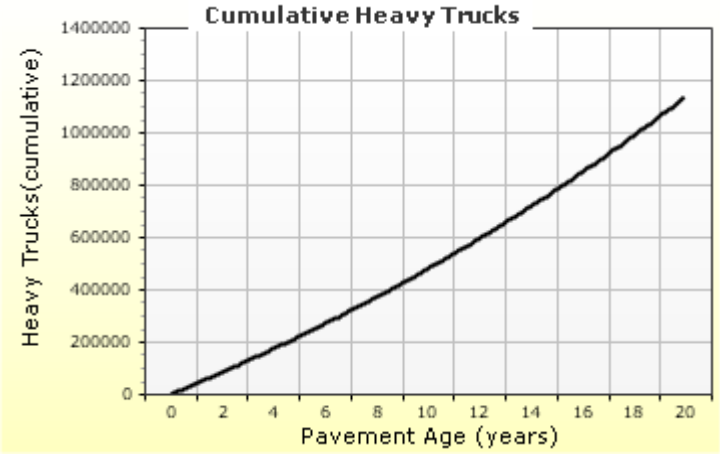
*** Traffic cap is not enforced**







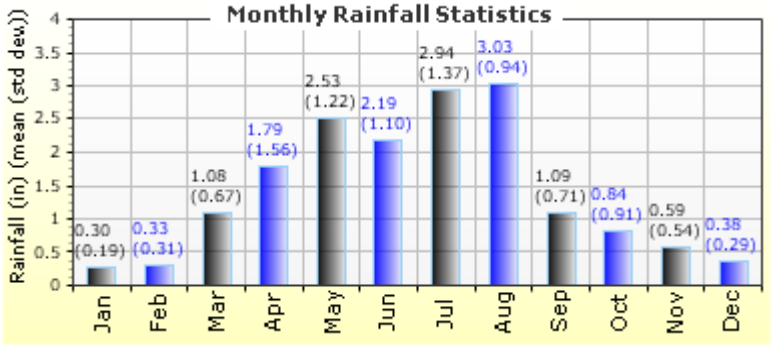




Climate Inputs

Climate Data Sources:

Climate Station Cities:	Location (lat lon elevation(ft))
COLORADO SPRINGS_	38.81200 -104.71100 6170

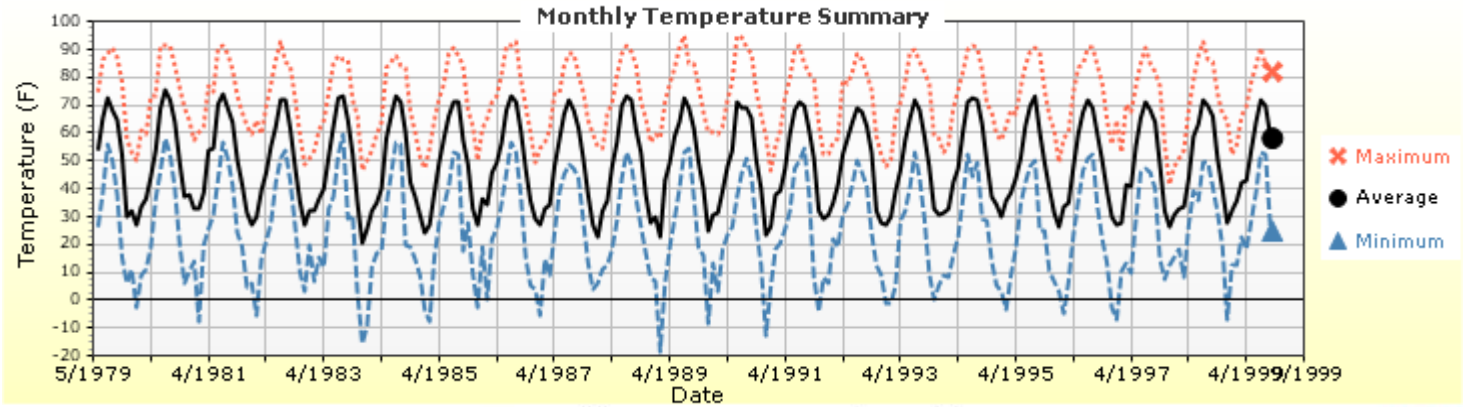


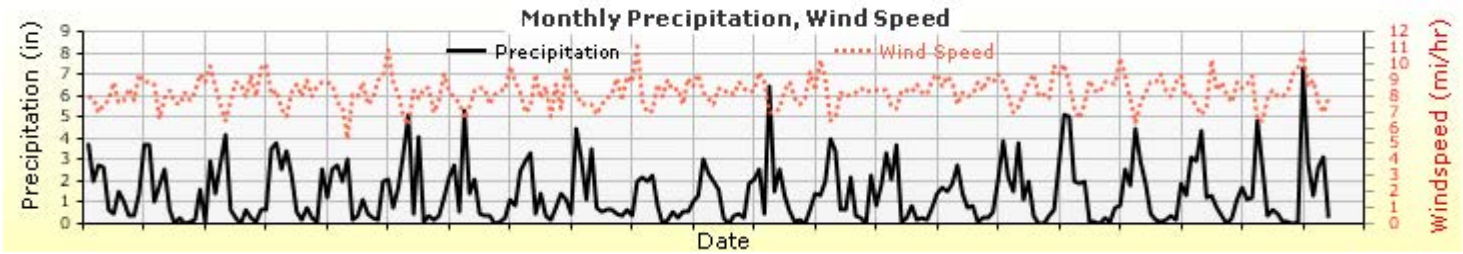
Annual Statistics:

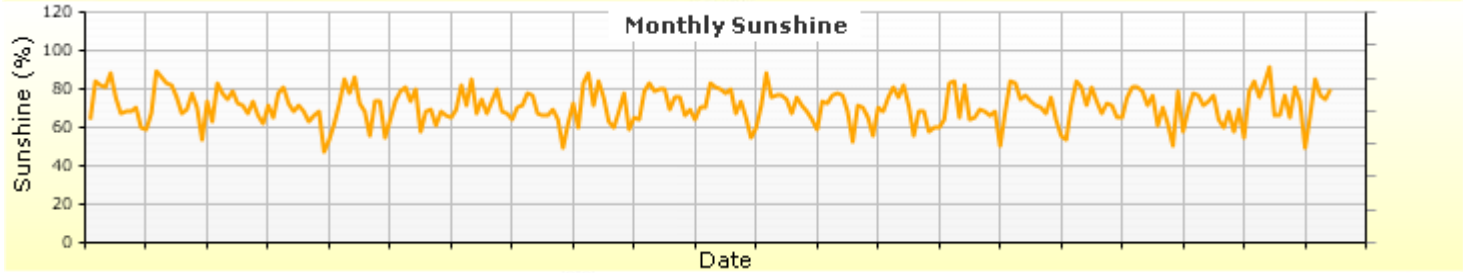
Mean annual air temperature (ºF)	49.11
Mean annual precipitation (in)	17.31
Freezing index (ºF - days)	555.60
Average annual number of freeze/thaw cycles:	83.33

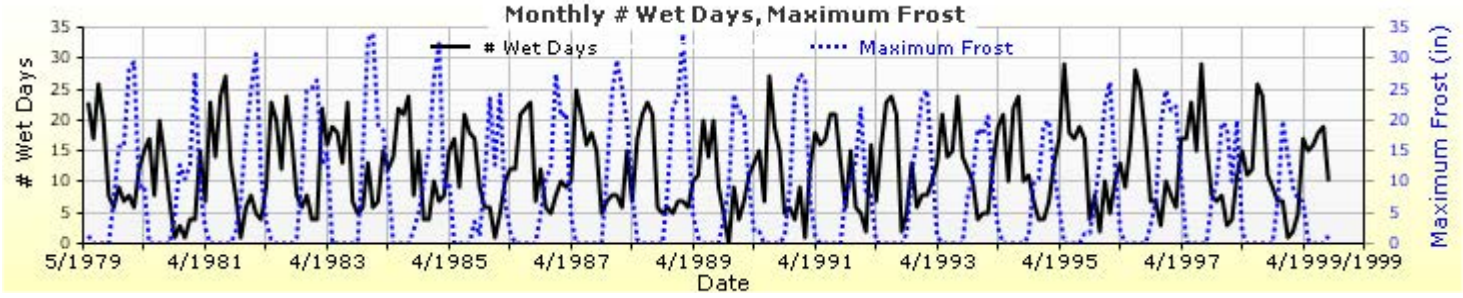
Water table depth (ft)	7.00

Monthly Climate Summary:

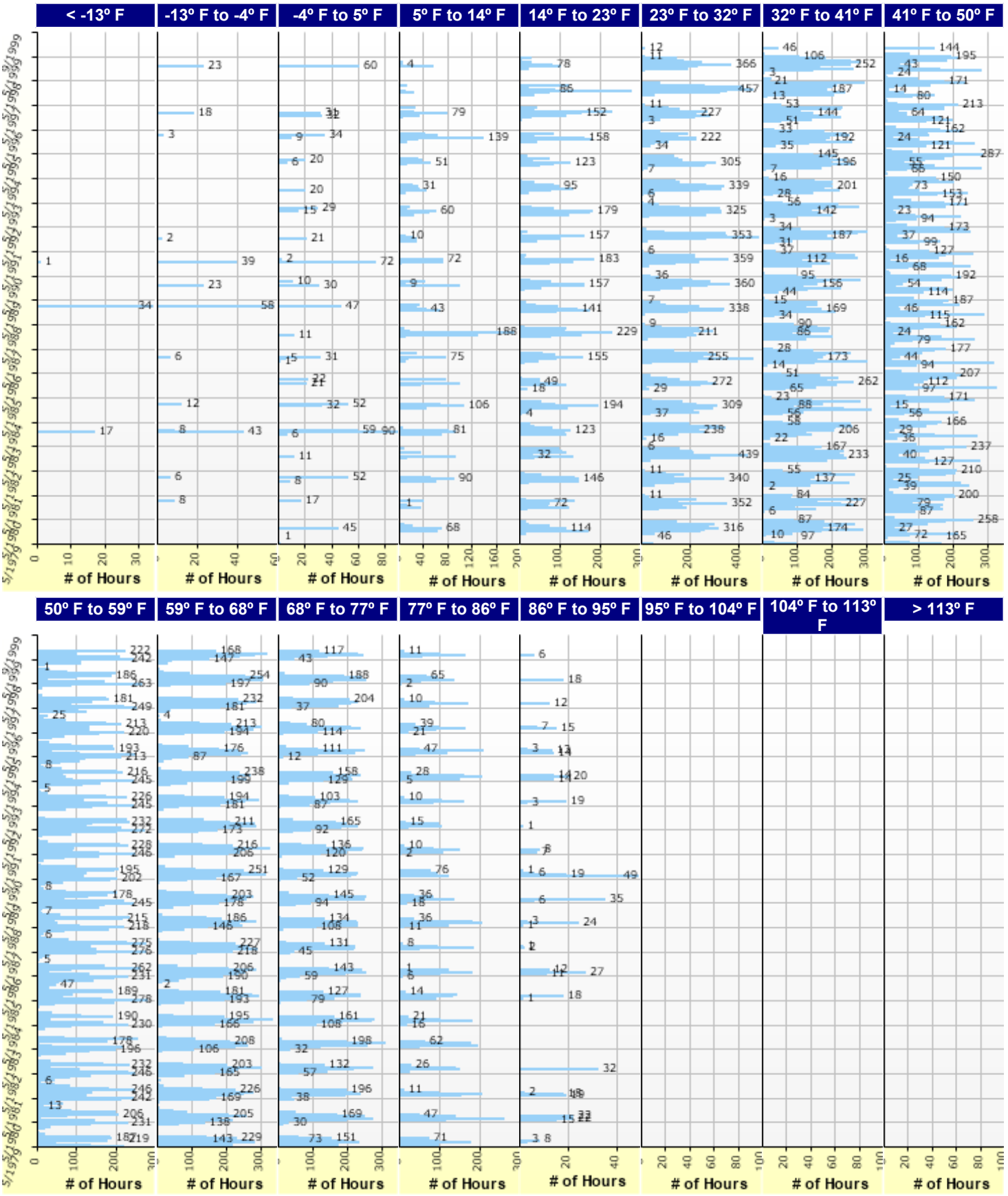








Hourly Air Temperature Distribution by Month:



Design Properties

HMA Design Properties

Use Multilayer Rutting Model	False
Using G* based model (not nationally calibrated)	False
Is NCHRP 1-37A HMA Rutting Model Coefficients	True
Endurance Limit	-
Use Reflective Cracking	True

Structure - ICM Properties	
AC surface shortwave absorptivity	0.85

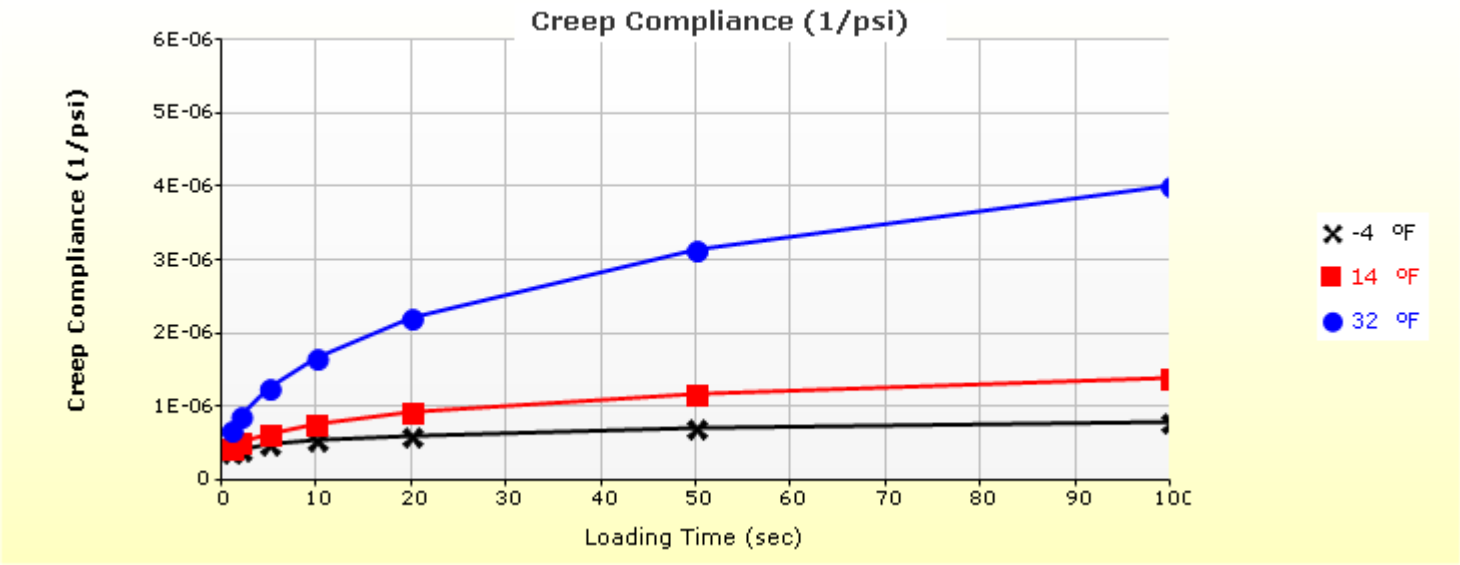
Layer Name	Layer Type	Interface Friction
Layer 1 Flexible : R2 Level 1 SMA	Flexible (1)	1.00
Layer 2 Flexible : R2 Level 1 SX (75) PG 64-22	Flexible (1)	1.00
Layer 3 Non-stabilized Base : Class 6 ABC	Non-stabilized Base (4)	1.00
Layer 4 Subgrade : Clayey Sand	Subgrade (5)	1.00
Layer 5 Subgrade : A-6	Subgrade (5)	-

Thermal Cracking (Input Level: 1)

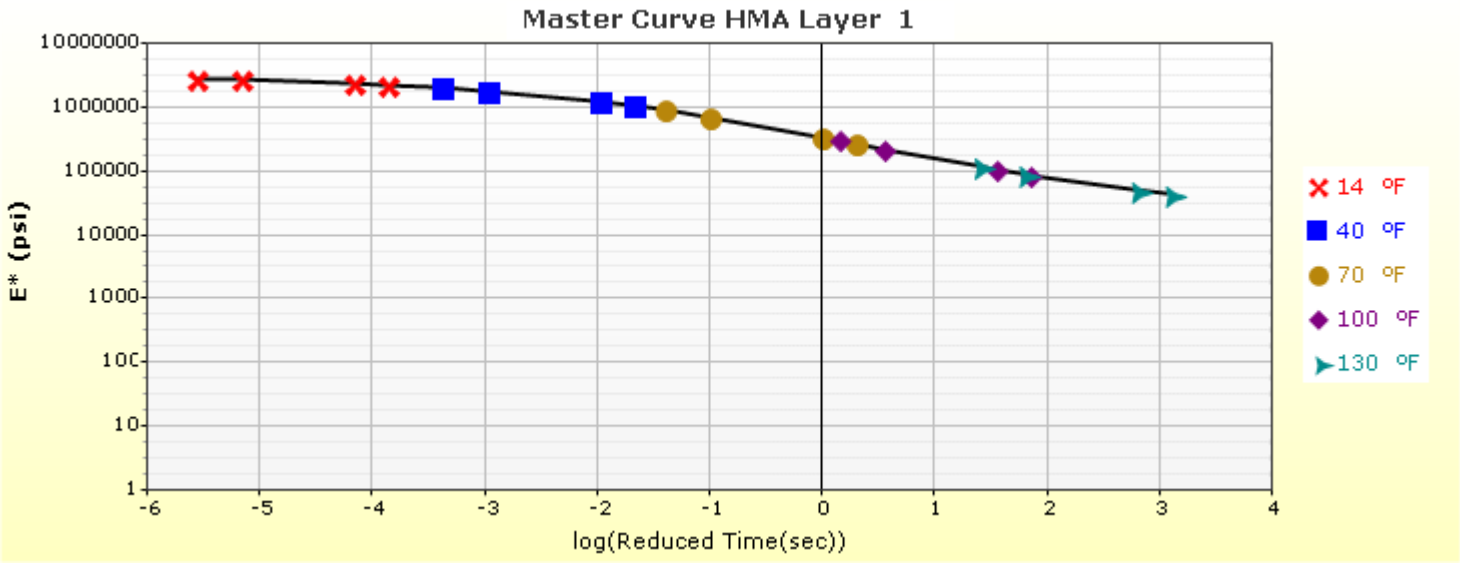
Indirect tensile strength at 14 ºF (psi)	515.00

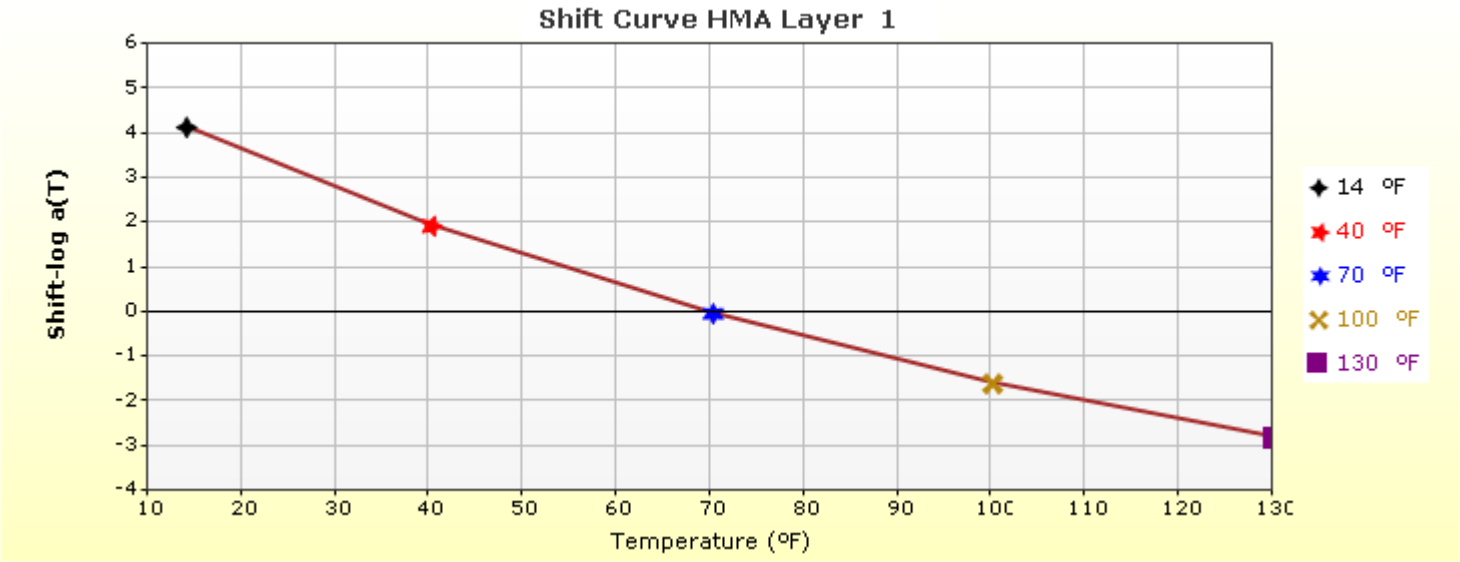
Thermal Contraction	
Is thermal contraction calculated?	True
Mix coefficient of thermal contraction (in/in/ºF)	-
Aggregate coefficient of thermal contraction (in/in/ºF)	5.0e-006
Voids in Mineral Aggregate (%)	16.9

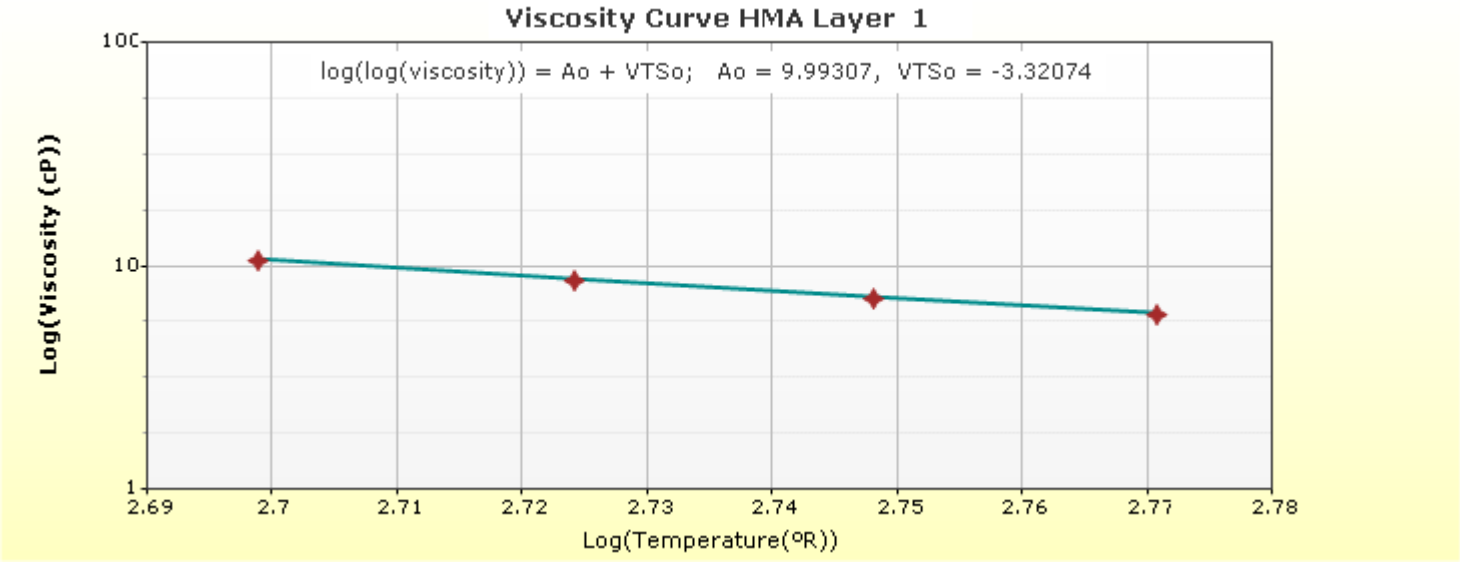
	Creep Compliance (1/psi)		
Loading time (sec)	-4 ºF	14 ºF	32 ºF
1	4.01e-007	4.45e-007	6.88e-007
2	4.28e-007	5.41e-007	8.96e-007
5	4.98e-007	6.37e-007	1.27e-006
10	5.51e-007	7.85e-007	1.69e-006
20	6.17e-007	9.33e-007	2.23e-006
50	7.19e-007	1.18e-006	3.14e-006
100	7.96e-007	1.39e-006	4.01e-006



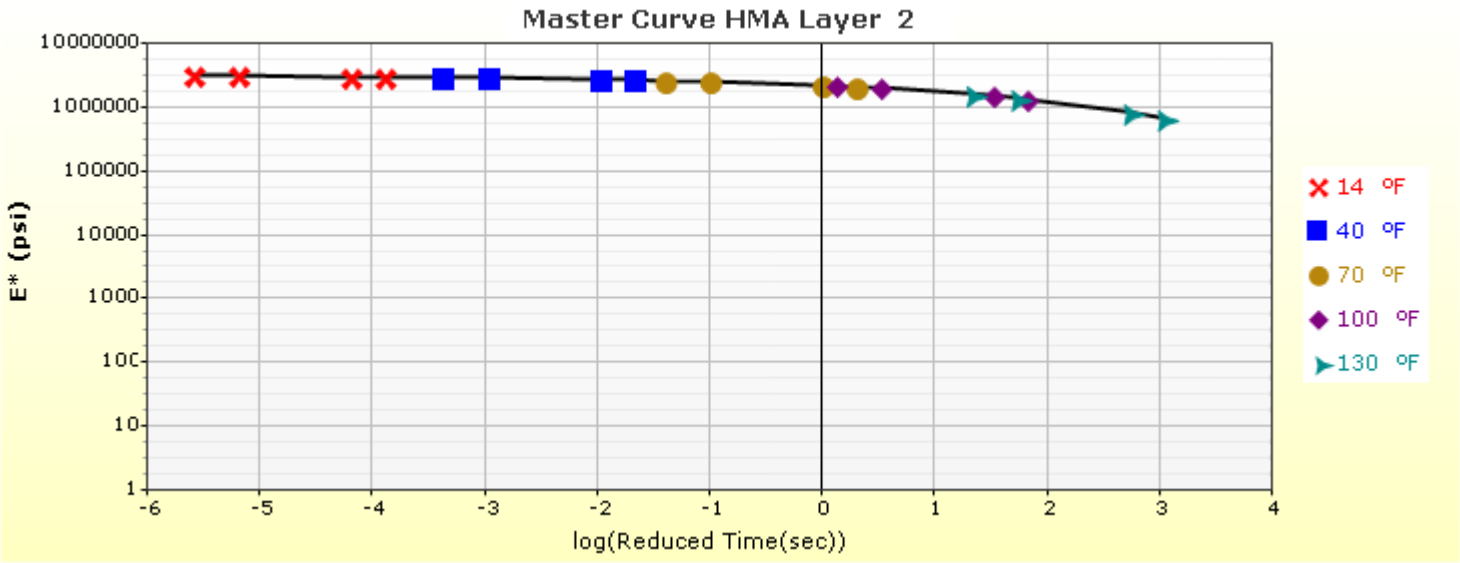
HMA Layer 1: Layer 1 Flexible : R2 Level 1 SMA

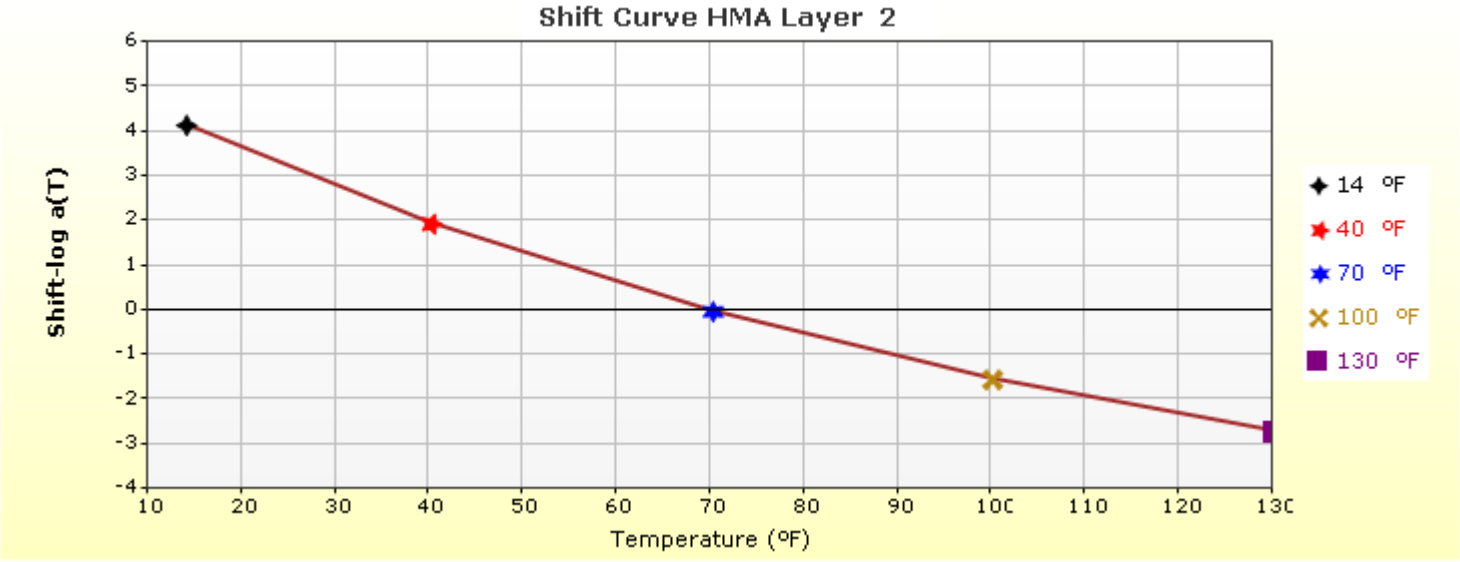


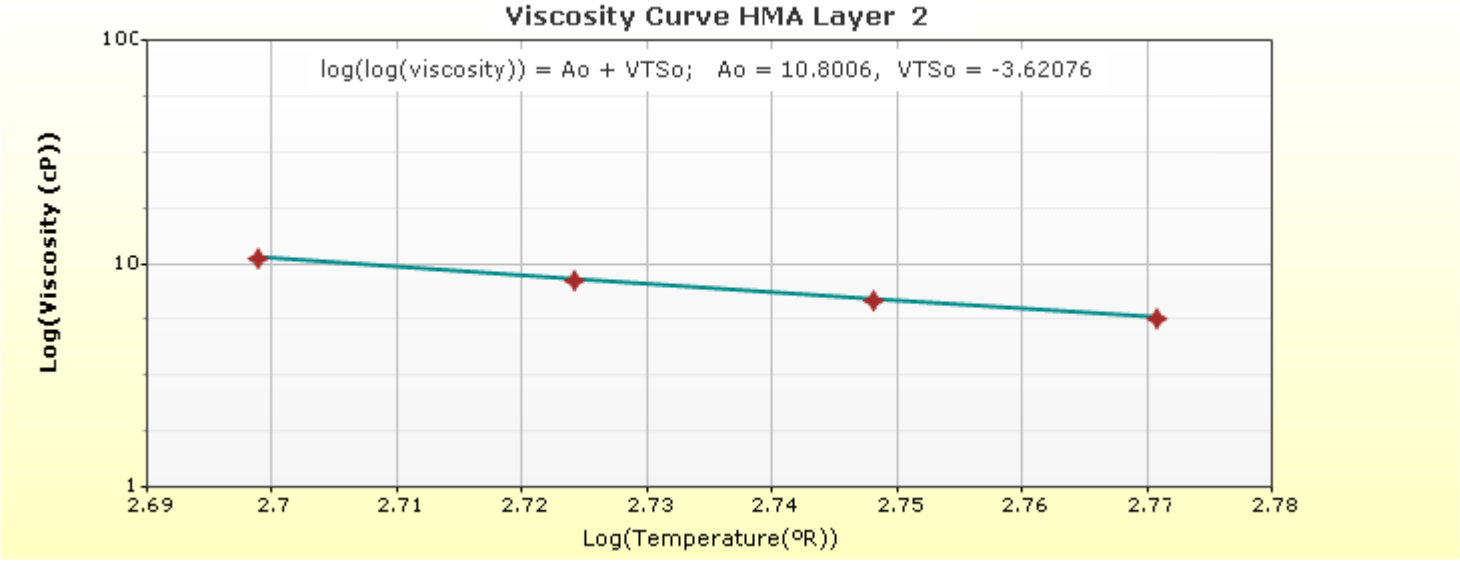




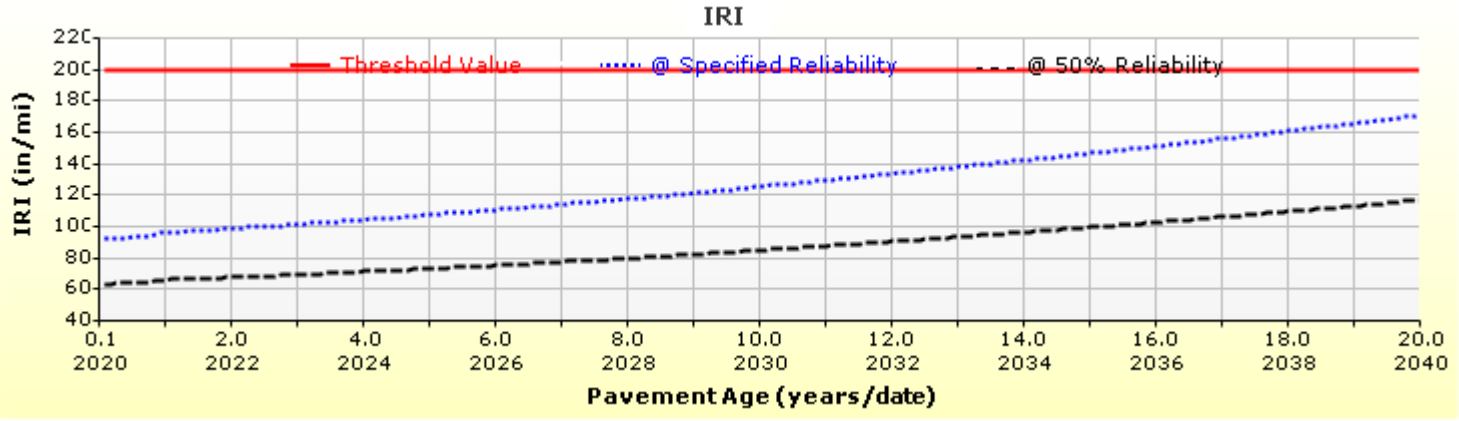
HMA Layer 2: Layer 2 Flexible : R2 Level 1 SX(75) PG 64-22

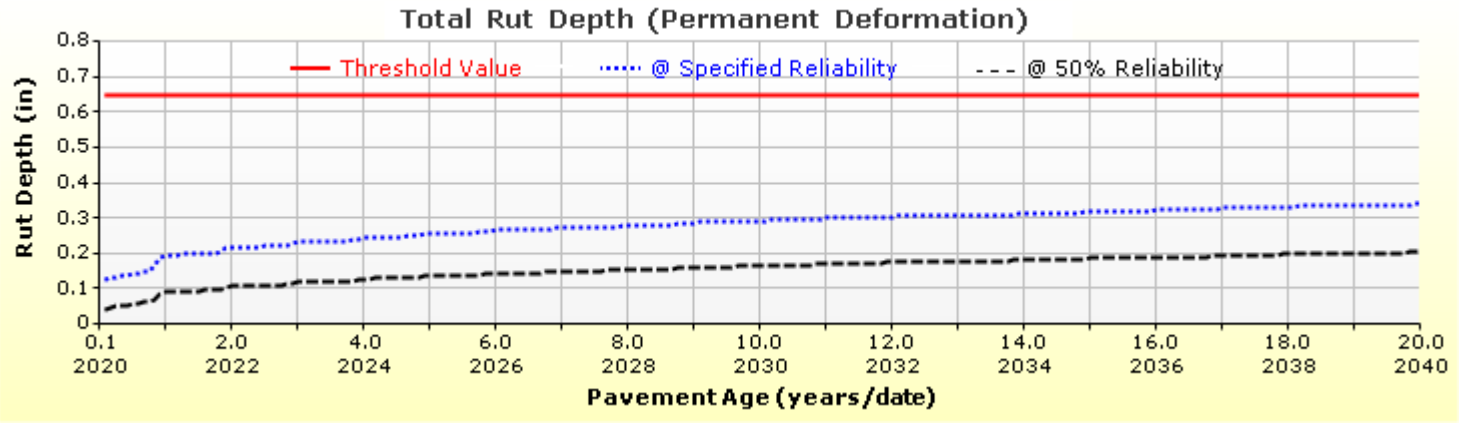


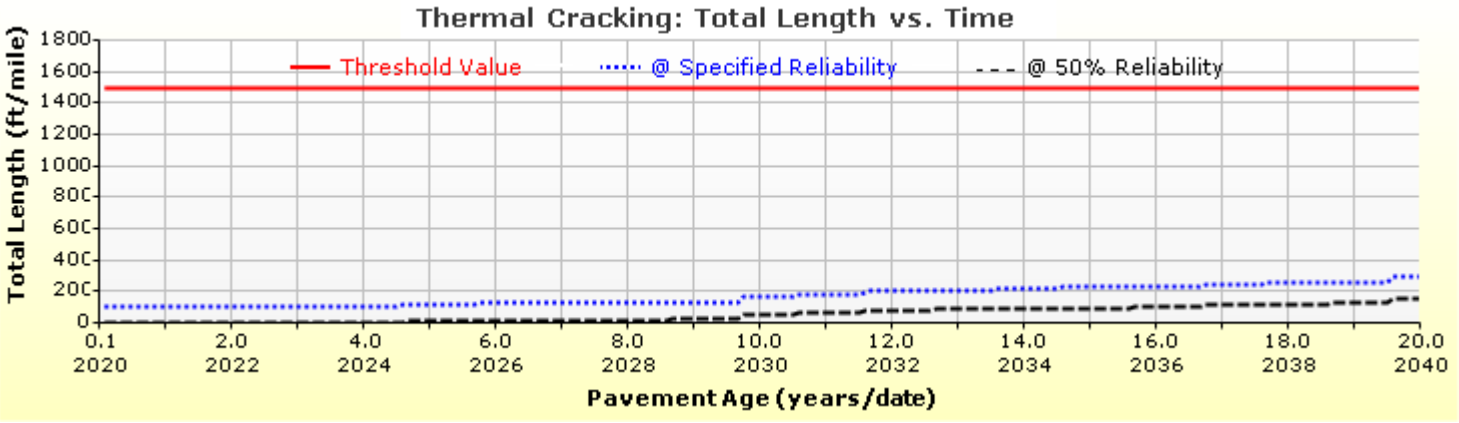


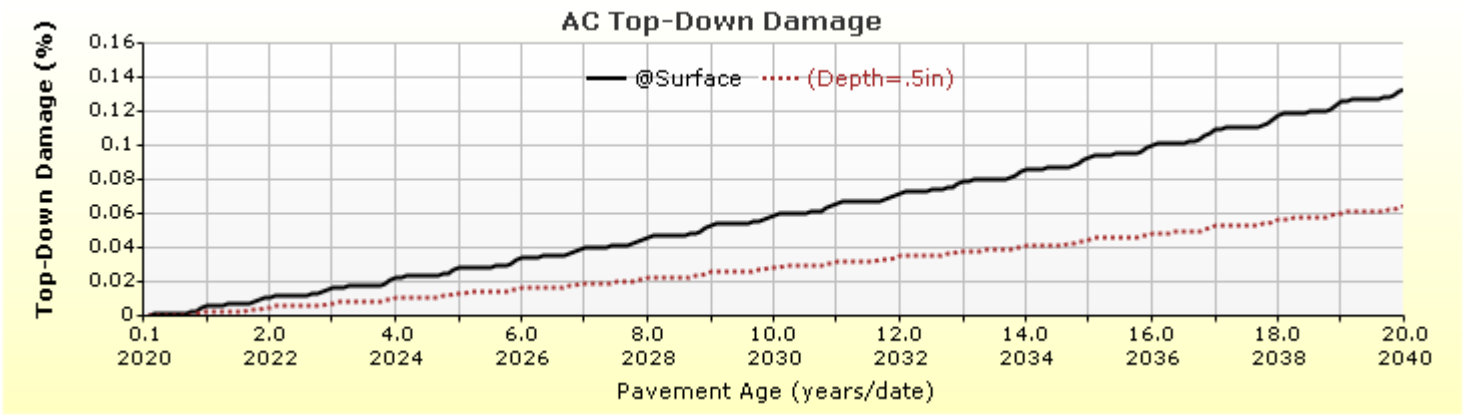


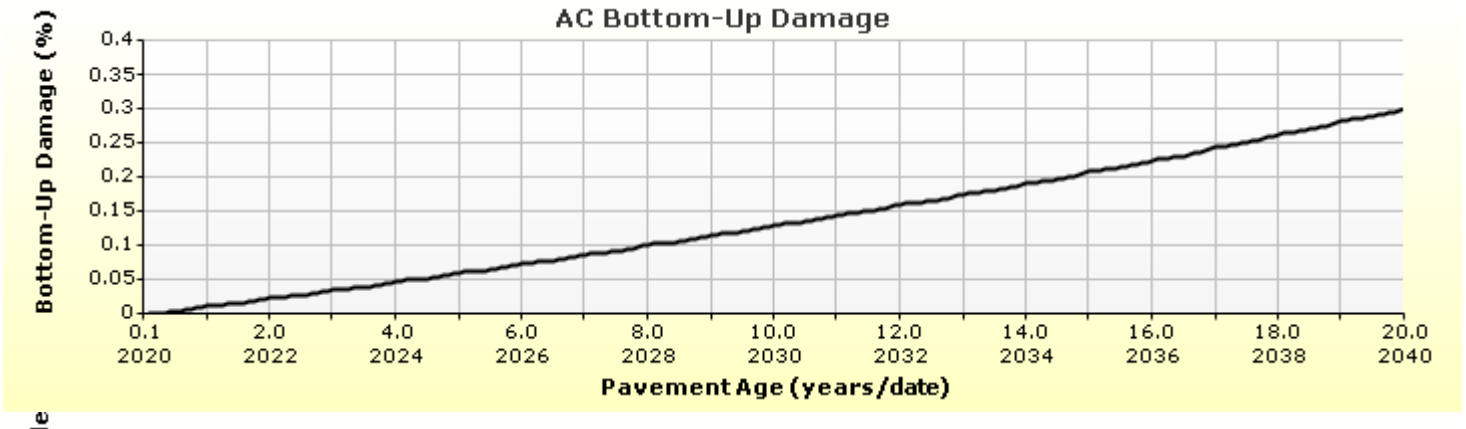
Analysis Output Charts

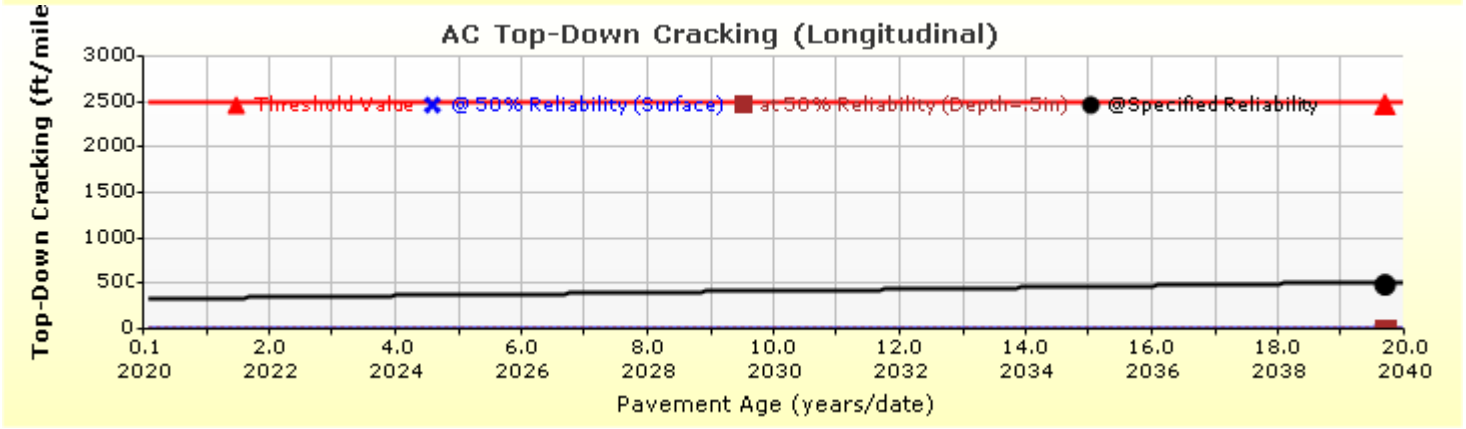


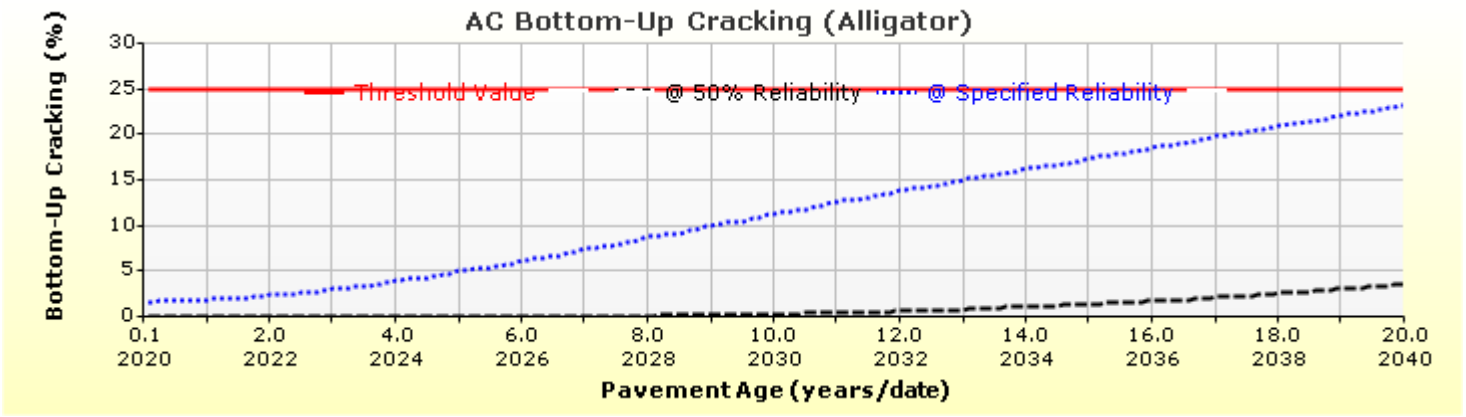


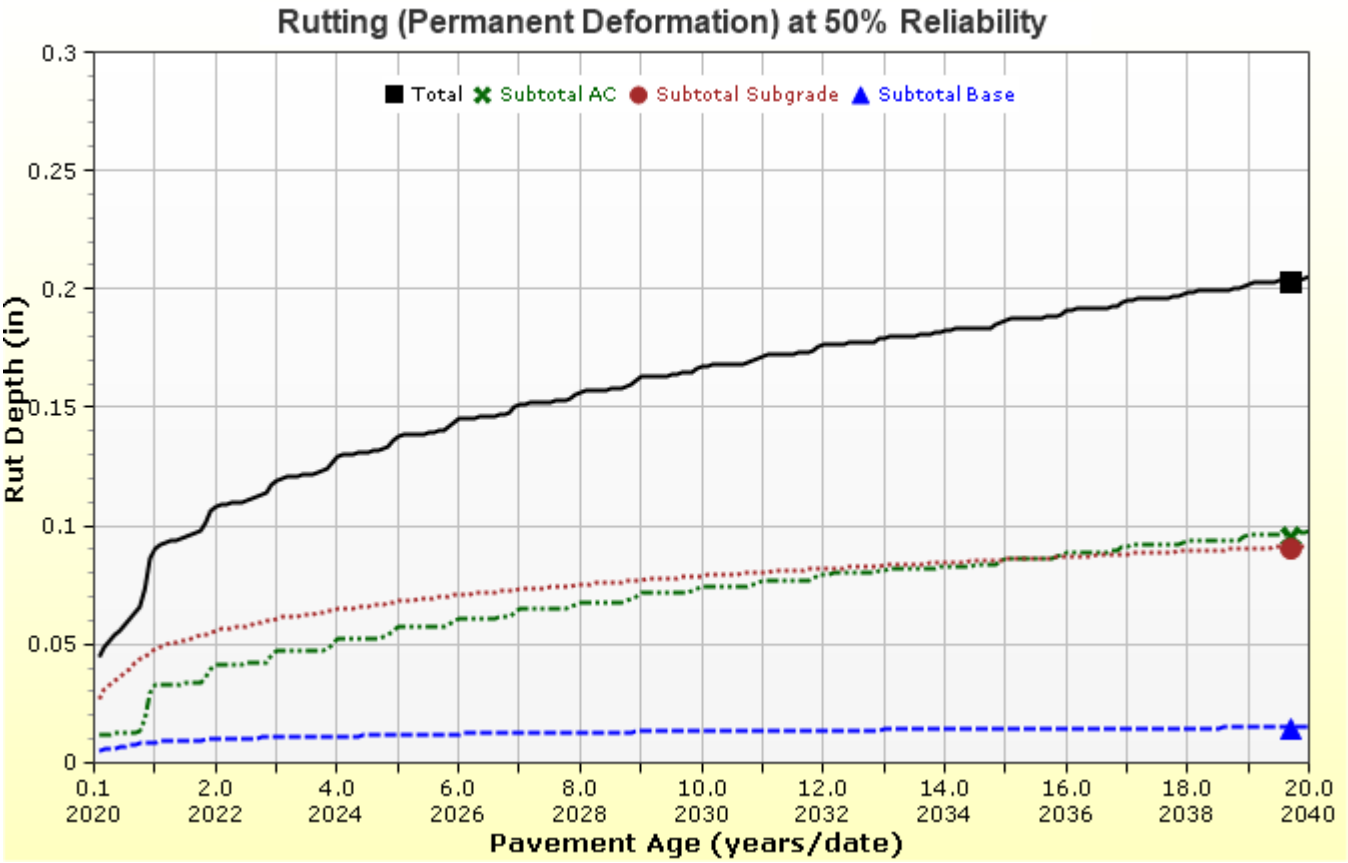


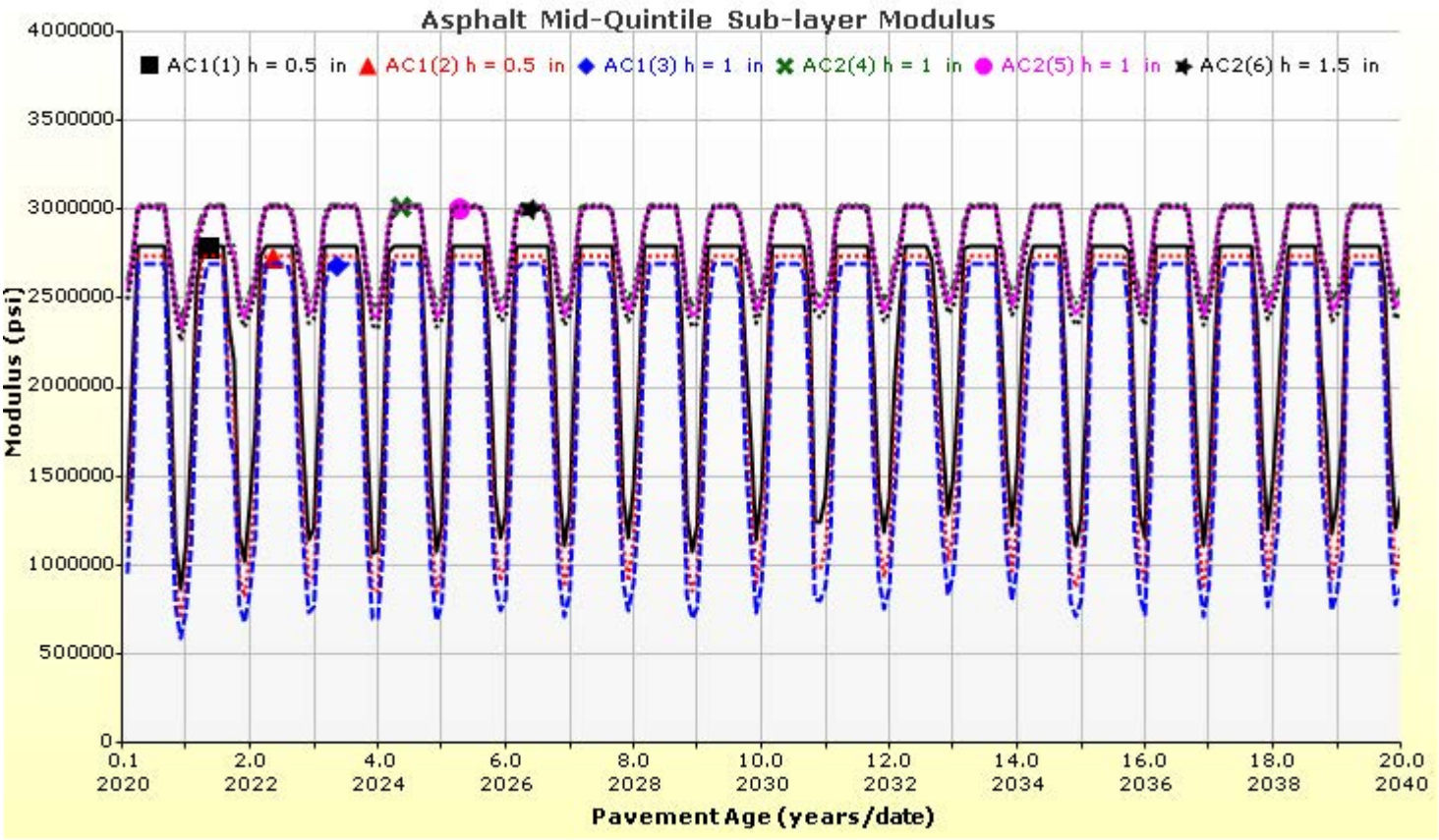

AC Top-Down Damage
Top-Down Damage (%)
@Surface
(Depth=.5in)
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)

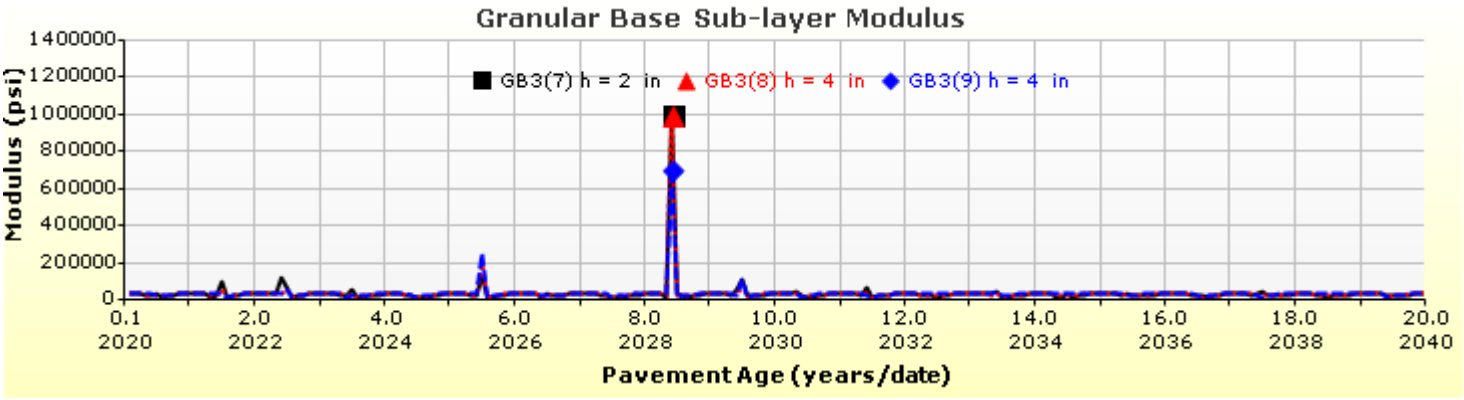

AC Bottom-Up Damage
Bottom-Up Damage (%)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)

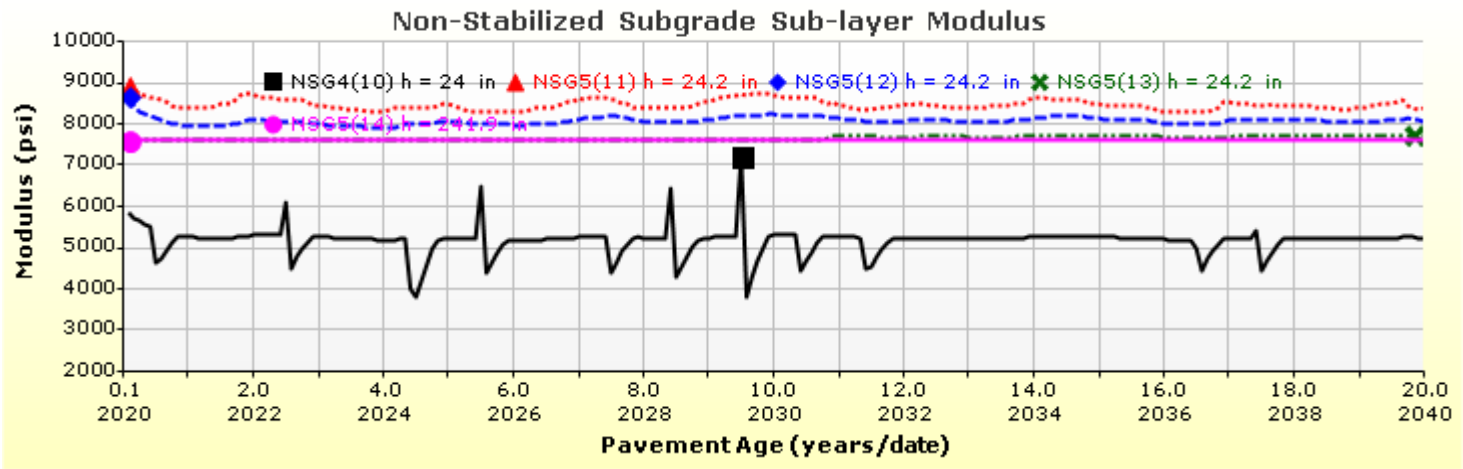

AC Top-Down Cracking (Longitudinal)
Top-Down Cracking (ft/mile
Threshold Value
@ 50% Reliability (Surface)
@ 50% Reliability (Depth=.5in)
@Specified Reliability
3000
2500
2000
1500
1000
500
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)


AC Bottom-Up Cracking (Alligator)
Bottom-Up Cracking (%)
Threshold Value
@ 50% Reliability
@ Specified Reliability
30
25
20
15
10
5
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)


Rutting (Permanent Deformation) at 50% Reliability
Total
Subtotal AC
Subtotal Subgrade
Subtotal Base
Rut Depth (in)
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1
2020
2.0
2022
4.0
2024
6.0
2026
8.0
2028
10.0
2030
12.0
2032
14.0
2034
16.0
2036
18.0
2038
20.0
2040
Pavement Age (years/date)


Asphalt Mid-Quintile Sub-layer Modulus
AC1(1) h = 0.5 in
AC1(2) h = 0.5 in
AC1(3) h = 1 in
AC2(4) h = 1 in
AC2(5) h = 1 in
AC2(6) h = 1.5 in
Modulus (psi)
4000000
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)


Granular Base Sub-layer Modulus
GB3(7) h = 2 in
GB3(8) h = 4 in
GB3(9) h = 4 in
Modulus (psi)
1400000
1200000
1000000
800000
600000
400000
200000
0
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)


Non-Stabilized Subgrade Sub-layer Modulus
NSG4(10) h = 24 in
NSG5(11) h = 24.2 in
NSG5(12) h = 24.2 in
NSG5(13) h = 24.2 in
NSG5(14) h = 241.9 in
Modulus (psi)
10000
9000
8000
7000
6000
5000
4000
3000
2000
0.1 2020
2.0 2022
4.0 2024
6.0 2026
8.0 2028
10.0 2030
12.0 2032
14.0 2034
16.0 2036
18.0 2038
20.0 2040
Pavement Age (years/date)

Layer Information

Layer 1 Flexible : R2 Level 1 SMA

Asphalt		
Thickness (in)	2.0	
Unit weight (pcf)	145.0	
Poisson's ratio	Is Calculated?	True
	Ratio	-
	Parameter A	-1.63
	Parameter B	3.84E-06

Asphalt Dynamic Modulus (Input Level: 1)

T (ºF)	0.5 Hz	1 Hz	10 Hz	25 Hz
14	1875400	2299039	2624309	2726019
40	846575	1309050	1799540	1983379
70	230100	427271	753122	918360
100	76296	127286	231357	296468
130	40803	55308	84229	102895

Asphalt Binder

Temperature (ºF)	Binder Gstar (Pa)	Phase angle (deg)
158	1233	64
168.8	673	66
179.6	383	68

General Info

Name	Value
Reference temperature (ºF)	70
Effective binder content (%)	12.2
Air voids (%)	4.7
Thermal conductivity (BTU/hr-ft-ºF)	0.67
Heat capacity (BTU/lb-ºF)	0.23

Identifiers

Field	Value
Display name/identifier	R2 Level 1 SMA
Description of object	Mix ID # FS1919
Author	CDOT
Date Created	4/3/2013 12:00:00 AM
Approver	CDOT
Date approved	4/3/2013 12:00:00 AM
State	Colorado
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	SMA
User defined field 2	
User defined field 3	
Revision Number	0

Layer 2 Flexible : R2 Level 1 SX(75) PG 64-22

Asphalt		
Thickness (in)	3.5	
Unit weight (pcf)	140.5	
Poisson's ratio	Is Calculated?	True
	Ratio	-
	Parameter A	-1.63
	Parameter B	3.84E-06

Asphalt Dynamic Modulus (Input Level: 1)

T (ºF)	0.5 Hz	1 Hz	10 Hz	25 Hz
14	2910500	2947100	3034800	3058600
40	2620500	2695700	2882400	2934800
70	2057300	2190500	2549800	2658300
100	1334300	1500400	2017600	2195500
130	697600	836500	1365200	1584000

Asphalt Binder

Temperature (ºF)	Binder Gstar (Pa)	Phase angle (deg)
168.8	451	85
147.2	1857	81.6
158	889	83.1

General Info

Name	Value
Reference temperature (ºF)	70
Effective binder content (%)	11.8
Air voids (%)	6.9
Thermal conductivity (BTU/hr-ft-ºF)	0.67
Heat capacity (BTU/lb-ºF)	0.23

Identifiers

Field	Value
Display name/identifier	R2 Level 1 SX(75) PG 64-22
Description of object	Mix ID # 19127A
Author	CDOT
Date Created	4/3/2013 12:00:00 AM
Approver	CDOT
Date approved	4/3/2013 12:00:00 AM
State	Colorado
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	SX
User defined field 2	
User defined field 3	
Revision Number	0

Layer 3 Non-stabilized Base : Class 6 ABC

Unbound	
Layer thickness (in)	10.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
22000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Class 6 ABC
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	20

Sieve

Liquid Limit	30.0
Plasticity Index	6.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	125.8
Saturated hydraulic conductivity (ft/hr)	False	2.257e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	8.3

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	12.2329
bf	1.1153
cf	0.8619
hr	244.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	12.0
#100	
#80	
#60	
#50	
#40	
#30	
#20	
#16	
#10	
#8	55.0
#4	65.0
3/8-in.	
1/2-in.	
3/4-in.	95.0
1-in.	100.0
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 4 Subgrade : Clayey Sand

Unbound	
Layer thickness (in)	24.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
7000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Clayey Sand
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	33

Sieve

Liquid Limit	37.0
Plasticity Index	18.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	112.9
Saturated hydraulic conductivity (ft/hr)	False	1.153e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	14.9

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	102.5522
bf	0.7198
cf	0.2545
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	47.0
#100	
#80	
#60	
#50	
#40	72.0
#30	
#20	
#16	
#10	
#8	
#4	98.0
3/8-in.	
1/2-in.	
3/4-in.	
1-in.	
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 5 Subgrade : A-6

Unbound	
Layer thickness (in)	Semi-infinite
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
14000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-6
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	33.0
Plasticity Index	16.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	107.9
Saturated hydraulic conductivity (ft/hr)	False	1.95e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	17.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	108.4091
bf	0.6801
cf	0.2161
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	63.2
#100	
#80	73.5
#60	
#50	
#40	82.4
#30	
#20	
#16	
#10	90.2
#8	
#4	93.5
3/8-in.	96.4
1/2-in.	97.4
3/4-in.	98.4
1-in.	99.0
1 1/2-in.	99.5
2-in.	99.8
2 1/2-in.	
3-in.	
3 1/2-in.	100.0

Calibration Coefficients

AC Fatigue

$$N_f = 0.00432 * C * \beta_{f1} k_1 \left(\frac{1}{\varepsilon_1}\right)^{k_2\beta_{f2}} \left(\frac{1}{E}\right)^{k_3\beta_{f3}}$$

$$C = 10^M$$

$$M = 4.84\left(\frac{V_b}{V_a + V_b} - 0.69\right)$$

k1: 0.007566
k2: 3.9492
k3: 1.281
Bf1: 130.3674
Bf2: 1
Bf3: 1.217799

AC Rutting

$$\frac{\varepsilon_p}{\varepsilon_r} = k_z \beta_{r1} 10^{k_1 T^{k_2 \beta_{r2}} N^{k_3 \beta_{r3}}}$$

$$k_z = (C_1 + C_2 * depth) * 0.328196^{depth}$$

$$C_1 = -0.1039 * H_\alpha^2 + 2.4868 * H_\alpha - 17.342$$

$$C_2 = 0.0172 * H_\alpha^2 - 1.7331 * H_\alpha + 27.428$$

Where:

$$H_{ac} = total\ AC\ thickness(in)$$

$\varepsilon_p = plastic\ strain\left({}^{in}/_{in}\right)$
$\varepsilon_r = resilient\ strain\left({}^{in}/_{in}\right)$
$T = layer\ temperature(^{\circ}F)$
$N = number\ of\ load\ repetitions$

AC Rutting Standard Deviation	0.1414 * Pow(RUT,0.25) + 0.001	
AC Layer	K1:-3.35412 K2:1.5606 K3:0.3791	Br1:6.7 Br2:1 Br3:1

Thermal Fracture

$$C_f = 400 * N\left(\frac{\log C / h_{ac}}{\sigma}\right)$$

$$\Delta C = (k * \beta t)^{n+1} * A * \Delta K^n$$

$$A = 10^{(4.389 - 2.52 * \log(E * \sigma_m * n))}$$

$C_f = observed\ amount\ of\ thermal\ cracking(ft/500ft)$
$k = refression\ coefficient\ determined\ through\ field\ calibration$
$N() = standard\ normal\ distribution\ evaluated\ at()$
$\sigma = standard\ deviation\ of\ the\ \log\ of\ the\ depth\ of\ cracks\ in\ the\ pavments$
$C = crack\ depth(in)$
$h_{ac} = thickness\ of\ asphalt\ layer(in)$
$\Delta C = Change\ in\ the\ crack\ depth\ due\ to\ a\ cooling\ cycle$
$\Delta K = Change\ in\ the\ stress\ intensity\ factor\ due\ to\ a\ cooling\ cycle$
$A, n = Fracture\ parameters\ for\ the\ asphalt\ mixture$
$E = mixture\ stiffness$
$\sigma_M = Undamaged\ mixture\ tensile\ strength$
$\beta_t = Calibration\ parameter$

Level 1 K: 6.3	Level 1 Standard Deviation: 0.1468 * THERMAL + 65.027
Level 2 K: 0.5	Level 2 Standard Deviation: 0.2841 * THERMAL + 55.462
Level 3 K: 6.3	Level 3 Standard Deviation: 0.3972 * THERMAL + 20.422

CSM Fatigue

$$N_f = 10^{\left(\frac{k_1 \beta_{c1} \left(\frac{\sigma_s}{M_r}\right)}{k_2 \beta_{c2}}\right)}$$

$N_f = number\ of\ repetitions\ to\ fatigue\ cracking$
$\sigma_s = Tensile\ stress(psi)$
$M_r = modulus\ of\ rupture(psi)$

k1: 1	k2: 1	Bc1: 0.75	Bc2:1.1

Subgrade Rutting

$$\delta_a(N) = \beta_{s_1} k_1 \varepsilon_v h \left(\frac{\varepsilon_0}{\varepsilon_r}\right) \left| e^{-\left(\frac{\rho}{N}\right)^{\beta}} \right|$$

$\delta_a = permanent\ deformation\ for\ the\ layer$
$N = number\ of\ repetitions$
$\varepsilon_v = average\ veritcal\ strain(in/in)$
$\varepsilon_0, \beta, \rho = material\ properties$
$\varepsilon_r = resilient\ strain(in/in)$

Granular		Fine	
k1: 2.03	Bs1: 0.22	k1: 1.35	Bs1: 0.37
Standard Deviation (BASERUT) 0.0104 * Pow(BASERUT,0.67) + 0.001		Standard Deviation (BASERUT) 0.0663 * Pow(SUBRUT,0.5) + 0.001	

AC Cracking

AC Top Down Cracking

$$FC_{top} = \left(\frac{C_4}{1 + e^{(C_1 - C_2 * log_{10}(Damage))}}\right) * 10.56$$

c1: 7	c2: 3.5	c3: 0	c4: 1000

AC Cracking Top Standard Deviation

200 + 2300/(1+exp(1.072-2.1654*LOG10 (TOP+0.0001)))

AC Bottom Up Cracking

$$FC = \left(\frac{6000}{1 + e^{(C_1 * C_1' + C_2 * C_2' log_{10}(D * 100))}}\right) * \left(\frac{1}{60}\right)$$

$$C_2' = -2.40874 - 39.748 * (1 + h_{ac})^{-2.856}$$

$$C_1' = -2 * C_2'$$

c1: 0.021	c2: 2.35	c3: 6000

AC Cracking Bottom Standard Deviation

1 + 15/(1+exp(-3.1472-4.1349*LOG10 (BOTTOM+0.0001)))

CSM Cracking

$$FC_{ctb} = C_1 + \frac{C_2}{1 + e^{C_3 - C_4(Damage)}}$$

C1: 0	C2: 75	C3: 5	C4: 3

CSM Standard Deviation

CTB*1

IRI Flexible Pavements

C1 - Rutting
C2 - Fatigue Crack
C3 - Transverse Crack
C4 - Site Factors

C1: 50	C2: 0.55	C3: 0.0111	C4: 0.02

Powers North of Research JPCP

File Name: C:\Users\darwinME\Desktop\AFK\Powers and Research\PCC\Powers North of Research JPCP.dgpx

Design Inputs

Design Life: 30 years
Design Type: JPCP

Existing construction: -
Pavement construction: March, 2020
Traffic opening: August, 2020

Climate Data Sources (Lat/Lon): 38.812, -104.711

Design Structure

Layer type	Material Type	Thickness (in)
PCC	JPCP Default	9.0 (Optimized)
NonStabilized	Class 6 ABC	6.0
Subgrade	A-6	24.0
Subgrade	A-6	Semi-infinite

Joint Design:	
Joint spacing (ft)	15.0
Dowel diameter (in)	1.25
Slab width (ft)	12.0

Traffic

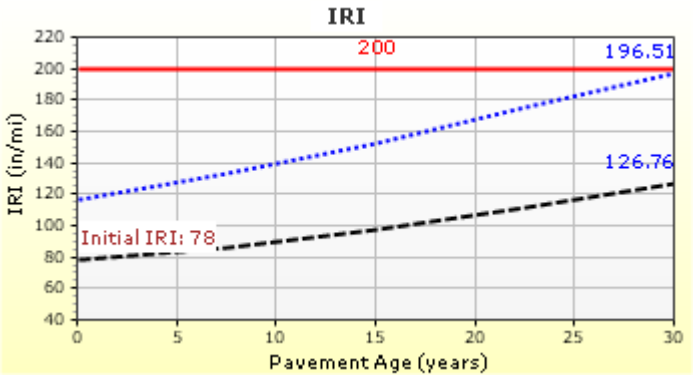
Age (year)	Heavy Trucks (cumulative)
2020 (initial)	2,179
2035 (15 years)	4,431,000
2050 (30 years)	11,304,200

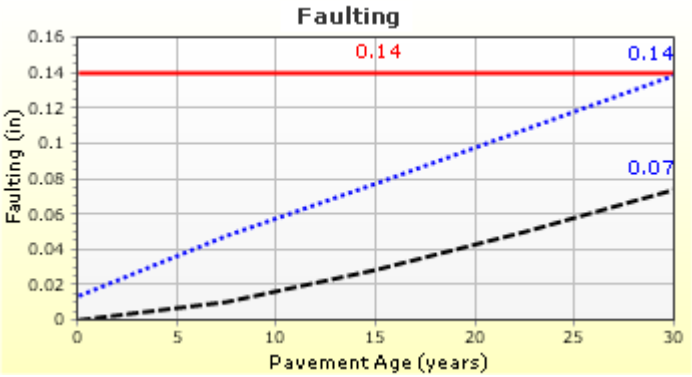
Design Outputs

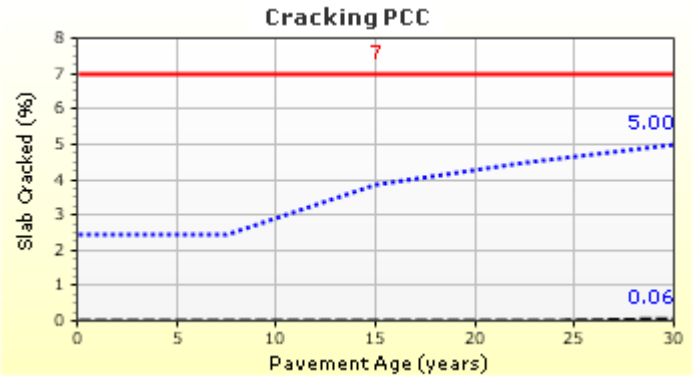
Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	200.00	196.51	95.00	95.79	Pass
Mean joint faulting (in)	0.14	0.14	95.00	95.36	Pass
JPCP transverse cracking (percent slabs)	7.00	5.00	95.00	98.96	Pass

Distress Charts



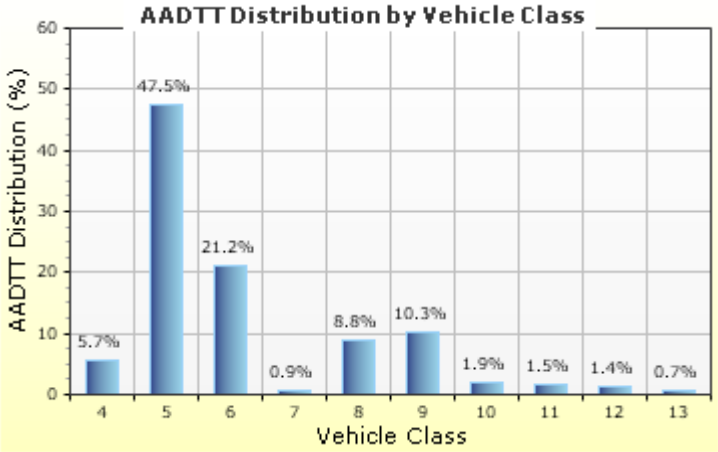


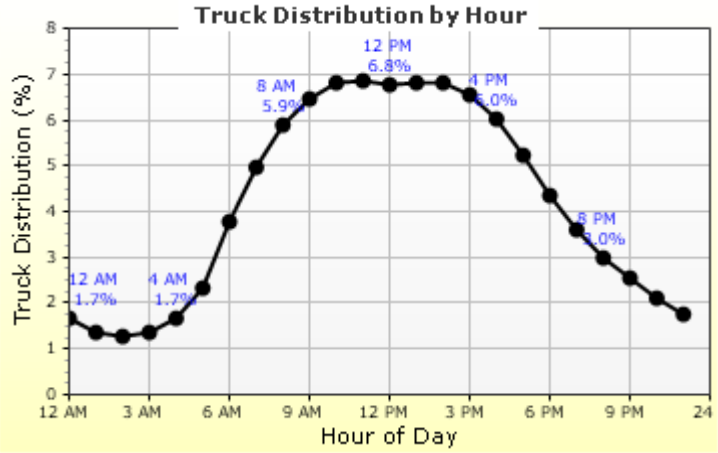


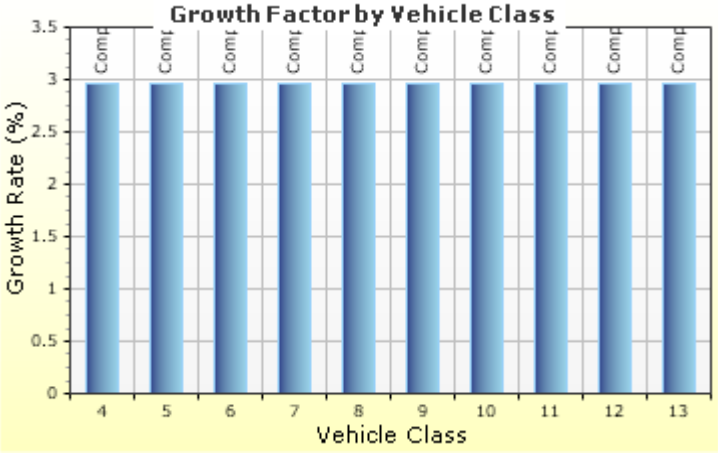
Traffic Inputs

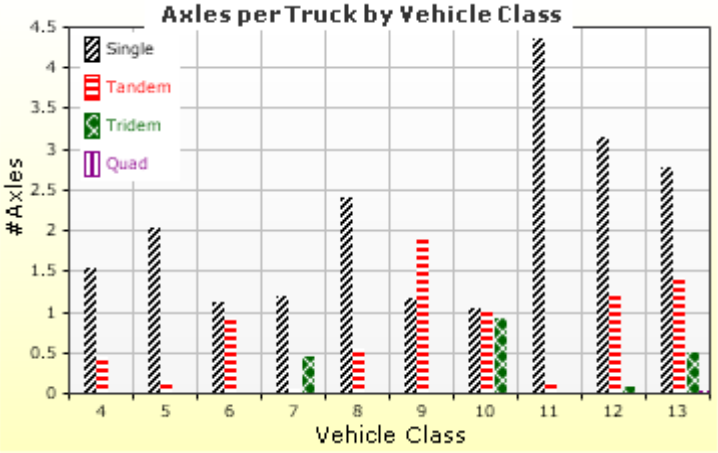
Graphical Representation of Traffic Inputs

Initial two-way AADTT:	2,179	Percent of trucks in design direction (%):	50.0
Number of lanes in design direction:	3	Percent of trucks in design lane (%):	60.0
		Operational speed (mph)	70.0

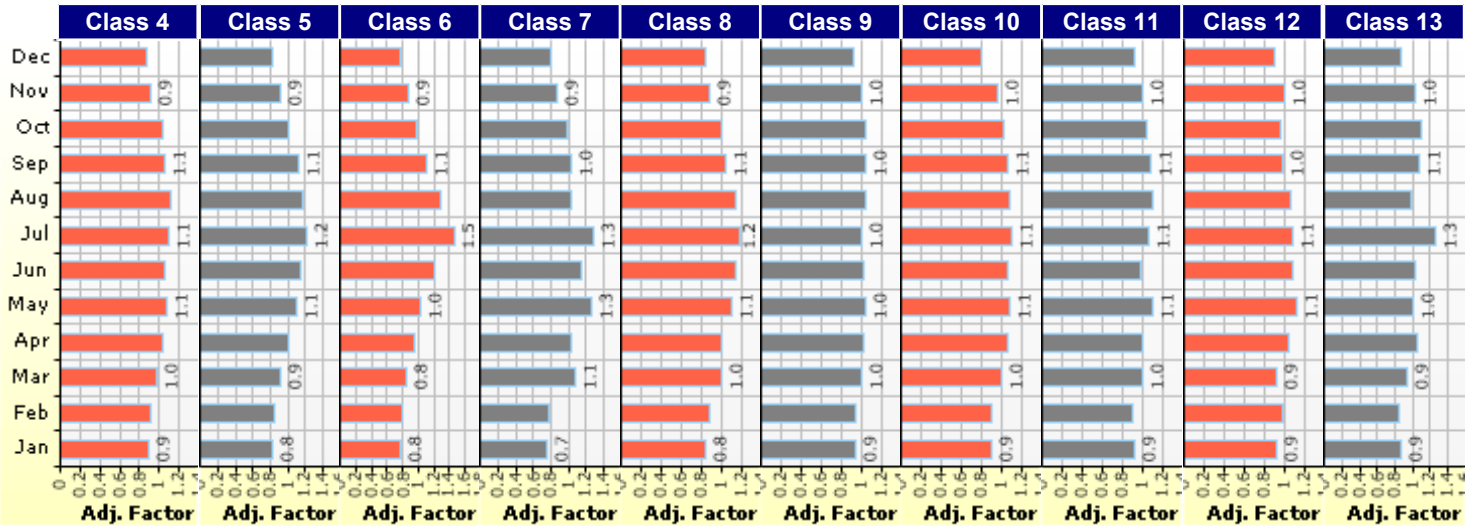








Traffic Volume Monthly Adjustment Factors



Tabular Representation of Traffic Inputs

Volume Monthly Adjustment Factors

Level 3: Default MAF

Month	Vehicle Class									
	4	5	6	7	8	9	10	11	12	13
January	0.9	0.8	0.8	0.7	0.8	0.9	0.9	0.9	0.9	0.9
February	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.8
March	1.0	0.9	0.8	1.1	1.0	1.0	1.0	1.0	0.9	0.9
April	1.0	1.0	0.9	1.0	1.0	1.0	1.1	1.0	1.0	1.1
May	1.1	1.1	1.0	1.3	1.1	1.0	1.1	1.1	1.1	1.0
June	1.1	1.1	1.2	1.1	1.1	1.0	1.1	1.0	1.1	1.0
July	1.1	1.2	1.5	1.3	1.2	1.0	1.1	1.1	1.1	1.3
August	1.1	1.2	1.3	1.0	1.1	1.0	1.1	1.1	1.1	1.0
September	1.1	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1
October	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.1
November	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0
December	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.9	0.9

Distributions by Vehicle Class

Vehicle Class	AADTT Distribution (%) (Level 3)	Growth Factor	
		Rate (%)	Function
Class 4	5.74%	2.97%	Compound
Class 5	47.46%	2.97%	Compound
Class 6	21.21%	2.97%	Compound
Class 7	0.94%	2.97%	Compound
Class 8	8.84%	2.97%	Compound
Class 9	10.31%	2.97%	Compound
Class 10	1.9%	2.97%	Compound
Class 11	1.51%	2.97%	Compound
Class 12	1.4%	2.97%	Compound
Class 13	0.69%	2.97%	Compound

Truck Distribution by Hour

Hour	Distribution (%)	Hour	Distribution (%)
12 AM	1.65%	12 PM	6.75%
1 AM	1.37%	1 PM	6.81%
2 AM	1.28%	2 PM	6.83%
3 AM	1.36%	3 PM	6.56%
4 AM	1.66%	4 PM	6.02%
5 AM	2.32%	5 PM	5.23%
6 AM	3.8%	6 PM	4.35%
7 AM	4.95%	7 PM	3.59%
8 AM	5.9%	8 PM	2.98%
9 AM	6.48%	9 PM	2.56%
10 AM	6.83%	10 PM	2.12%
11 AM	6.85%	11 PM	1.75%
		Total	100%

Axle Configuration

Traffic Wander	
Mean wheel location (in)	18.0
Traffic wander standard deviation (in)	10.0
Design lane width (ft)	12.0

Axle Configuration	
Average axle width (ft)	8.5
Dual tire spacing (in)	12.0
Tire pressure (psi)	120.0

Average Axle Spacing	
Tandem axle spacing (in)	51.6
Tridem axle spacing (in)	49.2
Quad axle spacing (in)	49.2

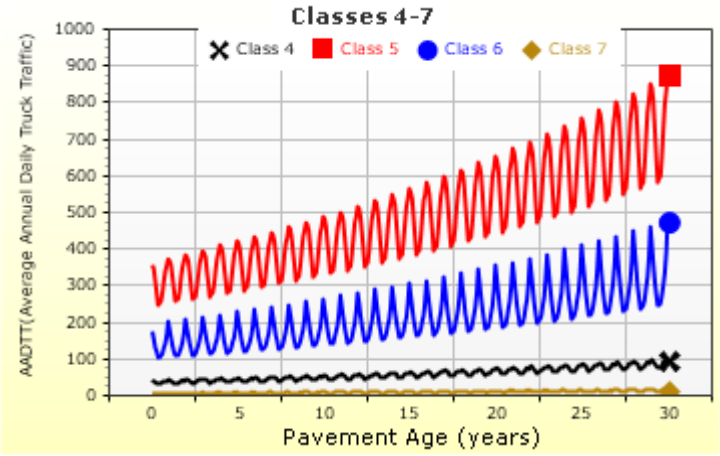
Wheelbase				
Value Type	Axle Type	Short	Medium	Long
Average spacing of axles (ft)		12.0	15.0	18.0
Percent of Trucks (%)		17.0	22.0	61.0

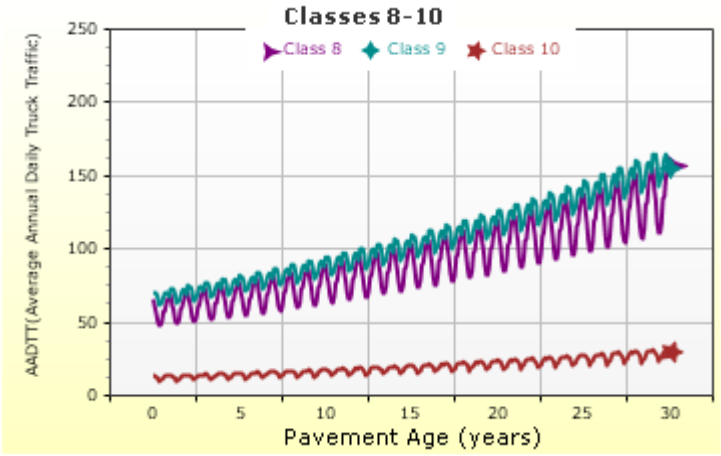
Number of Axles per Truck

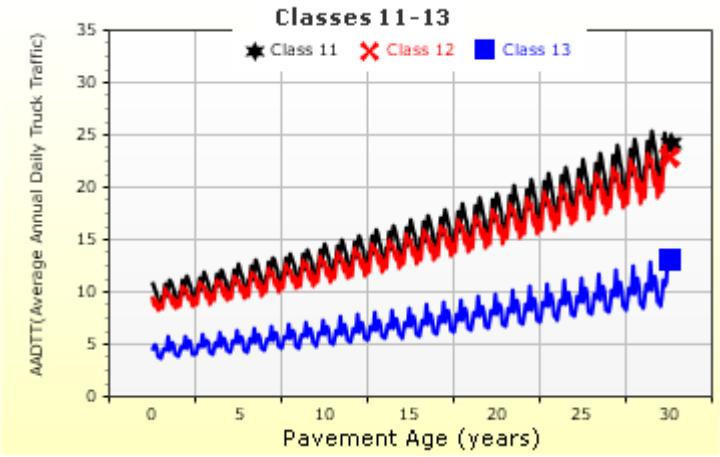
Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.53	0.45	0	0
Class 5	2.02	0.16	0.02	0
Class 6	1.12	0.93	0	0
Class 7	1.19	0.07	0.45	0.02
Class 8	2.41	0.56	0.02	0
Class 9	1.16	1.88	0.01	0
Class 10	1.05	1.01	0.93	0.02
Class 11	4.35	0.13	0	0
Class 12	3.15	1.22	0.09	0
Class 13	2.77	1.4	0.51	0.04

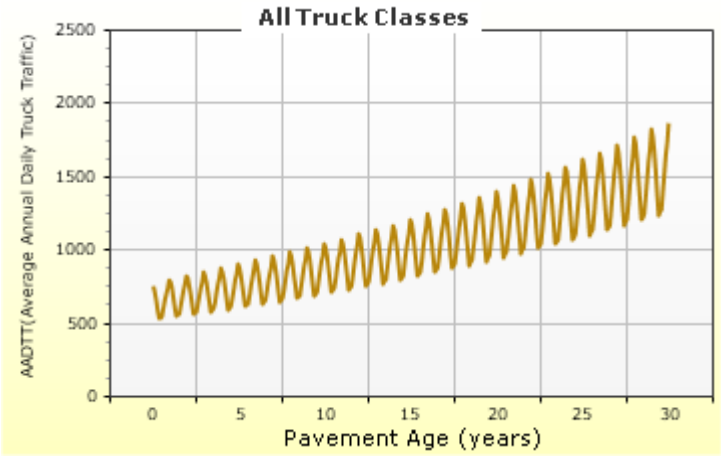
AADTT (Average Annual Daily Truck Traffic) Growth

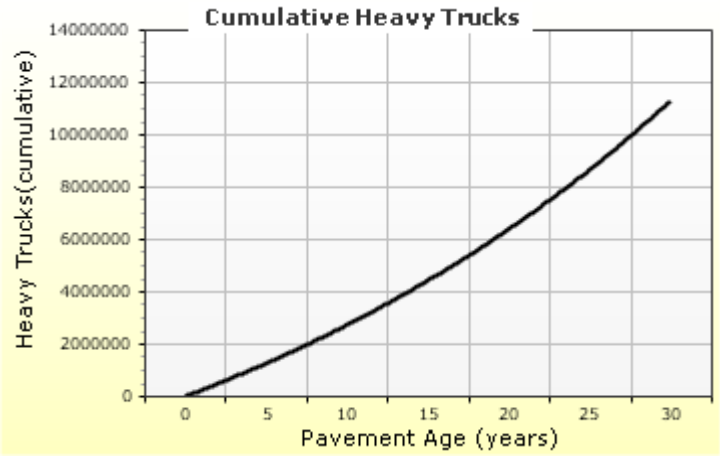
*** Traffic cap is not enforced**







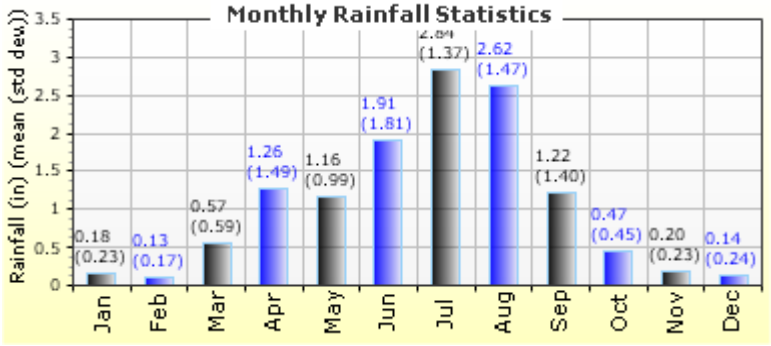




Climate Inputs

Climate Data Sources:

Climate Station Cities:	Location (lat lon elevation(ft))
COLORADO SPRINGS,	38.81200 -104.71100 6170

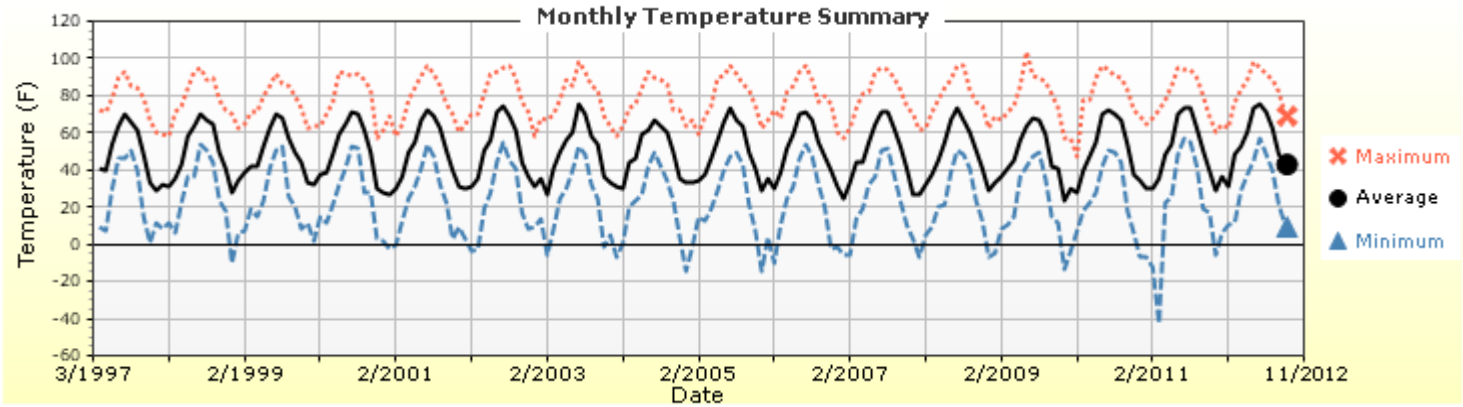


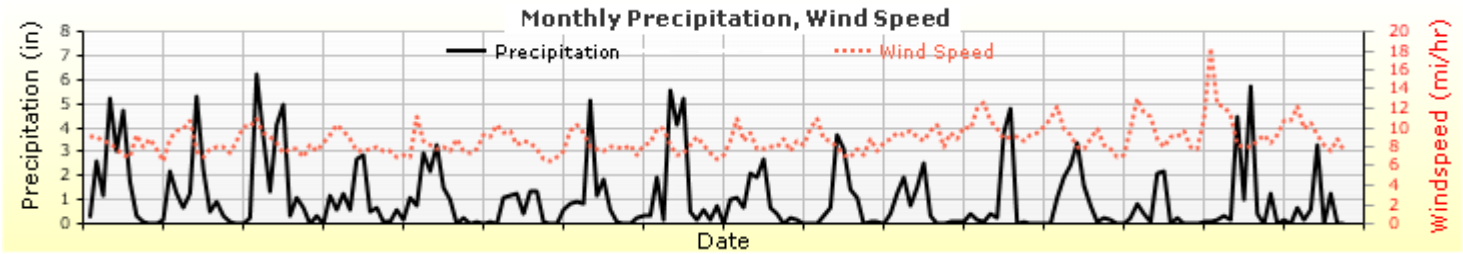
Annual Statistics:

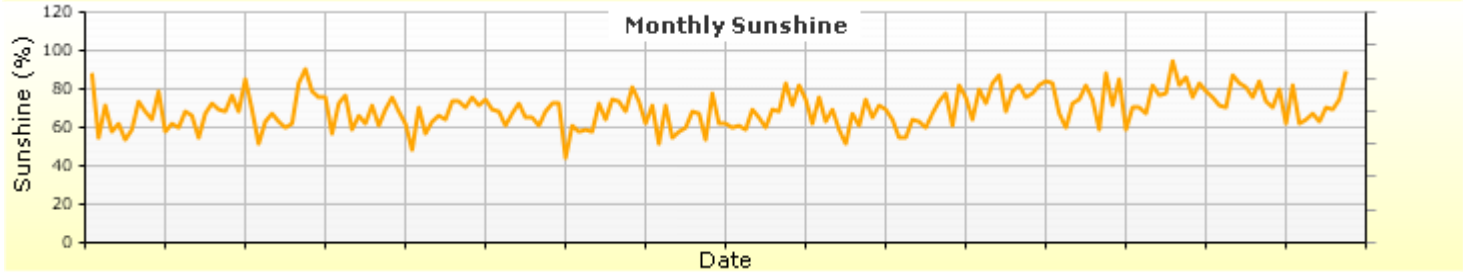
Mean annual air temperature (ºF)	49.78
Mean annual precipitation (in)	12.82
Freezing index (ºF - days)	487.57
Average annual number of freeze/thaw cycles:	131.57

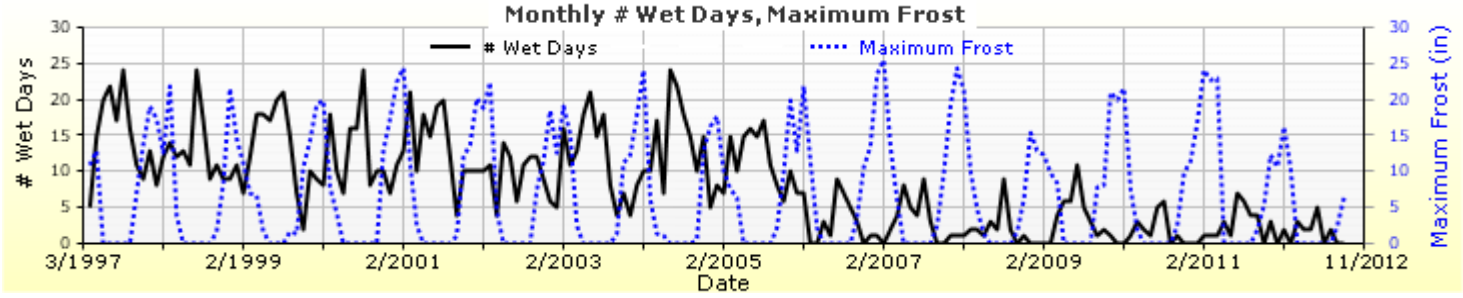
Water table depth (ft)	10.00

Monthly Climate Summary:

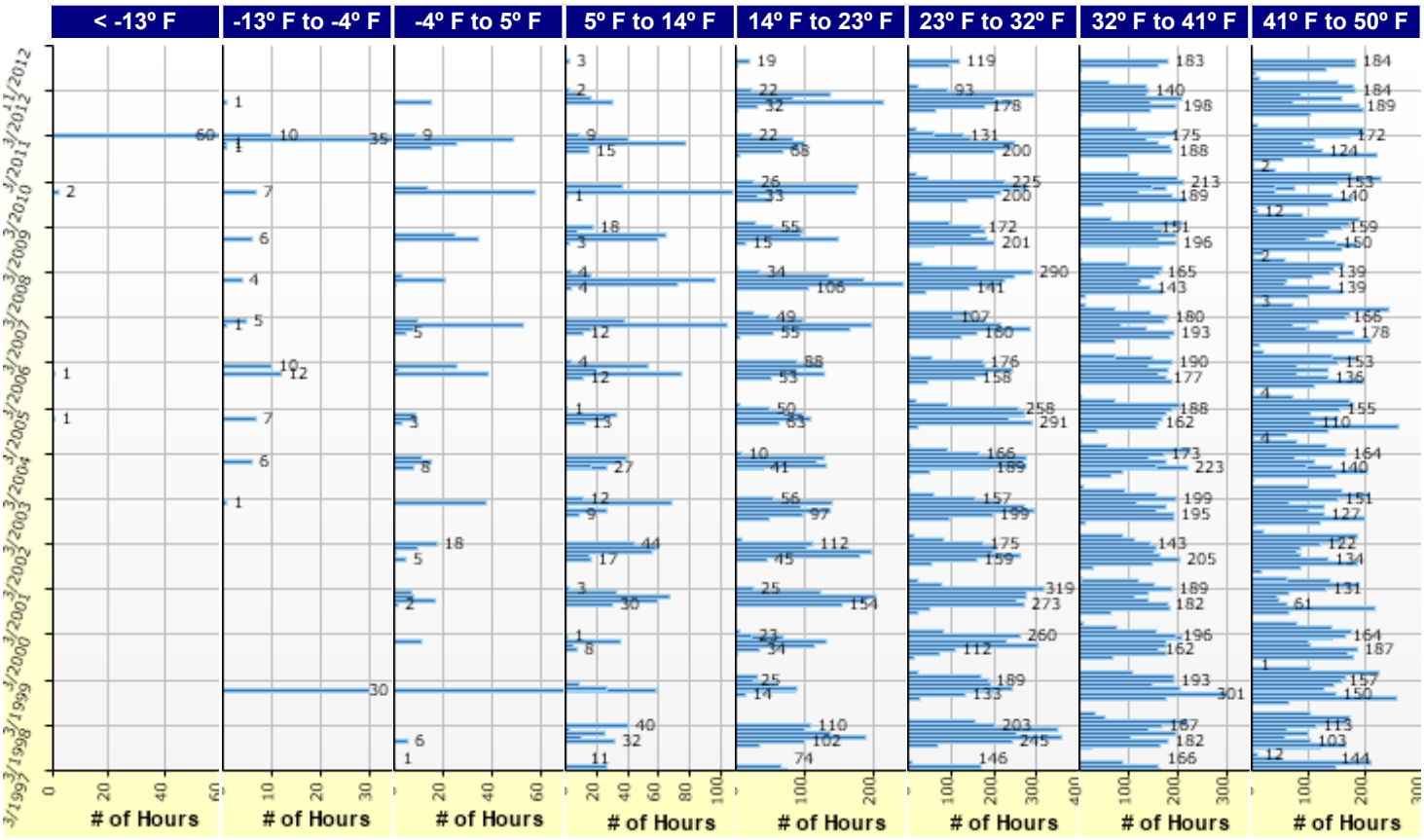


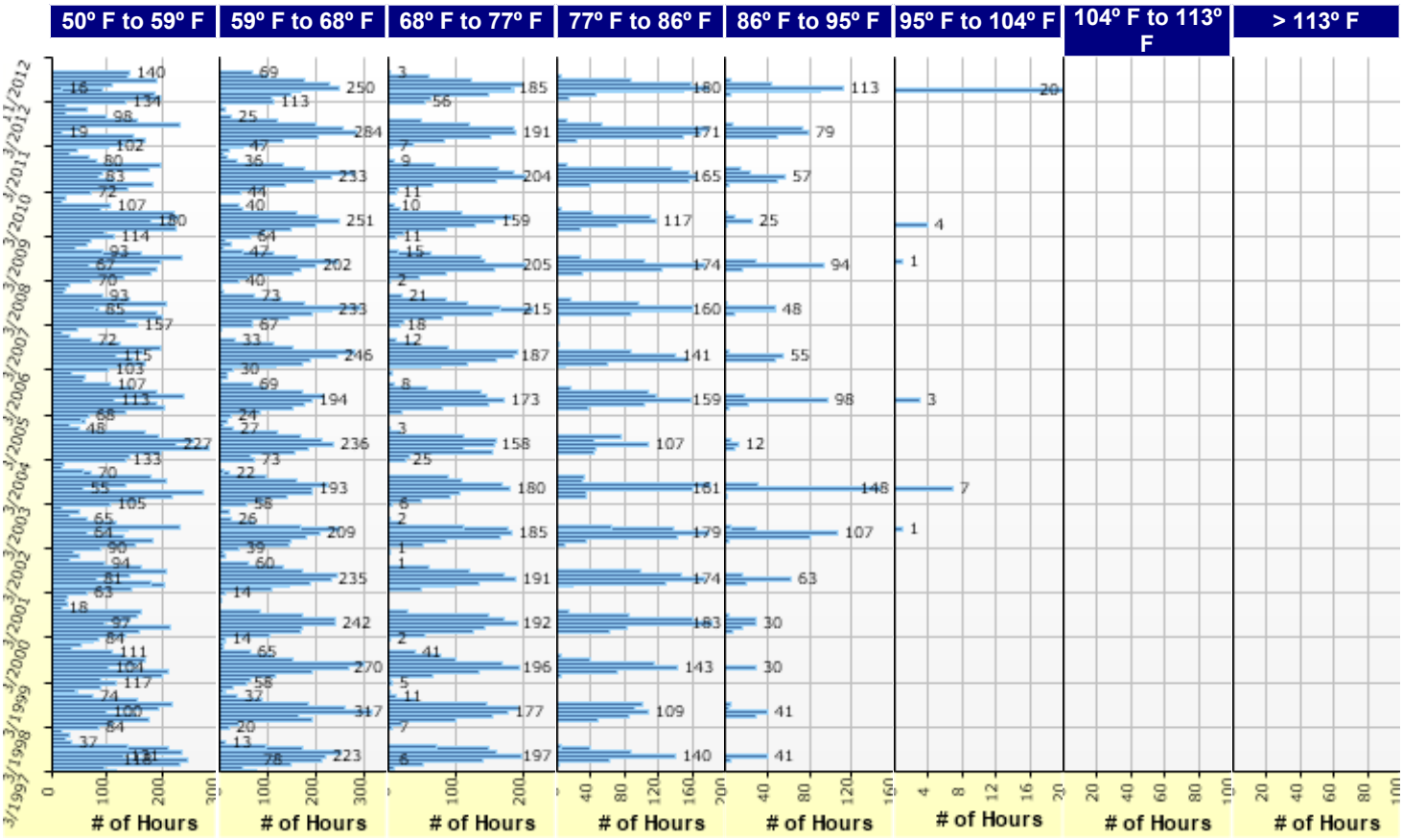






Hourly Air Temperature Distribution by Month:





Design Properties

JPCP Design Properties

Structure - ICM Properties	
PCC surface shortwave absorptivity	0.85

Doweled Joints	
Is joint doweled ?	True
Dowel diameter (in)	1.25
Dowel spacing (in)	12.00

Tied Shoulders	
Tied shoulders	False
Load transfer efficiency (%)	-

PCC joint spacing (ft)	
Is joint spacing random ?	False
Joint spacing (ft)	15.00

Widened Slab	
Is slab widened ?	False
Slab width (ft)	12.00

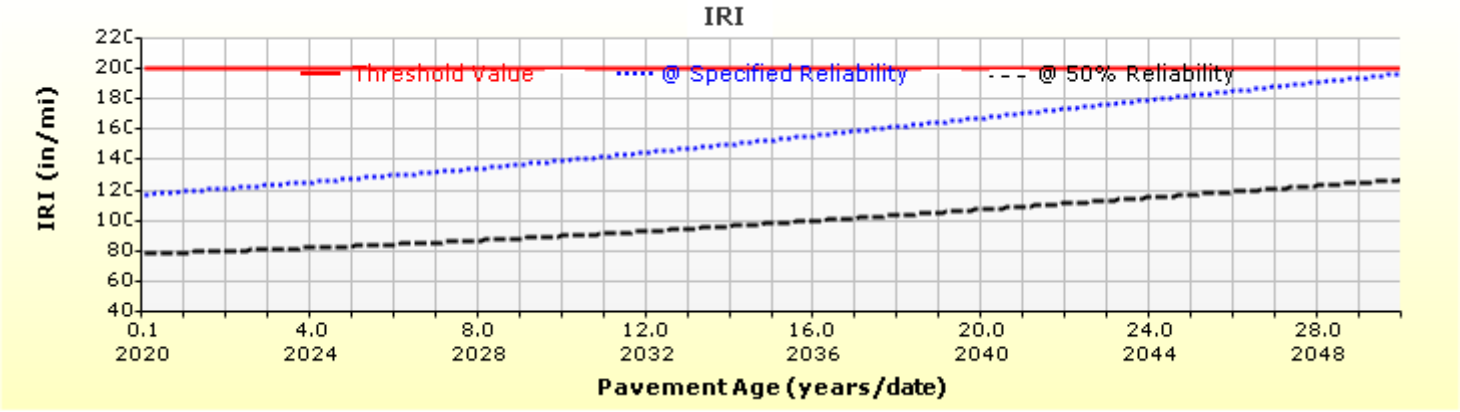
PCC-Base Contact Friction	
PCC-Base full friction contact	True
Months until friction loss	240.00

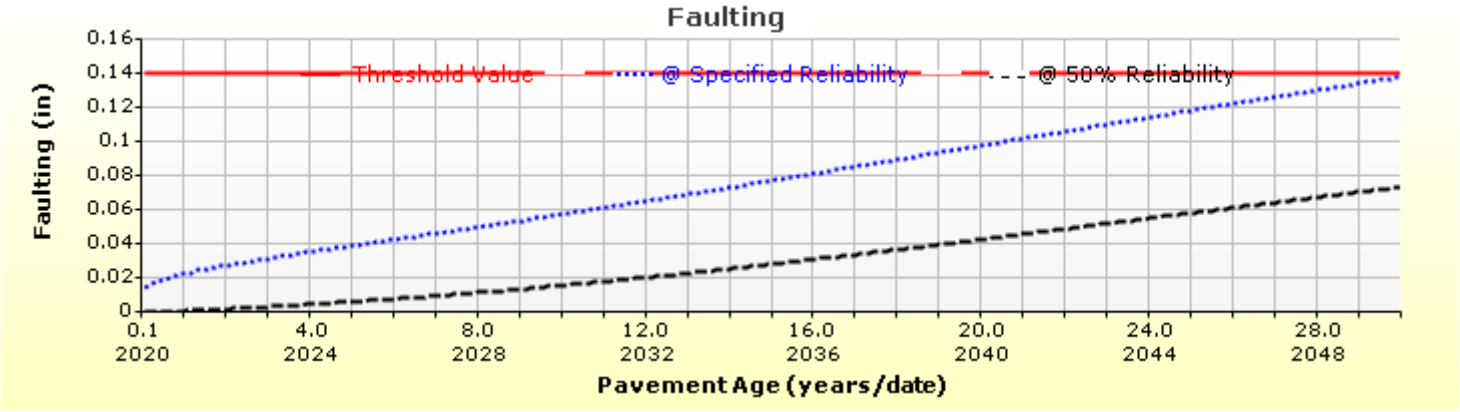
Sealant type	Preformed

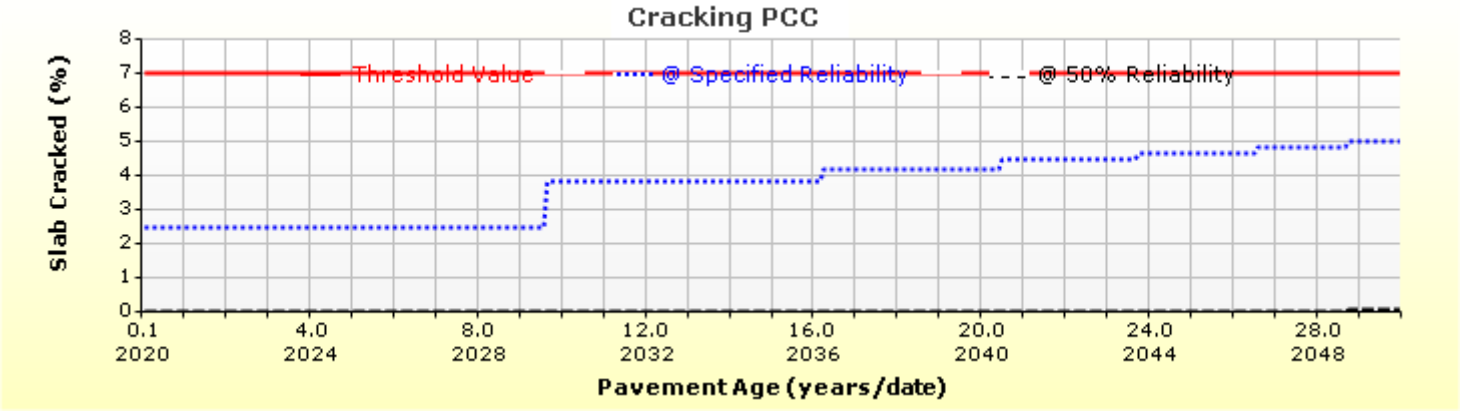
Erodibility index	5

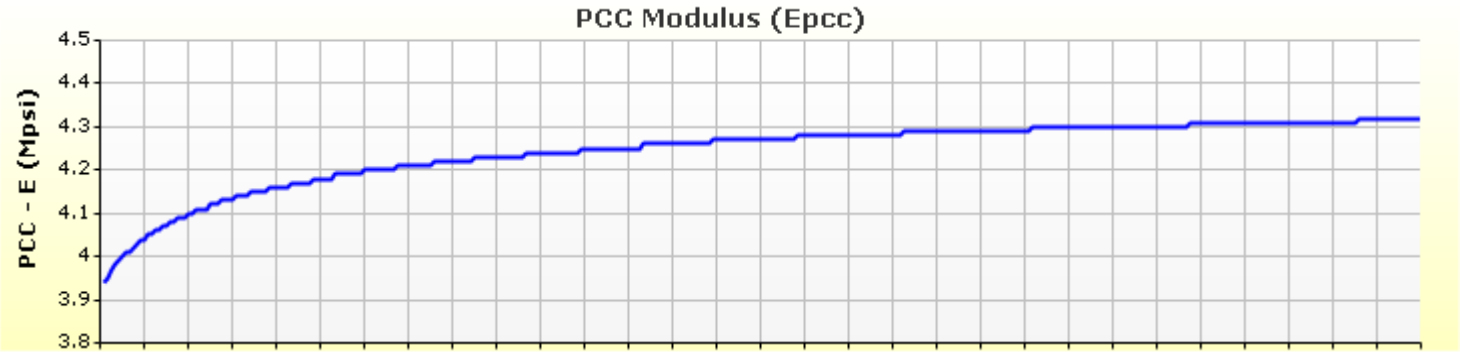
Permanent curl/warp effective temperature difference (ºF)	-10.00

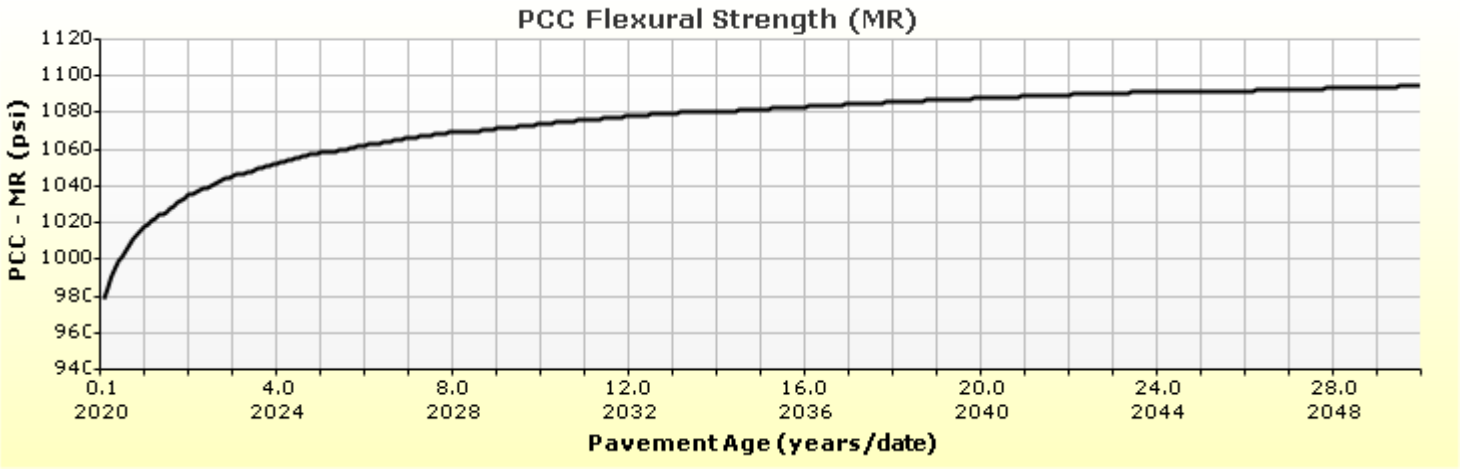
Analysis Output Charts

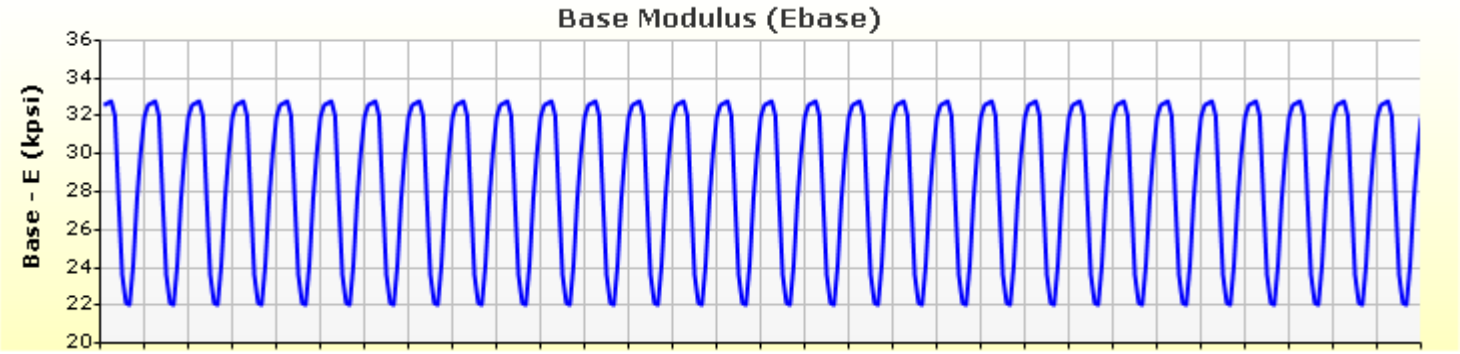


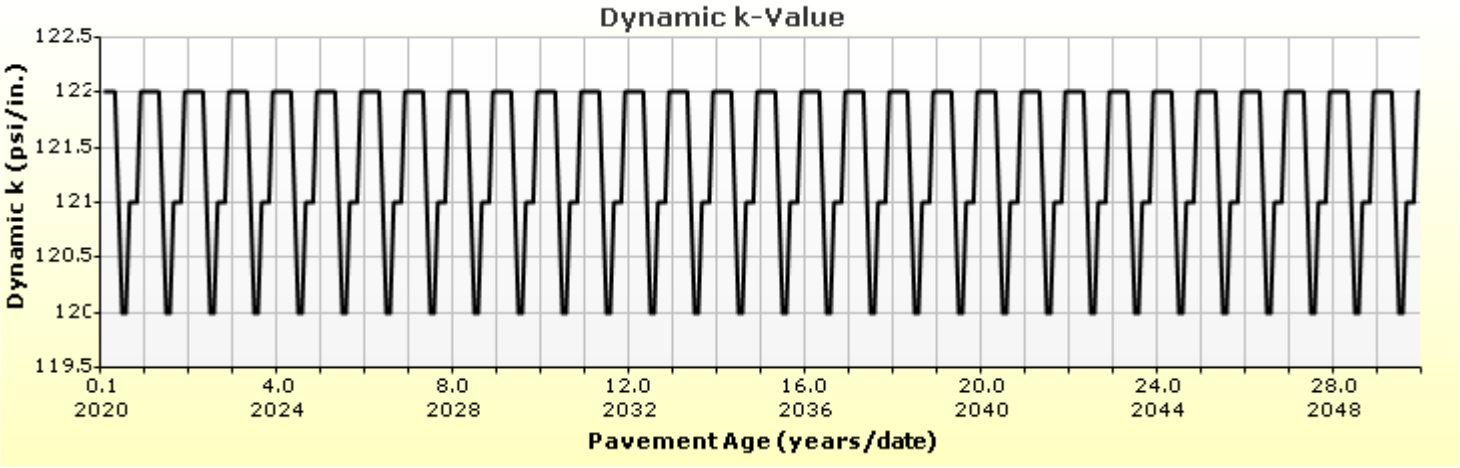


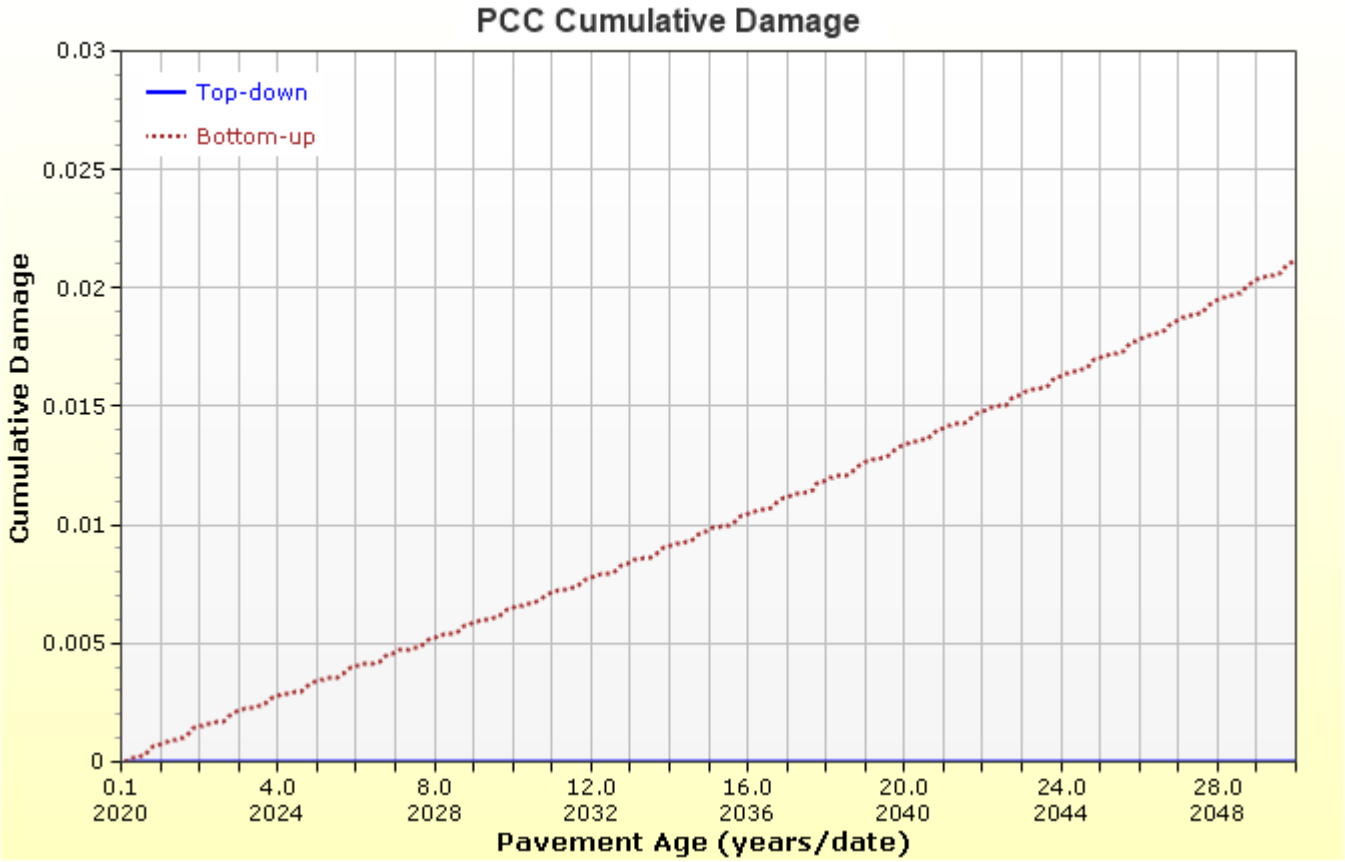


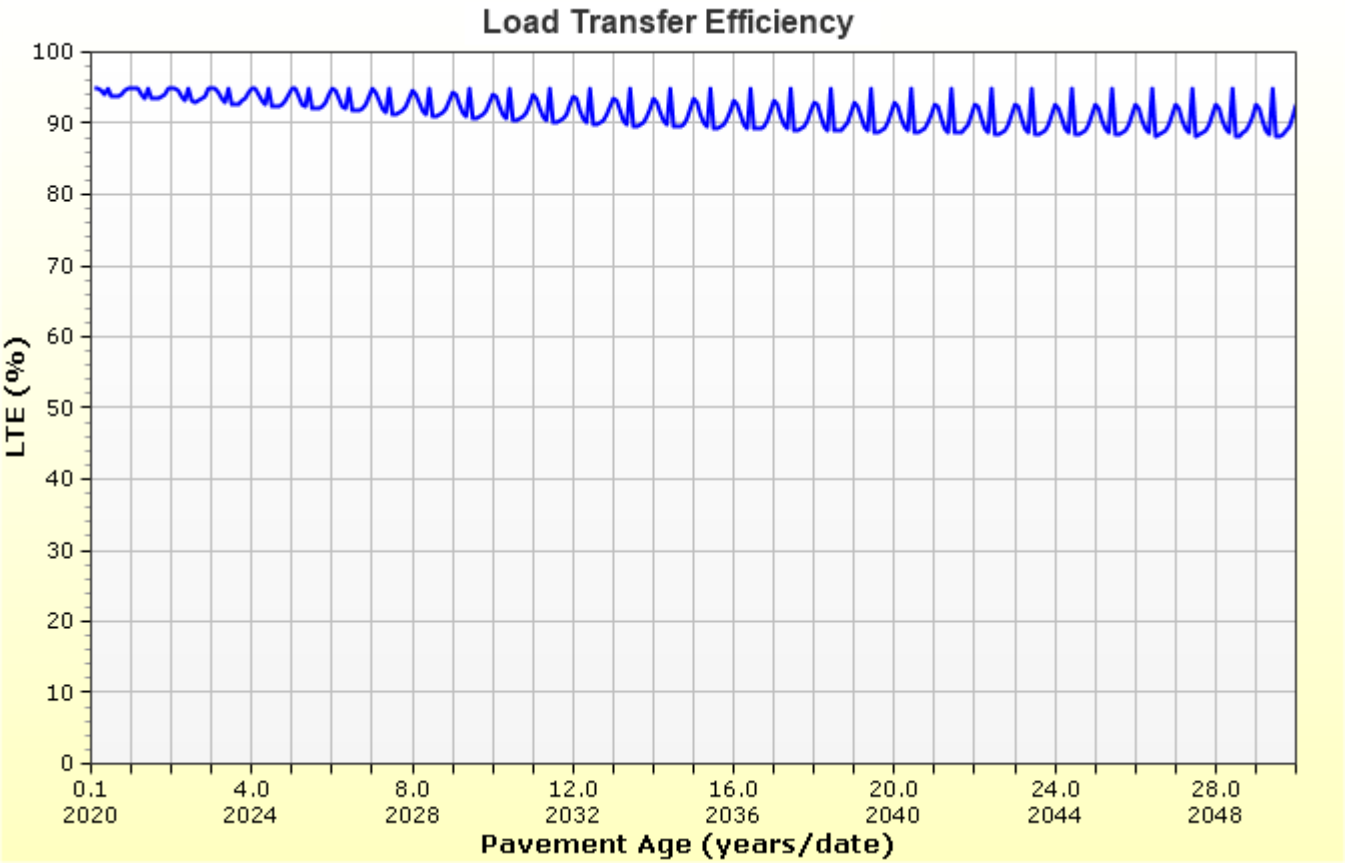

PCC Modulus (Epcc)
PCC - E (Mpsi)
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8


PCC Flexural Strength (MR)
PCC - MR (psi)
1120
1100
1080
1060
1040
1020
1000
980
960
940
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)


Base Modulus (Ebase)
Base - E (kpsi)
36
34
32
30
28
26
24
22
20


Dynamic k-Value
Dynamic k (psi/in.)
122.5
122
121.5
121
120.5
120
119.5
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)


PCC Cumulative Damage
Top-down
Bottom-up
Cumulative Damage
0.03
0.025
0.02
0.015
0.01
0.005
0
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)


Load Transfer Efficiency
LTE (%)
100
90
80
70
60
50
40
30
20
10
0
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)

Layer Information

Layer 1 PCC : JPCP Default

PCC	
Thickness (in)	9.0
Unit weight (pcf)	139.8
Poisson's ratio	0.2

Thermal	
PCC coefficient of thermal expansion (in/in/ºF x 10^-6)	4.72
PCC thermal conductivity (BTU/hr-ft-ºF)	1.25
PCC heat capacity (BTU/lb-ºF)	0.28

Mix		
Cement type		Type I (1)
Cementitious material content (lb/yd^3)		677
Water to cement ratio		0.44
Aggregate type		Granite (3)
PCC zero-stress temperature (ºF)	Calculated Internally?	True
	User Value	-
	Calculated Value	60.1
Ultimate shrinkage (microstrain)	Calculated Internally?	True
	User Value	-
	Calculated Value	701.5
Reversible shrinkage (%)		50
Time to develop 50% of ultimate shrinkage (days)		35
Curing method		Curing Compound

PCC strength and modulus (Input Level: 3)

28-Day PCC modulus of rupture (psi)	900.0
28-Day PCC elastic modulus (psi)	3550000.0

Identifiers

Field	Value
Display name/identifier	JPCP Default
Description of object	
Author	
Date Created	11/17/2017 1:59:42 PM
Approver	
Date approved	11/17/2017 1:59:42 PM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Layer 2 Non-stabilized Base : Class 6 ABC

Unbound	
Layer thickness (in)	6.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
22000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Class 6 ABC
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	42

Sieve

Liquid Limit	30.0
Plasticity Index	6.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	125.3
Saturated hydraulic conductivity (ft/hr)	False	2.257e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	8.3

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	12.2329
bf	1.1153
cf	0.8619
hr	244.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	12.0
#100	
#80	
#60	
#50	
#40	
#30	
#20	
#16	
#10	
#8	55.0
#4	65.0
3/8-in.	
1/2-in.	
3/4-in.	95.0
1-in.	100.0
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 3 Subgrade : A-6

Unbound	
Layer thickness (in)	24.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
7000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-6
Description of object	clayey sand
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	32

Sieve

Liquid Limit	37.0
Plasticity Index	18.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	112.9
Saturated hydraulic conductivity (ft/hr)	False	1.153e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	14.9

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	102.5522
bf	0.7198
cf	0.2545
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	47.0
#100	
#80	
#60	
#50	
#40	72.0
#30	
#20	
#16	
#10	
#8	
#4	98.0
3/8-in.	
1/2-in.	
3/4-in.	
1-in.	
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 4 Subgrade : A-6

Unbound	
Layer thickness (in)	Semi-infinite
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
7000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-6
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	33.0
Plasticity Index	16.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	107.9
Saturated hydraulic conductivity (ft/hr)	False	1.95e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	17.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	108.4091
bf	0.6801
cf	0.2161
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	63.2
#100	
#80	73.5
#60	
#50	
#40	82.4
#30	
#20	
#16	
#10	90.2
#8	
#4	93.5
3/8-in.	96.4
1/2-in.	97.4
3/4-in.	98.4
1-in.	99.0
1 1/2-in.	99.5
2-in.	99.8
2 1/2-in.	
3-in.	
3 1/2-in.	100.0

Calibration Coefficients

PCC Faulting

$$C_{12} = C_1 + (C_2 * FR^{0.25})$$
$$C_{34} = C_3 + (C_4 * FR^{0.25})$$
$$FaultMax_0 = C_{12} * \delta_{curling} * \left[\log(1 + C_5 * 5.0^{EROD}) * \log\left(P_{200} * \frac{WetDays}{p_S}\right)\right]^{C_6}$$
$$FaultMax_i = FaultMax_0 + C_7 * \sum_{j=1}^{m} DE_j * \log(1 + C_5 * 5.0^{EROD})^{C_6}$$
$$\Delta Fault_i = C_{34} * (FaultMax_{i-1} - Fault_{i-1})^2 * DE_i$$
$$C_8 = DowelDeterioration$$

C1: 0.5104	C2: 0.00838	C3: 0.00147	C4: 0.008345
C5: 5999	C6: 0.8404	C7: 5.9293	C8: 400
PCC Reliability Faulting Standard Deviation			
0.0831*Pow(FAULT,0.3426) + 0.00521			

IRI-jpcp

C1 - Cracking	C1: 0.8203	C2: 0.4417
C2 - Spalling	C3: 1.4929	C4: 25.24
C3 - Faulting	**Reliability Standard Deviation**	
C4 - Site Factor	5.4	

PCC Cracking

$$\log(N) = C1 \cdot \left(\frac{MR}{\sigma}\right)^{C2}$$
$$CRK = \frac{100}{1 + C4\ FD^{C5}}$$

Fatigue Coefficients		Cracking Coefficients	
C1: 2	C2: 1.22	C4: 0.6	C5: -2.05
PCC Reliability Cracking Standard Deviation			
Pow(57.08*CRACK,0.33) + 1.5			

Powers South of Research JPCP

File Name: C:\Users\darwinME\Desktop\DPC\Powers South of Research JPCP.dgpx

Design Inputs

Design Life: 30 years
Design Type: JPCP

Existing construction: -
Pavement construction: March, 2020
Traffic opening: August, 2020

Climate Data Sources (Lat/Lon): 38.812, -104.711

Design Structure

Layer type	Material Type	Thickness (in)
PCC	JPCP Default	10.5 (Optimized)
NonStabilized	Class 6 ABC	6.0
Subgrade	A-6	24.0
Subgrade	A-6	Semi-infinite

Joint Design:	
Joint spacing (ft)	15.0
Dowel diameter (in)	1.25
Slab width (ft)	12.0

Traffic

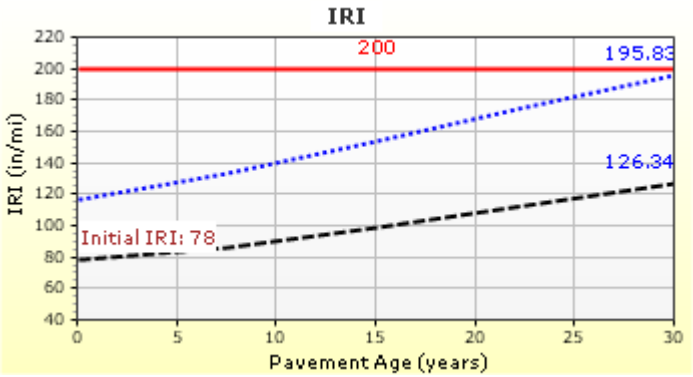
Age (year)	Heavy Trucks (cumulative)
2020 (initial)	2,468
2035 (15 years)	4,673,300
2050 (30 years)	10,953,700

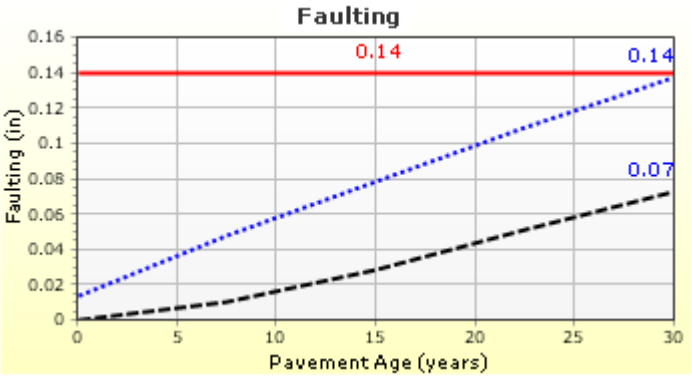
Design Outputs

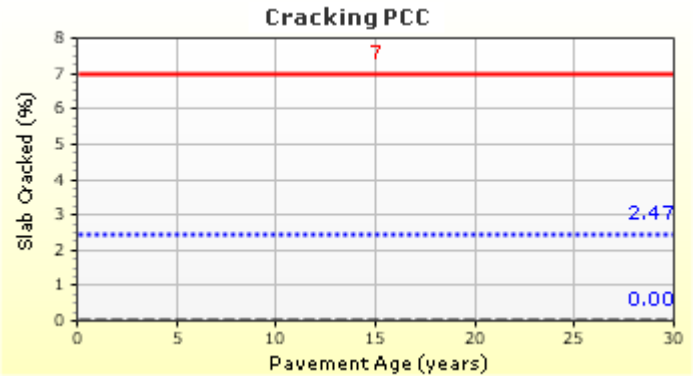
Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	200.00	195.83	95.00	95.94	Pass
Mean joint faulting (in)	0.14	0.14	95.00	95.58	Pass
JPCP transverse cracking (percent slabs)	7.00	2.47	95.00	100.00	Pass

Distress Charts



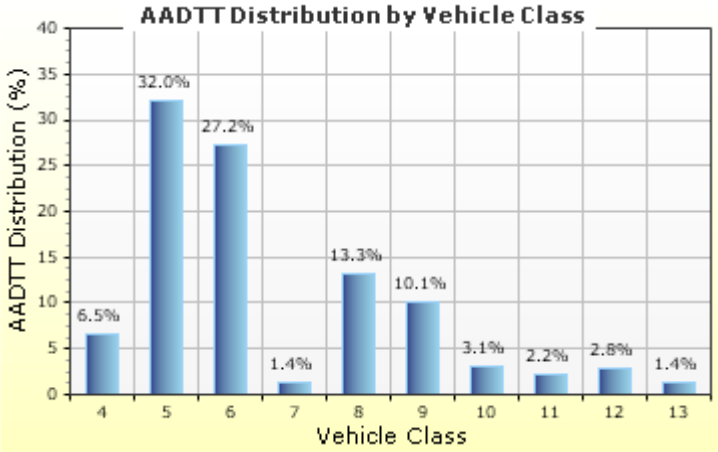


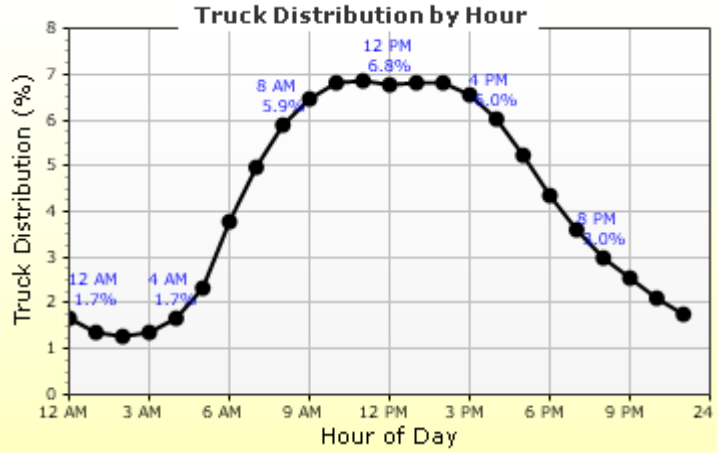


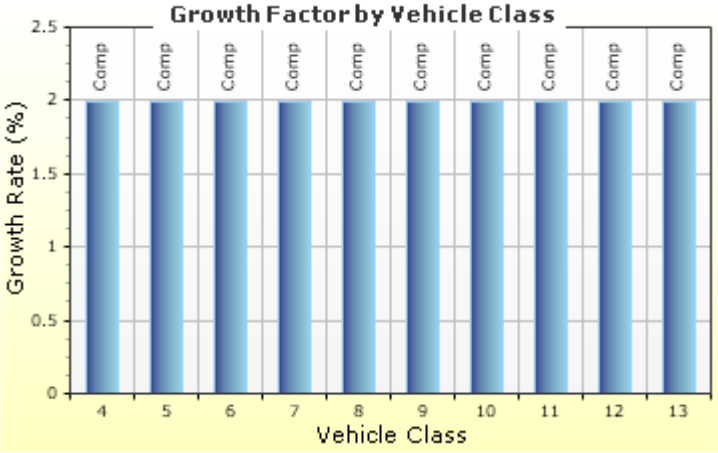
Traffic Inputs

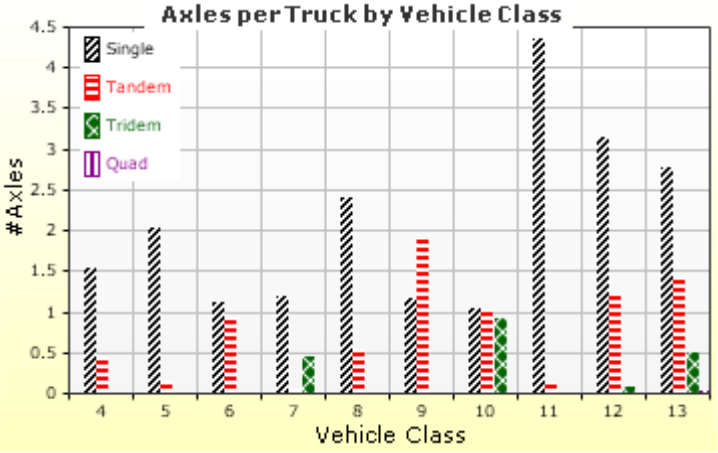
Graphical Representation of Traffic Inputs

Initial two-way AADTT:	2,468	Percent of trucks in design direction (%):	50.0
Number of lanes in design direction:	3	Percent of trucks in design lane (%):	60.0
		Operational speed (mph)	70.0

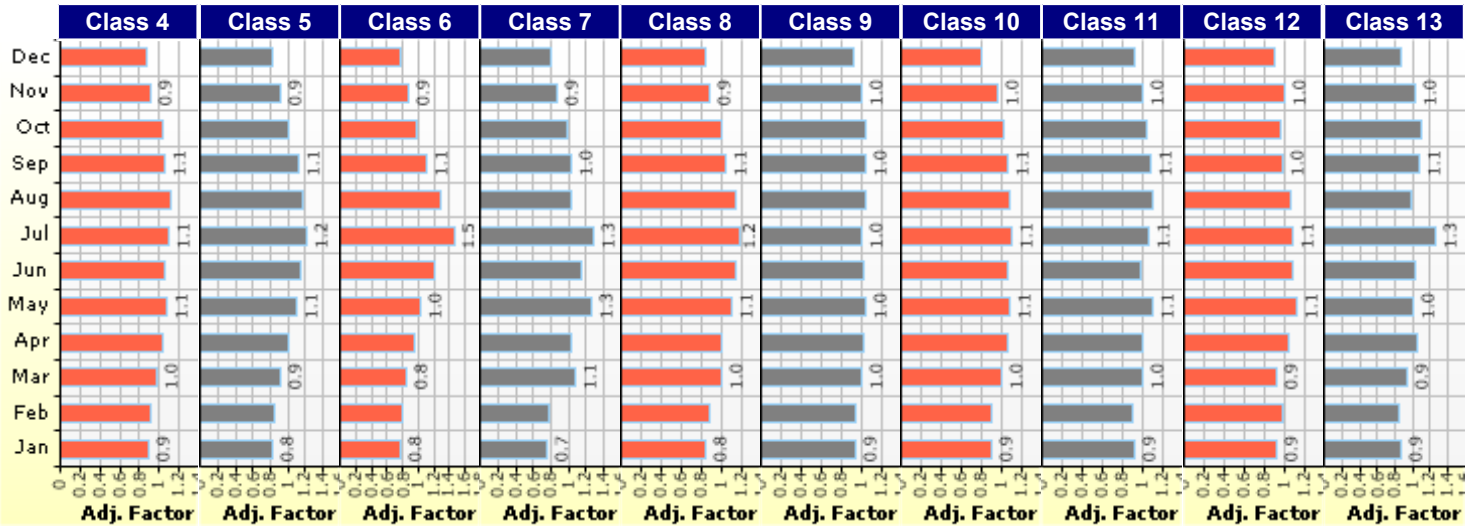








Traffic Volume Monthly Adjustment Factors



Tabular Representation of Traffic Inputs

Volume Monthly Adjustment Factors

Level 3: Default MAF

Month	Vehicle Class									
	4	5	6	7	8	9	10	11	12	13
January	0.9	0.8	0.8	0.7	0.8	0.9	0.9	0.9	0.9	0.9
February	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.8
March	1.0	0.9	0.8	1.1	1.0	1.0	1.0	1.0	0.9	0.9
April	1.0	1.0	0.9	1.0	1.0	1.0	1.1	1.0	1.0	1.1
May	1.1	1.1	1.0	1.3	1.1	1.0	1.1	1.1	1.1	1.0
June	1.1	1.1	1.2	1.1	1.1	1.0	1.1	1.0	1.1	1.0
July	1.1	1.2	1.5	1.3	1.2	1.0	1.1	1.1	1.1	1.3
August	1.1	1.2	1.3	1.0	1.1	1.0	1.1	1.1	1.1	1.0
September	1.1	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1
October	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.1
November	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0
December	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.9	0.9

Distributions by Vehicle Class

Vehicle Class	AADTT Distribution (%) (Level 3)	Growth Factor	
		Rate (%)	Function
Class 4	6.54%	1.99%	Compound
Class 5	32.02%	1.99%	Compound
Class 6	27.23%	1.99%	Compound
Class 7	1.38%	1.99%	Compound
Class 8	13.25%	1.99%	Compound
Class 9	10.07%	1.99%	Compound
Class 10	3.1%	1.99%	Compound
Class 11	2.19%	1.99%	Compound
Class 12	2.82%	1.99%	Compound
Class 13	1.4%	1.99%	Compound

Truck Distribution by Hour

Hour	Distribution (%)	Hour	Distribution (%)
12 AM	1.65%	12 PM	6.75%
1 AM	1.37%	1 PM	6.81%
2 AM	1.28%	2 PM	6.83%
3 AM	1.36%	3 PM	6.56%
4 AM	1.66%	4 PM	6.02%
5 AM	2.32%	5 PM	5.23%
6 AM	3.8%	6 PM	4.35%
7 AM	4.95%	7 PM	3.59%
8 AM	5.9%	8 PM	2.98%
9 AM	6.48%	9 PM	2.56%
10 AM	6.83%	10 PM	2.12%
11 AM	6.85%	11 PM	1.75%
		Total	100%

Axle Configuration

Traffic Wander	
Mean wheel location (in)	18.0
Traffic wander standard deviation (in)	10.0
Design lane width (ft)	12.0

Axle Configuration	
Average axle width (ft)	8.5
Dual tire spacing (in)	12.0
Tire pressure (psi)	120.0

Average Axle Spacing	
Tandem axle spacing (in)	51.6
Tridem axle spacing (in)	49.2
Quad axle spacing (in)	49.2

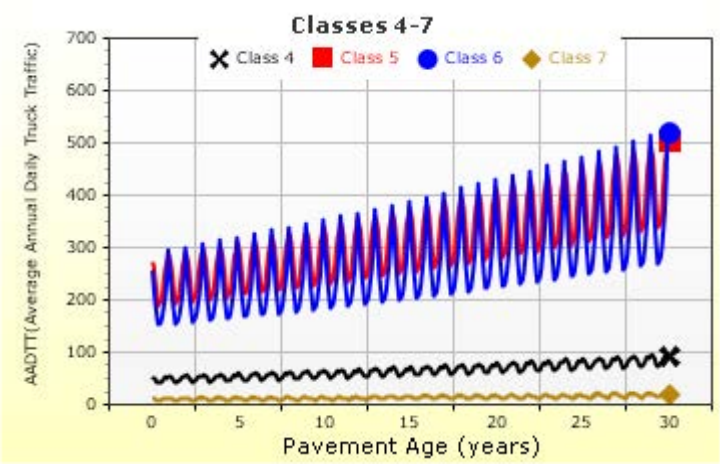
Wheelbase				
Value Type	Axle Type	Short	Medium	Long
Average spacing of axles (ft)		12.0	15.0	18.0
Percent of Trucks (%)		17.0	22.0	61.0

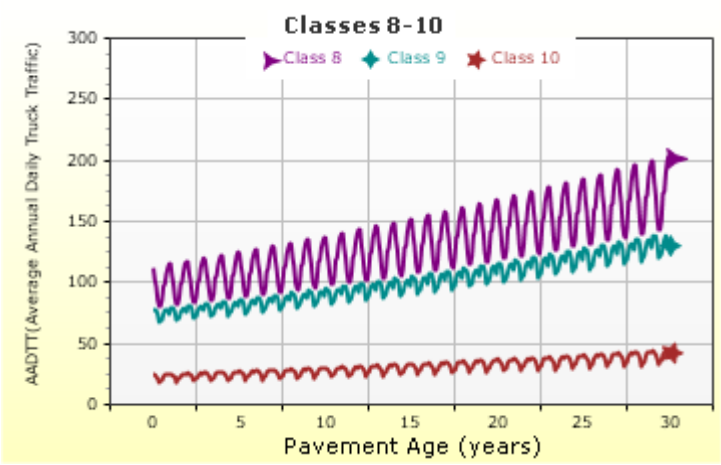
Number of Axles per Truck

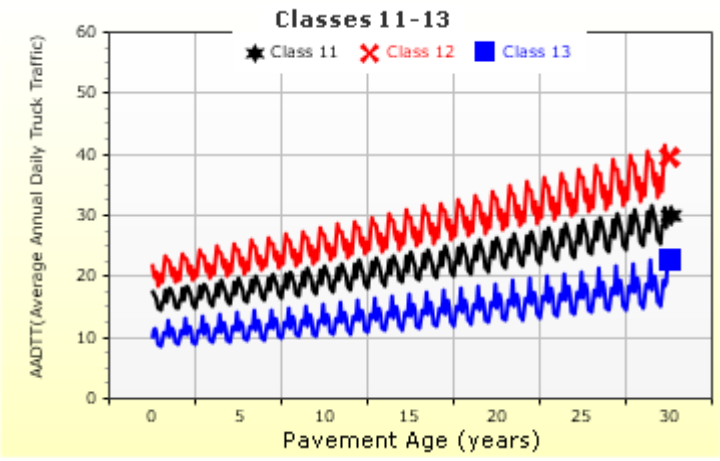
Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.53	0.45	0	0
Class 5	2.02	0.16	0.02	0
Class 6	1.12	0.93	0	0
Class 7	1.19	0.07	0.45	0.02
Class 8	2.41	0.56	0.02	0
Class 9	1.16	1.88	0.01	0
Class 10	1.05	1.01	0.93	0.02
Class 11	4.35	0.13	0	0
Class 12	3.15	1.22	0.09	0
Class 13	2.77	1.4	0.51	0.04

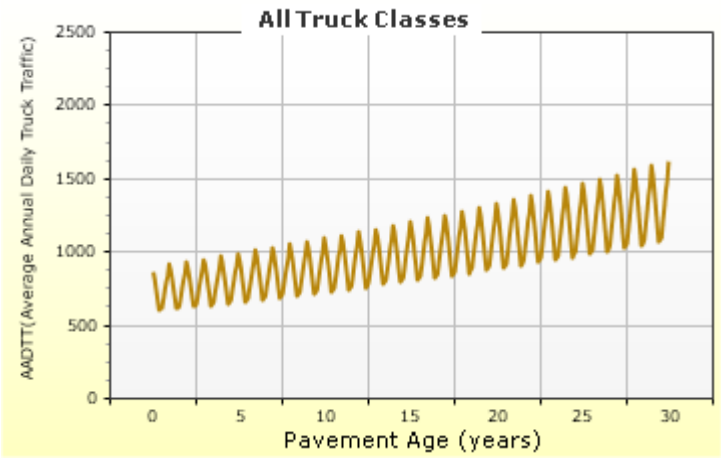
AADTT (Average Annual Daily Truck Traffic) Growth

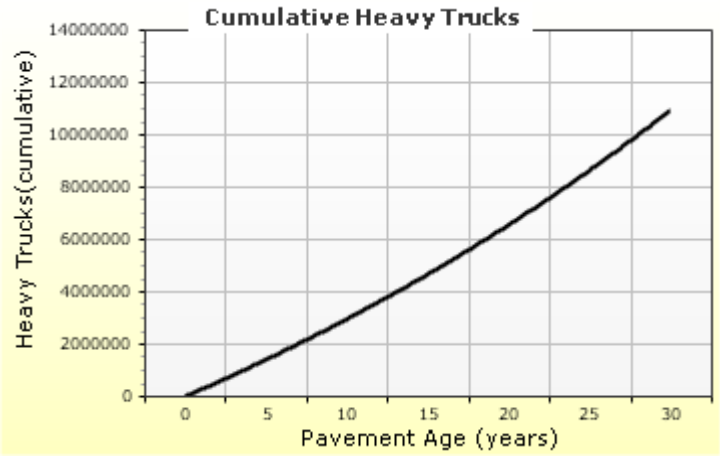
*** Traffic cap is not enforced**







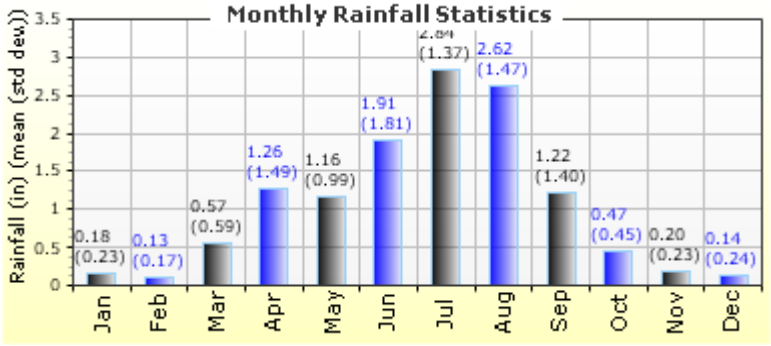




Climate Inputs

Climate Data Sources:

Climate Station Cities:	Location (lat lon elevation(ft))
COLORADO SPRINGS,	38.81200 -104.71100 6170

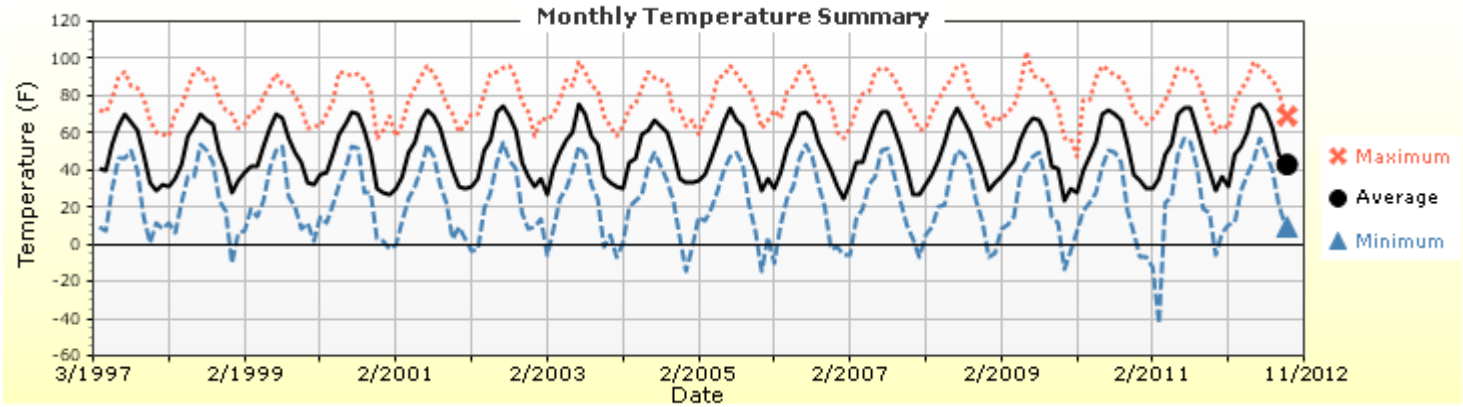


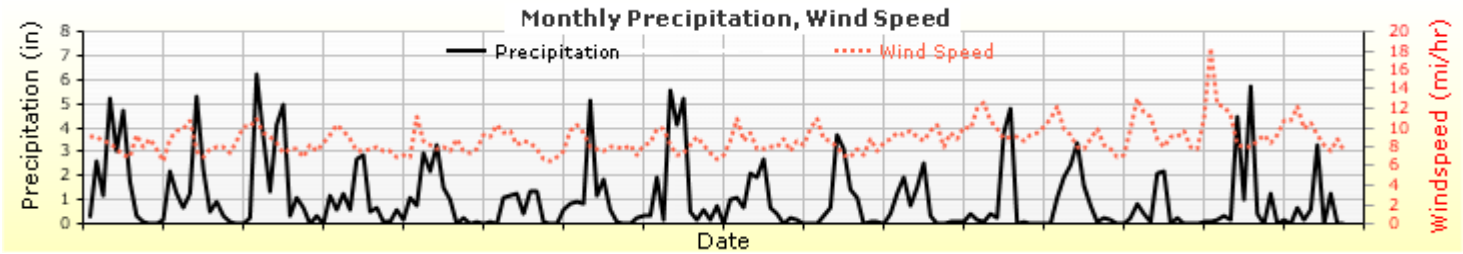
Annual Statistics:

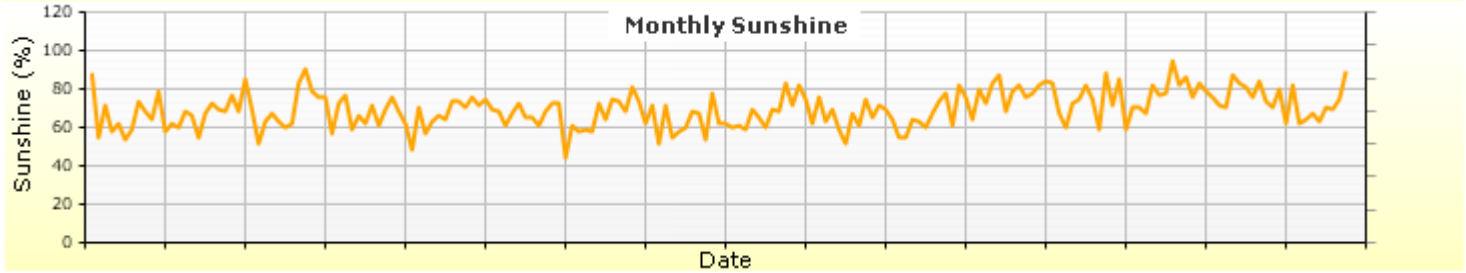
Mean annual air temperature (ºF)	49.78
Mean annual precipitation (in)	12.82
Freezing index (ºF - days)	487.57
Average annual number of freeze/thaw cycles:	131.57

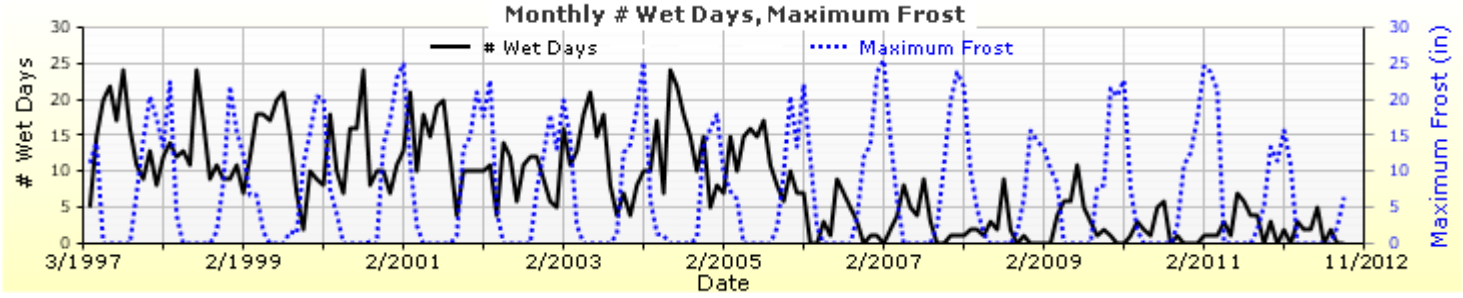
Water table depth (ft)	10.00

Monthly Climate Summary:

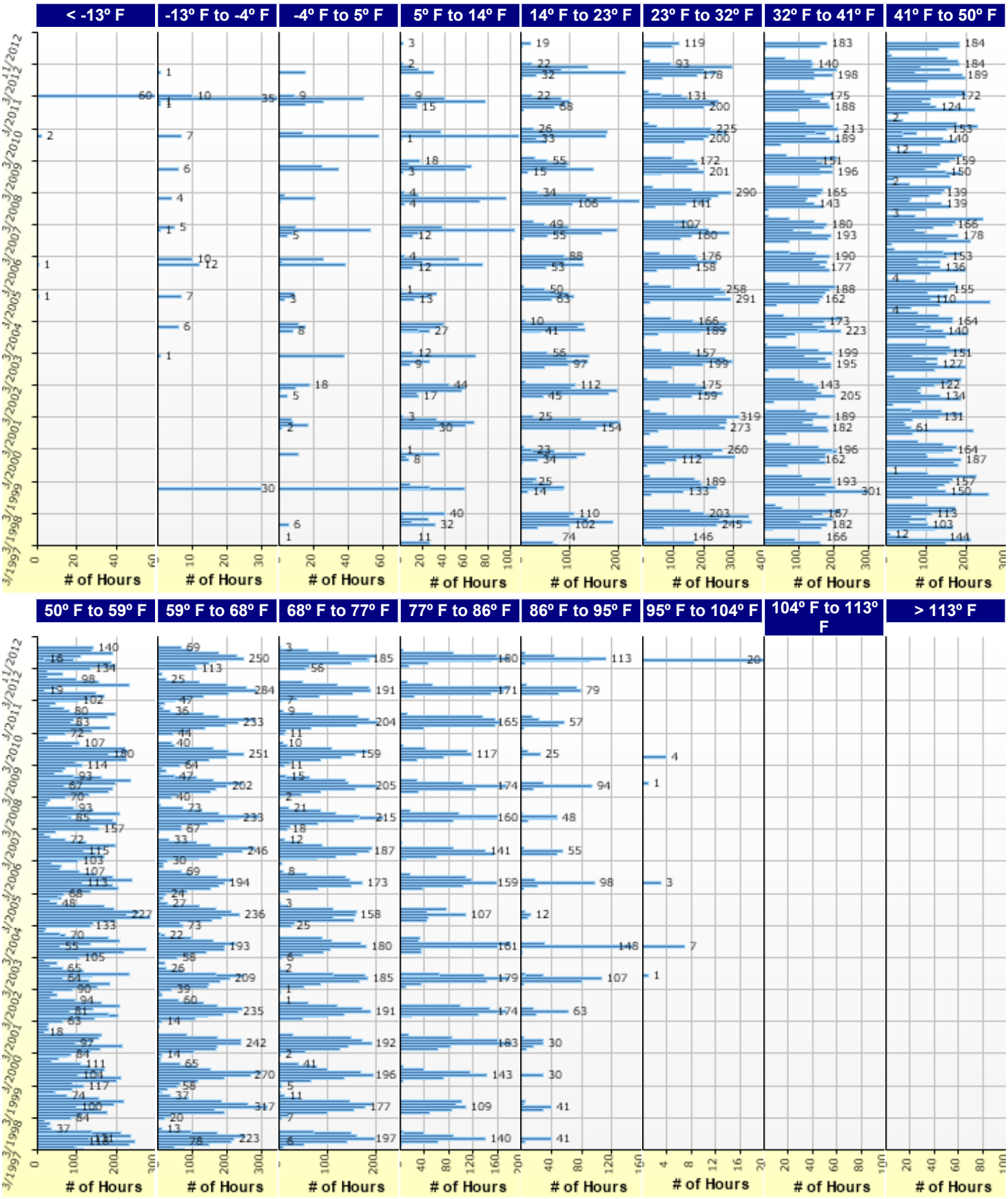








Hourly Air Temperature Distribution by Month:



Design Properties

JPCP Design Properties

Structure - ICM Properties	
PCC surface shortwave absorptivity	0.85

Doweled Joints	
Is joint doweled ?	True
Dowel diameter (in)	1.25
Dowel spacing (in)	12.00

Tied Shoulders	
Tied shoulders	False
Load transfer efficiency (%)	-

PCC joint spacing (ft)	
Is joint spacing random ?	False
Joint spacing (ft)	15.00

Widened Slab	
Is slab widened ?	False
Slab width (ft)	12.00

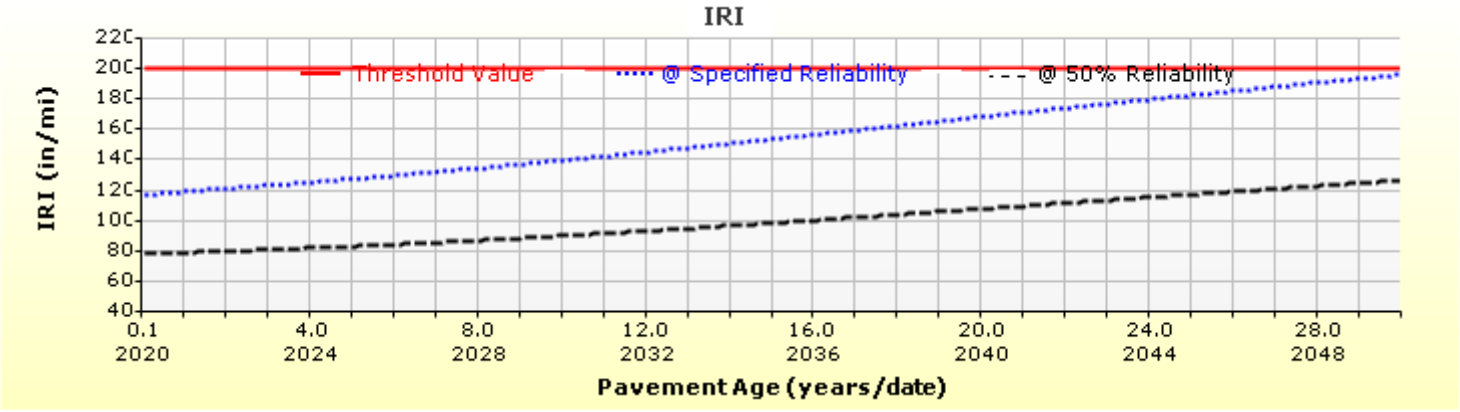
PCC-Base Contact Friction	
PCC-Base full friction contact	True
Months until friction loss	240.00

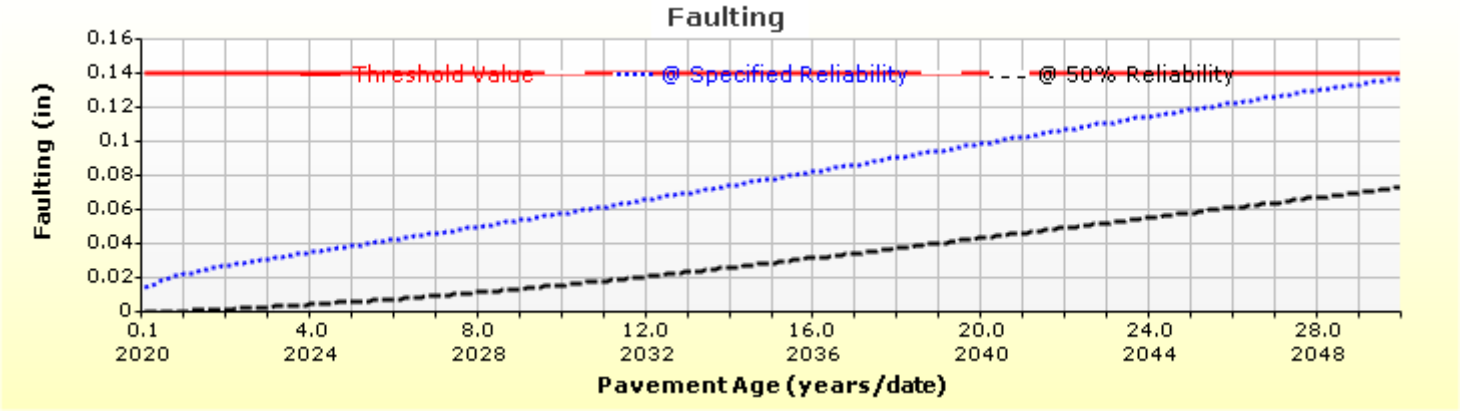
Sealant type	Preformed

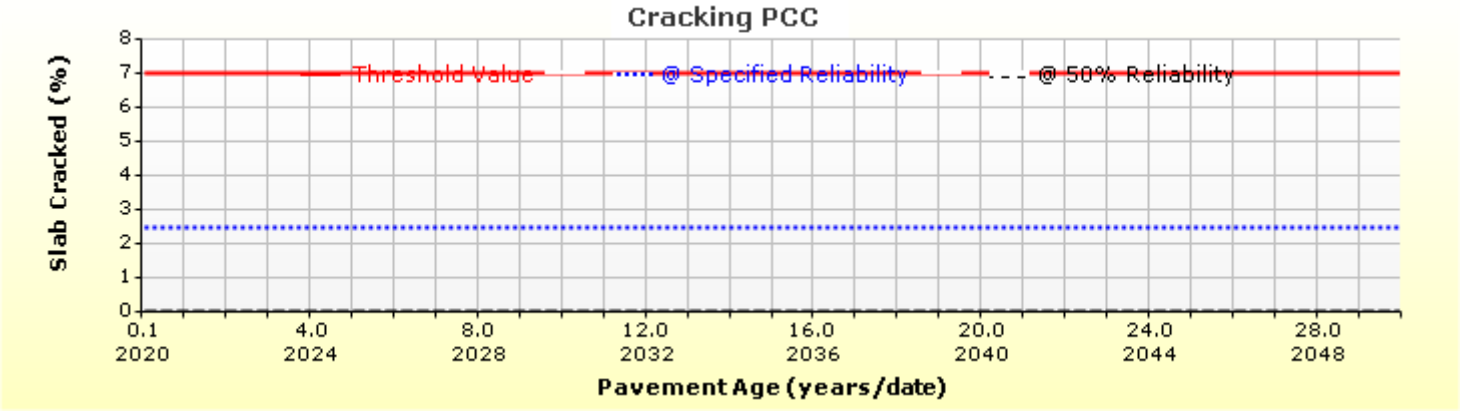
Erodibility index	5

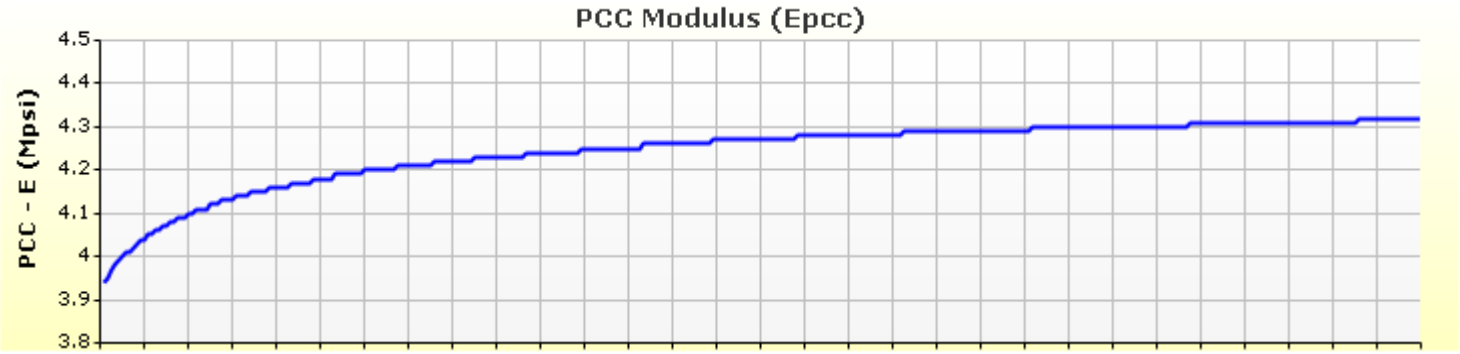
Permanent curl/warp effective temperature difference (ºF)	-10.00

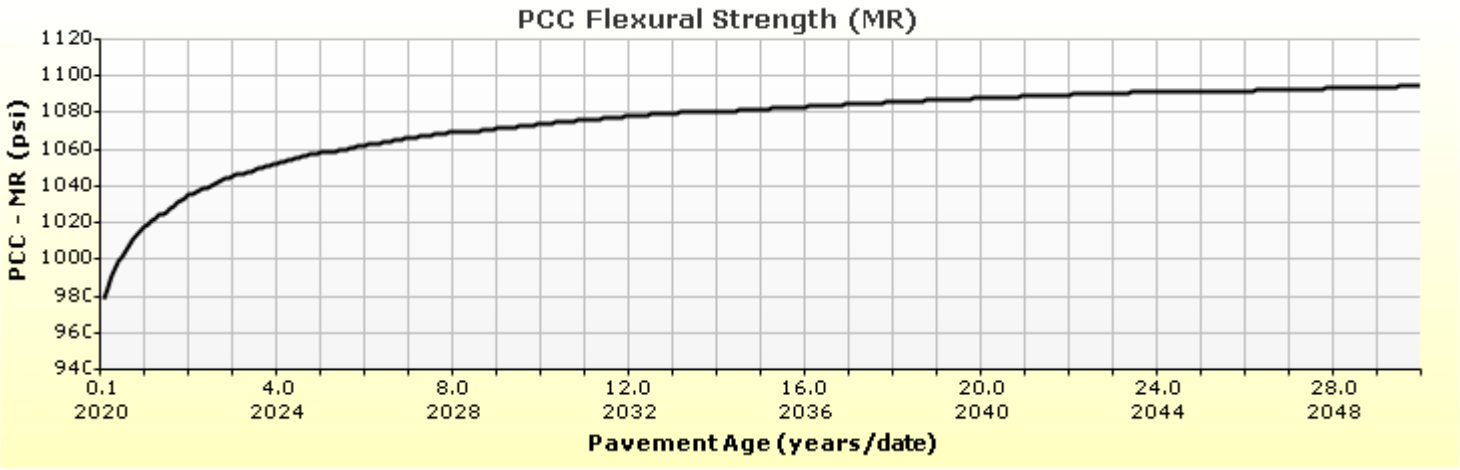
Analysis Output Charts

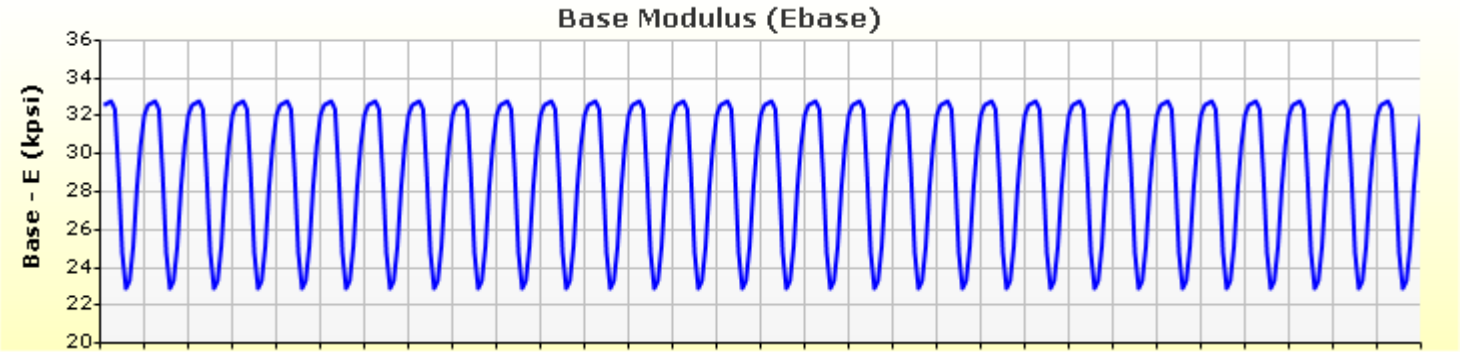


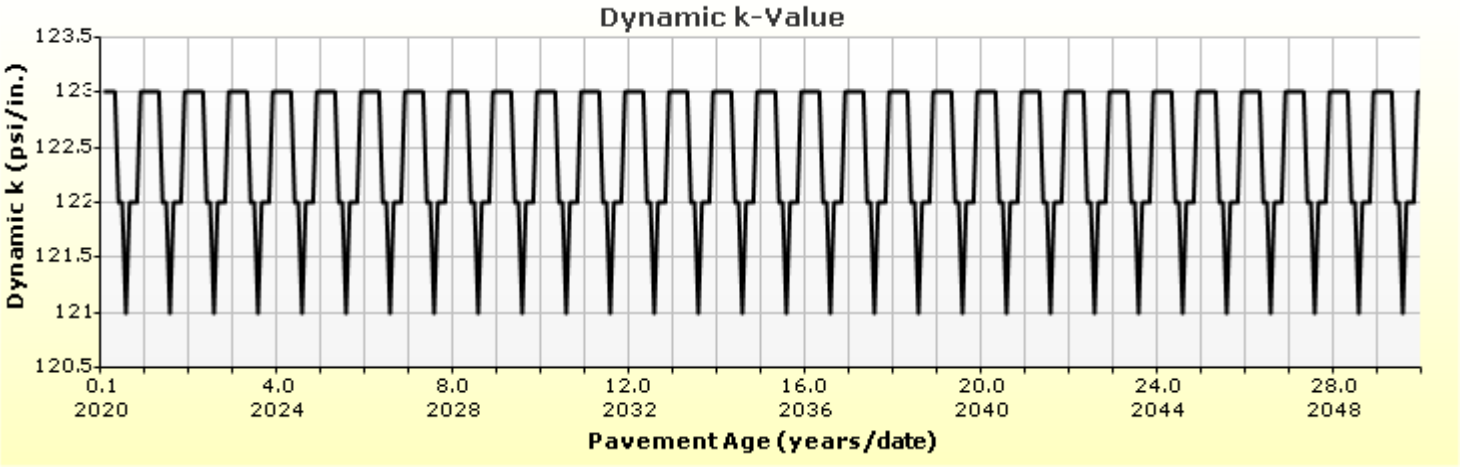


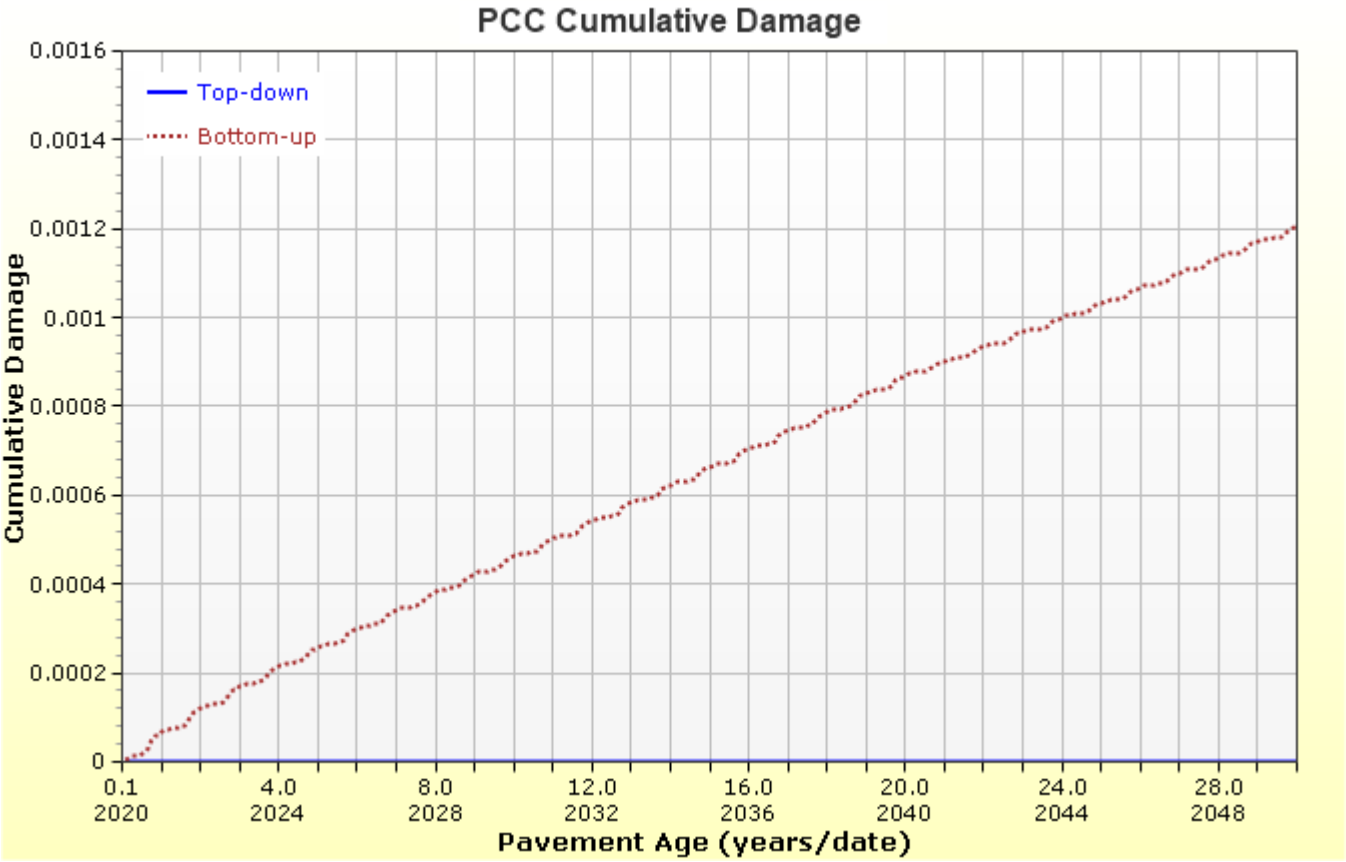


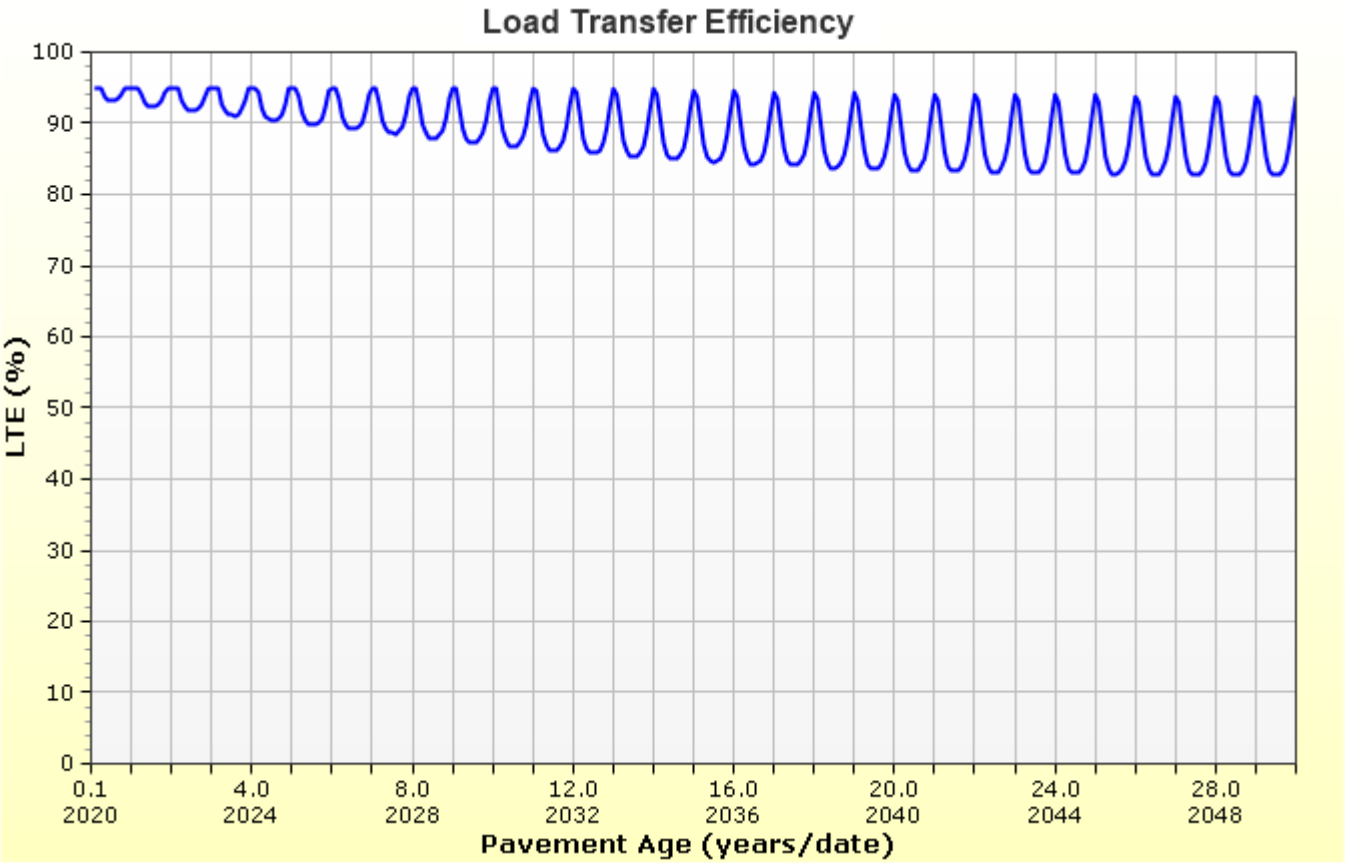

PCC Modulus (Epcc)
PCC - E (Mpsi)
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8


PCC Flexural Strength (MR)
PCC - MR (psi)
1120
1100
1080
1060
1040
1020
1000
980
960
940
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)


Base Modulus (Ebase)
Base - E (kpsi)
36
34
32
30
28
26
24
22
20


Dynamic k-Value
Dynamic k (psi/in.)
123.5
123
122.5
122
121.5
121
120.5
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)


PCC Cumulative Damage
Top-down
Bottom-up
Cumulative Damage
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)


Load Transfer Efficiency
LTE (%)
100
90
80
70
60
50
40
30
20
10
0
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)

Layer Information

Layer 1 PCC : JPCP Default

PCC	
Thickness (in)	10.5
Unit weight (pcf)	139.8
Poisson's ratio	0.2

Thermal	
PCC coefficient of thermal expansion (in/in/ºF x 10^-6)	4.72
PCC thermal conductivity (BTU/hr-ft-ºF)	1.25
PCC heat capacity (BTU/lb-ºF)	0.28

Mix		
Cement type		Type I (1)
Cementitious material content (lb/yd^3)		677
Water to cement ratio		0.44
Aggregate type		Granite (3)
PCC zero-stress temperature (ºF)	Calculated Internally?	True
	User Value	-
	Calculated Value	60.1
Ultimate shrinkage (microstrain)	Calculated Internally?	True
	User Value	-
	Calculated Value	701.5
Reversible shrinkage (%)		50
Time to develop 50% of ultimate shrinkage (days)		35
Curing method		Curing Compound

PCC strength and modulus (Input Level: 3)

28-Day PCC modulus of rupture (psi)	900.0
28-Day PCC elastic modulus (psi)	3550000.0

Identifiers

Field	Value
Display name/identifier	JPCP Default
Description of object	
Author	
Date Created	11/17/2017 1:59:42 PM
Approver	
Date approved	11/17/2017 1:59:42 PM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Layer 2 Non-stabilized Base : Class 6 ABC

Unbound	
Layer thickness (in)	6.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
22000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Class 6 ABC
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	42

Sieve

Liquid Limit	30.0
Plasticity Index	6.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	125.3
Saturated hydraulic conductivity (ft/hr)	False	2.257e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	8.3

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	12.2329
bf	1.1153
cf	0.8619
hr	244.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	12.0
#100	
#80	
#60	
#50	
#40	
#30	
#20	
#16	
#10	
#8	55.0
#4	65.0
3/8-in.	
1/2-in.	
3/4-in.	95.0
1-in.	100.0
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 3 Subgrade : A-6

Unbound	
Layer thickness (in)	24.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
7000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-6
Description of object	clayey sand
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	32

Sieve

Liquid Limit	37.0
Plasticity Index	18.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	112.9
Saturated hydraulic conductivity (ft/hr)	False	1.153e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	14.9

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	102.5522
bf	0.7198
cf	0.2545
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	47.0
#100	
#80	
#60	
#50	
#40	72.0
#30	
#20	
#16	
#10	
#8	
#4	98.0
3/8-in.	
1/2-in.	
3/4-in.	
1-in.	
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 4 Subgrade : A-6

Unbound	
Layer thickness (in)	Semi-infinite
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
7000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-6
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	33.0
Plasticity Index	16.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	107.9
Saturated hydraulic conductivity (ft/hr)	False	1.95e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	17.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	108.4091
bf	0.6801
cf	0.2161
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	63.2
#100	
#80	73.5
#60	
#50	
#40	82.4
#30	
#20	
#16	
#10	90.2
#8	
#4	93.5
3/8-in.	96.4
1/2-in.	97.4
3/4-in.	98.4
1-in.	99.0
1 1/2-in.	99.5
2-in.	99.8
2 1/2-in.	
3-in.	
3 1/2-in.	100.0

Calibration Coefficients

PCC Faulting

$$C_{12} = C_1 + (C_2 * FR^{0.25})$$
$$C_{34} = C_3 + (C_4 * FR^{0.25})$$
$$FaultMax_0 = C_{12} * \delta_{curling} * \left[\log(1 + C_5 * 5.0^{EROD}) * \log\left(P_{200} * \frac{WetDays}{p_S}\right)\right]^{C_6}$$
$$FaultMax_i = FaultMax_0 + C_7 * \sum_{j=1}^{m} DE_j * \log(1 + C_5 * 5.0^{EROD})^{C_6}$$
$$\Delta Fault_i = C_{34} * (FaultMax_{i-1} - Fault_{i-1})^2 * DE_i$$
$$C_8 = DowelDeterioration$$

C1: 0.5104	C2: 0.00838	C3: 0.00147	C4: 0.008345
C5: 5999	C6: 0.8404	C7: 5.9293	C8: 400
PCC Reliability Faulting Standard Deviation			
0.0831*Pow(FAULT,0.3426) + 0.00521			

IRI-jpcp

C1 - Cracking
C2 - Spalling
C3 - Faulting
C4 - Site Factor

C1: 0.8203	C2: 0.4417
C3: 1.4929	C4: 25.24
Reliability Standard Deviation	
5.4	

PCC Cracking

$$\log(N) = C1 \cdot \left(\frac{MR}{\sigma}\right)^{C2}$$
$$CRK = \frac{100}{1 + C4\ FD^{C5}}$$

Fatigue Coefficients		**Cracking Coefficients**	
C1: 2	C2: 1.22	C4: 0.6	C5: -2.05
PCC Reliability Cracking Standard Deviation			
Pow(57.08*CRACK,0.33) + 1.5			

Powers SB Off-ramp (1)

File Name: C:\Users\darwinME\Desktop\AFK\Powers and Research\PCC\Powers SB Off-ramp (1).dgpx

Design Inputs

Design Life: 30 years
Design Type: JPCP

Existing construction: -
Pavement construction: March, 2020
Traffic opening: August, 2020

Climate Data Sources (Lat/Lon): 38.812, -104.711

Design Structure

Layer type	Material Type	Thickness (in)
PCC	JPCP Default	7.5 (Optimized)
NonStabilized	Class 6 ABC	6.0
Subgrade	A-6	24.0
Subgrade	A-6	Semi-infinite

Joint Design:	
Joint spacing (ft)	15.0
Dowel diameter (in)	1.25
Slab width (ft)	12.0

Traffic

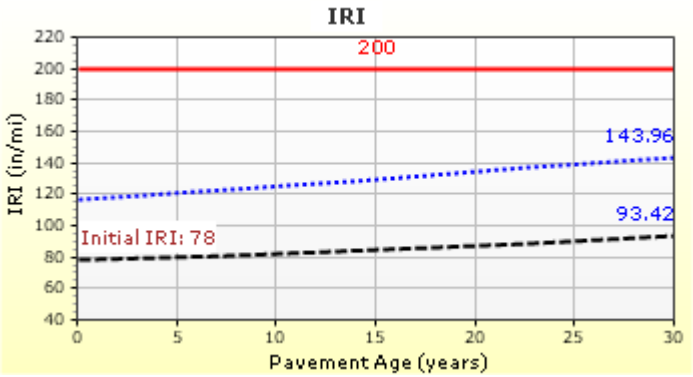
Age (year)	Heavy Trucks (cumulative)
2020 (initial)	101
2035 (15 years)	674,174
2050 (30 years)	1,688,400

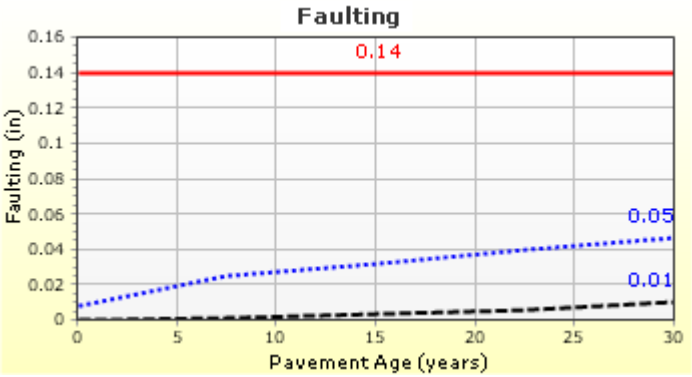
Design Outputs

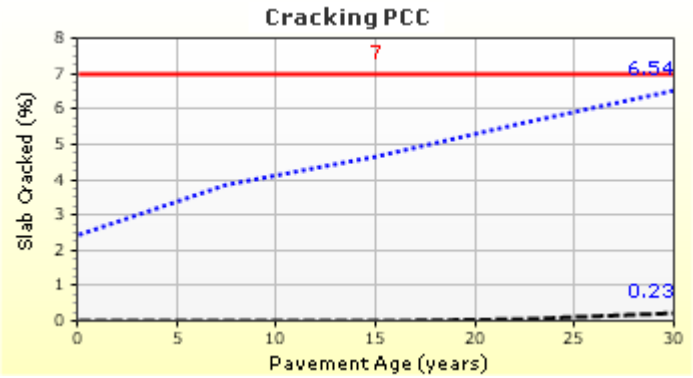
Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	200.00	143.96	95.00	99.97	Pass
Mean joint faulting (in)	0.14	0.05	95.00	100.00	Pass
JPCP transverse cracking (percent slabs)	7.00	6.54	95.00	96.11	Pass

Distress Charts



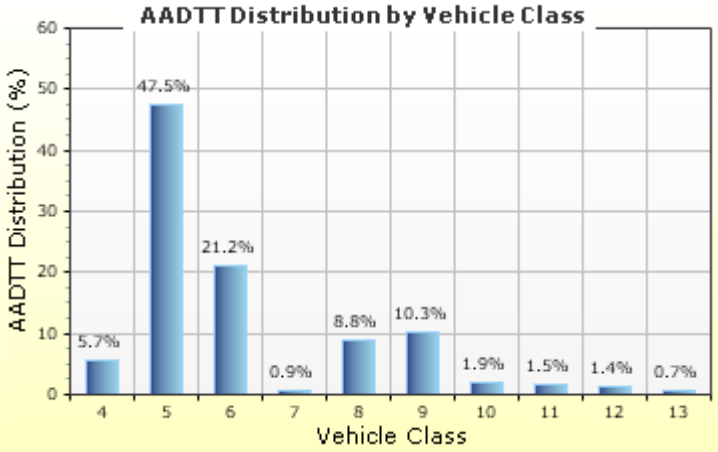


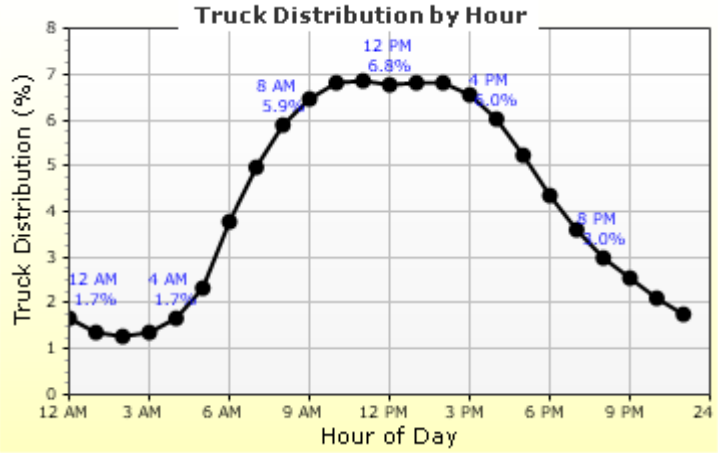


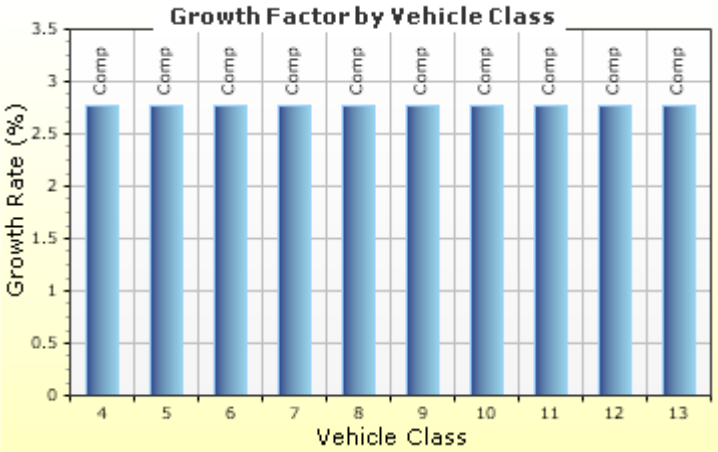
Traffic Inputs

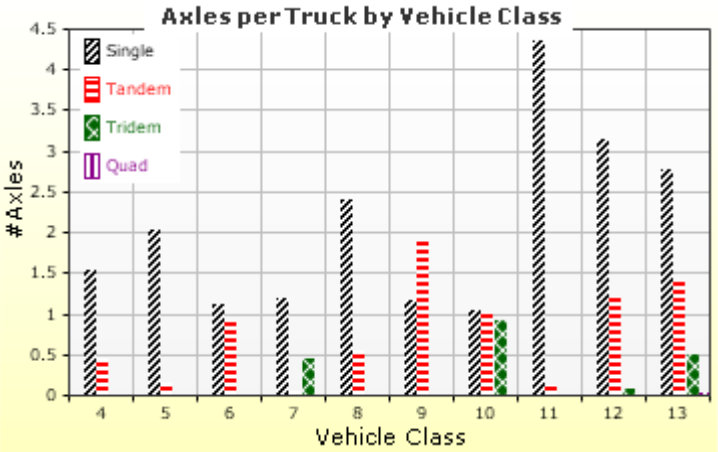
Graphical Representation of Traffic Inputs

Initial two-way AADTT:	101	Percent of trucks in design direction (%):	100.0
Number of lanes in design direction:	1	Percent of trucks in design lane (%):	100.0
		Operational speed (mph)	40.0

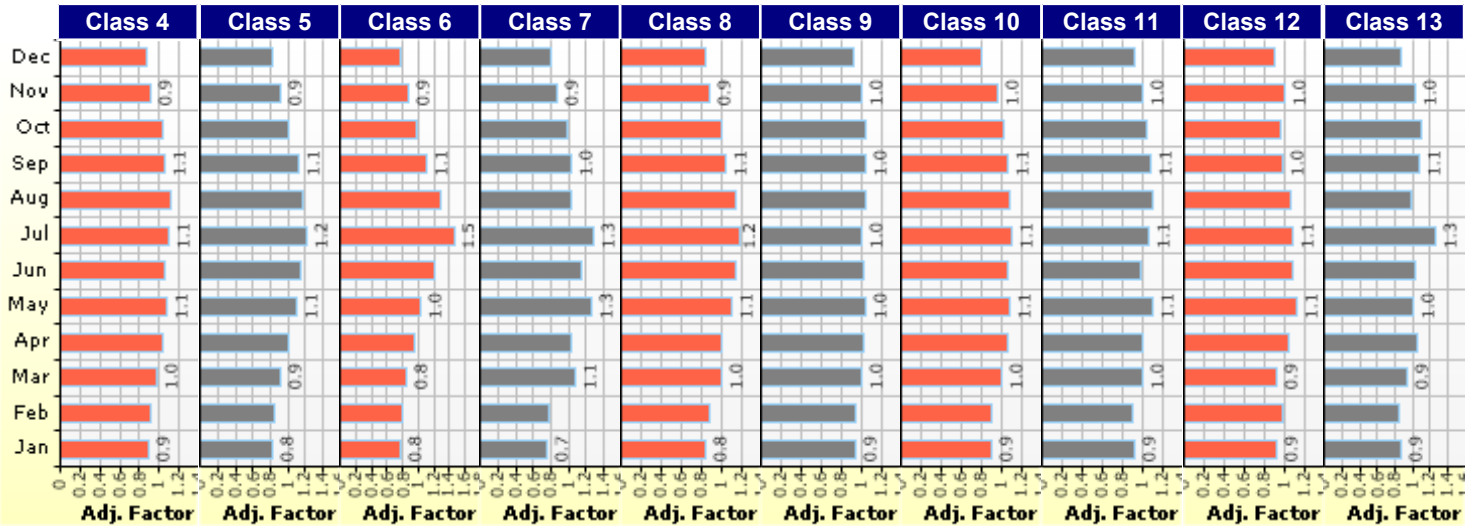








Traffic Volume Monthly Adjustment Factors



Tabular Representation of Traffic Inputs

Volume Monthly Adjustment Factors

Level 3: Default MAF

Month	Vehicle Class									
	4	5	6	7	8	9	10	11	12	13
January	0.9	0.8	0.8	0.7	0.8	0.9	0.9	0.9	0.9	0.9
February	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.8
March	1.0	0.9	0.8	1.1	1.0	1.0	1.0	1.0	0.9	0.9
April	1.0	1.0	0.9	1.0	1.0	1.0	1.1	1.0	1.0	1.1
May	1.1	1.1	1.0	1.3	1.1	1.0	1.1	1.1	1.1	1.0
June	1.1	1.1	1.2	1.1	1.1	1.0	1.1	1.0	1.1	1.0
July	1.1	1.2	1.5	1.3	1.2	1.0	1.1	1.1	1.1	1.3
August	1.1	1.2	1.3	1.0	1.1	1.0	1.1	1.1	1.1	1.0
September	1.1	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1
October	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.1
November	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0
December	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.9	0.9

Distributions by Vehicle Class

Vehicle Class	AADTT Distribution (%) (Level 3)	Growth Factor	
		Rate (%)	Function
Class 4	5.74%	2.76%	Compound
Class 5	47.46%	2.76%	Compound
Class 6	21.21%	2.76%	Compound
Class 7	0.94%	2.76%	Compound
Class 8	8.84%	2.76%	Compound
Class 9	10.31%	2.76%	Compound
Class 10	1.9%	2.76%	Compound
Class 11	1.51%	2.76%	Compound
Class 12	1.4%	2.76%	Compound
Class 13	0.69%	2.76%	Compound

Truck Distribution by Hour

Hour	Distribution (%)	Hour	Distribution (%)
12 AM	1.65%	12 PM	6.75%
1 AM	1.37%	1 PM	6.81%
2 AM	1.28%	2 PM	6.83%
3 AM	1.36%	3 PM	6.56%
4 AM	1.66%	4 PM	6.02%
5 AM	2.32%	5 PM	5.23%
6 AM	3.8%	6 PM	4.35%
7 AM	4.95%	7 PM	3.59%
8 AM	5.9%	8 PM	2.98%
9 AM	6.48%	9 PM	2.56%
10 AM	6.83%	10 PM	2.12%
11 AM	6.85%	11 PM	1.75%
		Total	100%

Axle Configuration

Traffic Wander	
Mean wheel location (in)	18.0
Traffic wander standard deviation (in)	10.0
Design lane width (ft)	12.0

Axle Configuration	
Average axle width (ft)	8.5
Dual tire spacing (in)	12.0
Tire pressure (psi)	120.0

Average Axle Spacing	
Tandem axle spacing (in)	51.6
Tridem axle spacing (in)	49.2
Quad axle spacing (in)	49.2

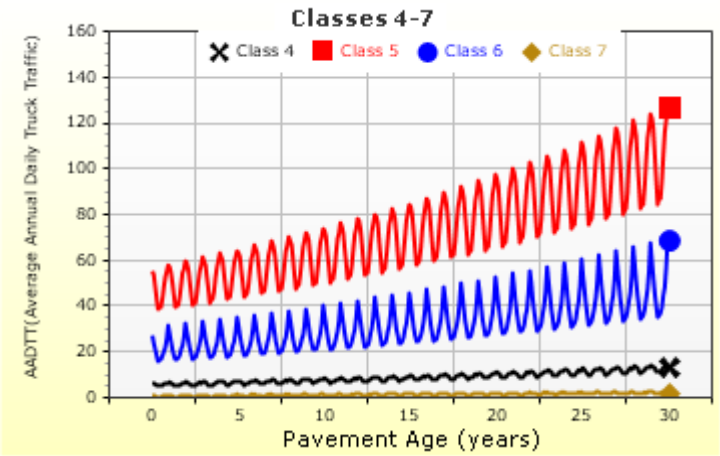
Wheelbase				
Value Type	Axle Type	Short	Medium	Long
Average spacing of axles (ft)		12.0	15.0	18.0
Percent of Trucks (%)		17.0	22.0	61.0

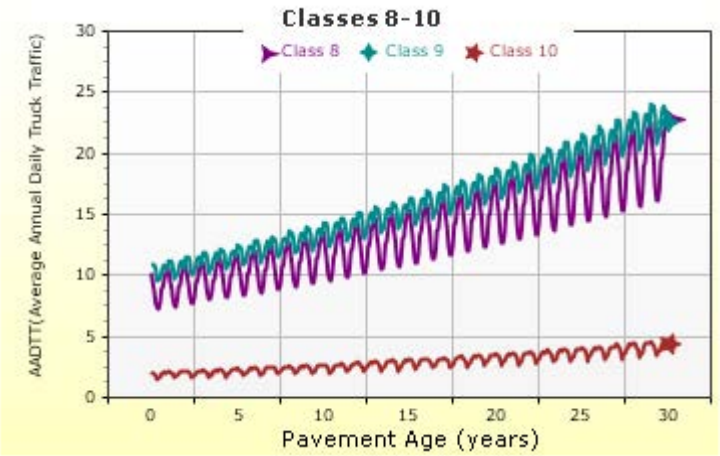
Number of Axles per Truck

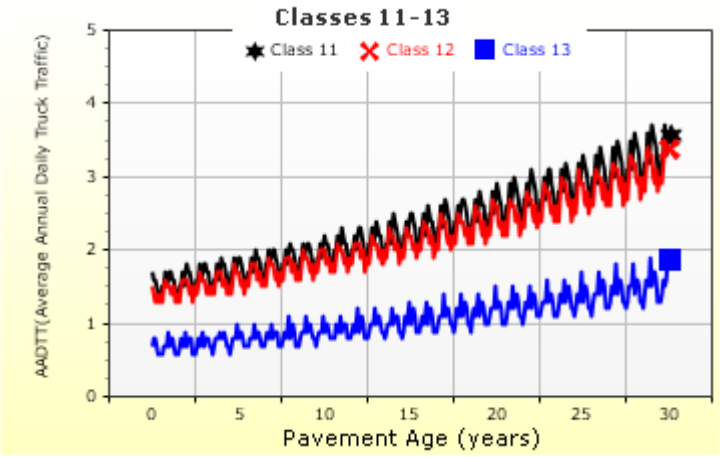
Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.53	0.45	0	0
Class 5	2.02	0.16	0.02	0
Class 6	1.12	0.93	0	0
Class 7	1.19	0.07	0.45	0.02
Class 8	2.41	0.56	0.02	0
Class 9	1.16	1.88	0.01	0
Class 10	1.05	1.01	0.93	0.02
Class 11	4.35	0.13	0	0
Class 12	3.15	1.22	0.09	0
Class 13	2.77	1.4	0.51	0.04

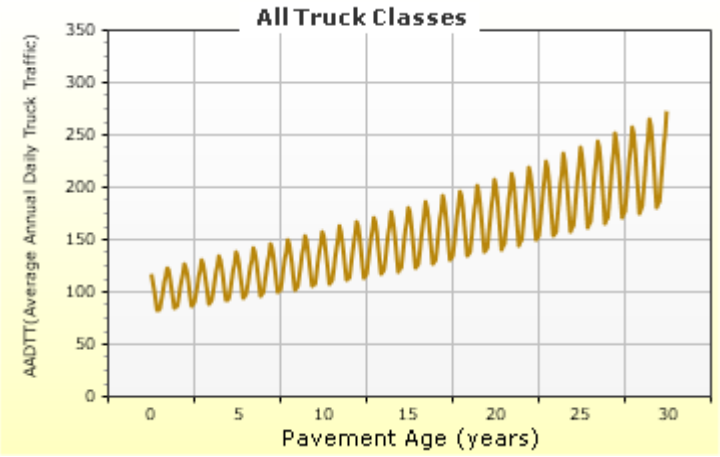
AADTT (Average Annual Daily Truck Traffic) Growth

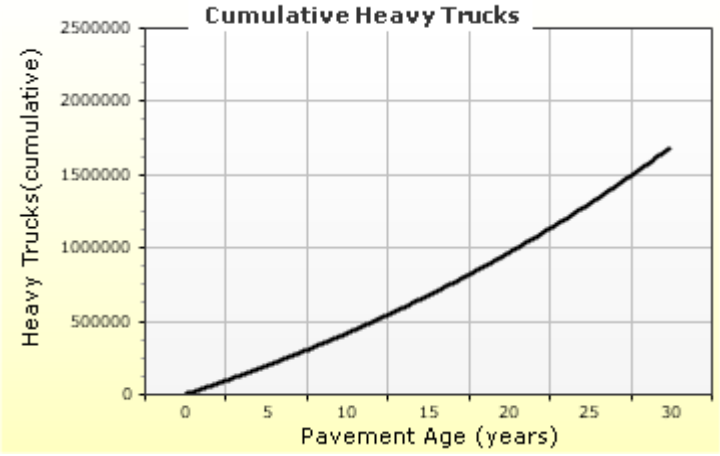
*** Traffic cap is not enforced**







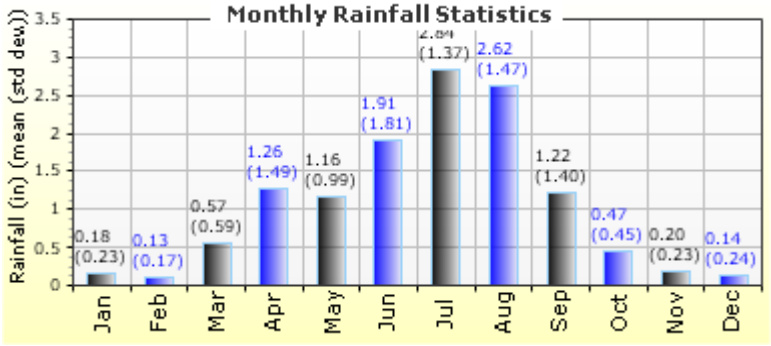




Climate Inputs

Climate Data Sources:

Climate Station Cities:	Location (lat lon elevation(ft))
COLORADO SPRINGS,	38.81200 -104.71100 6170

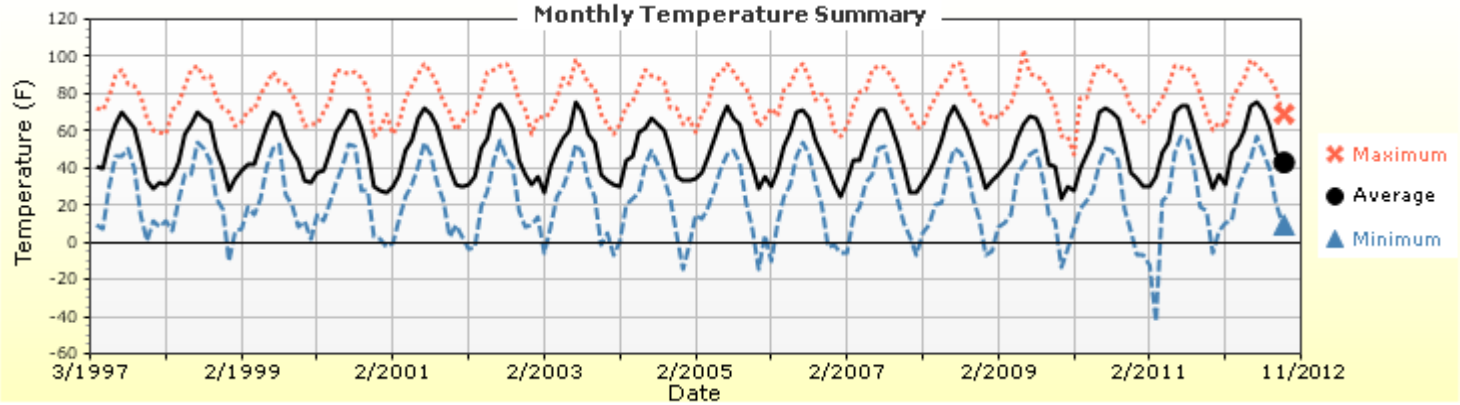


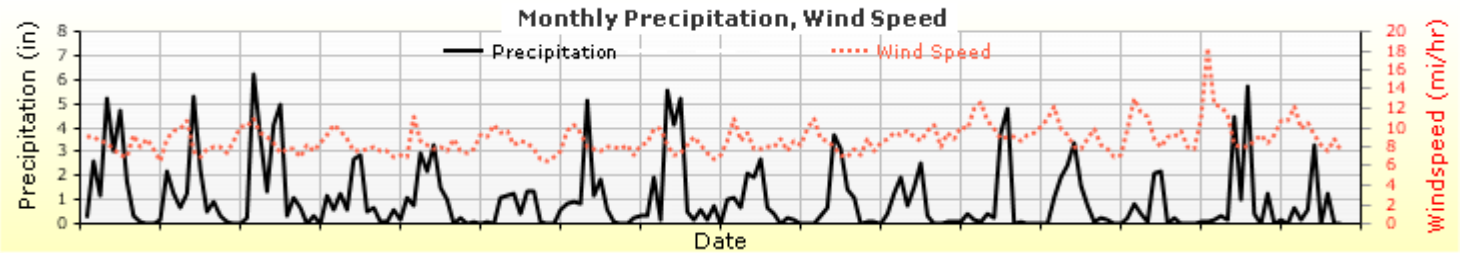
Annual Statistics:

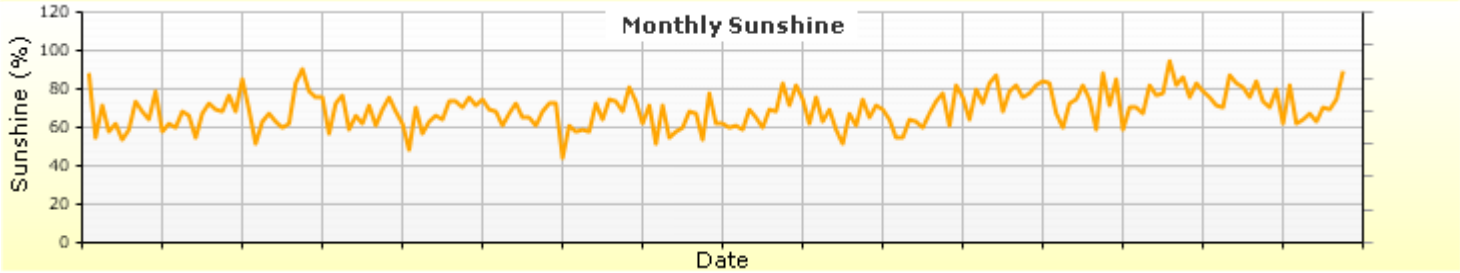
Mean annual air temperature (ºF)	49.78
Mean annual precipitation (in)	12.82
Freezing index (ºF - days)	487.57
Average annual number of freeze/thaw cycles:	131.57

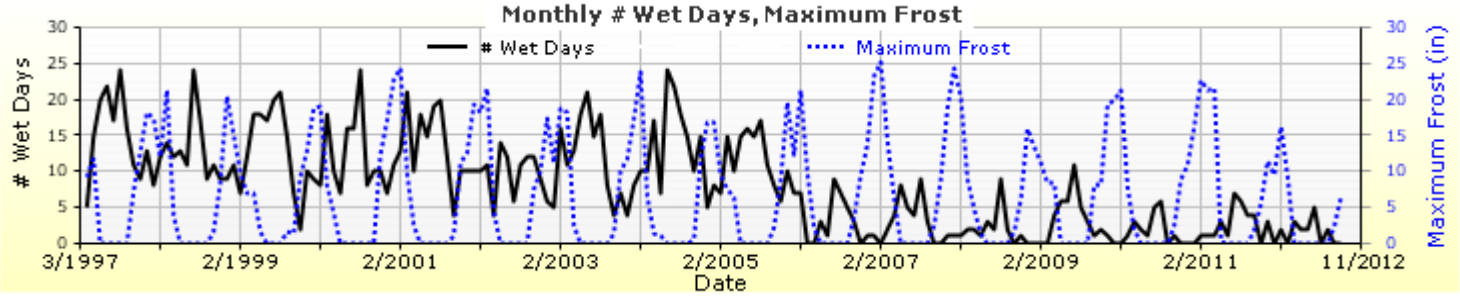
Water table depth (ft)	10.00

Monthly Climate Summary:

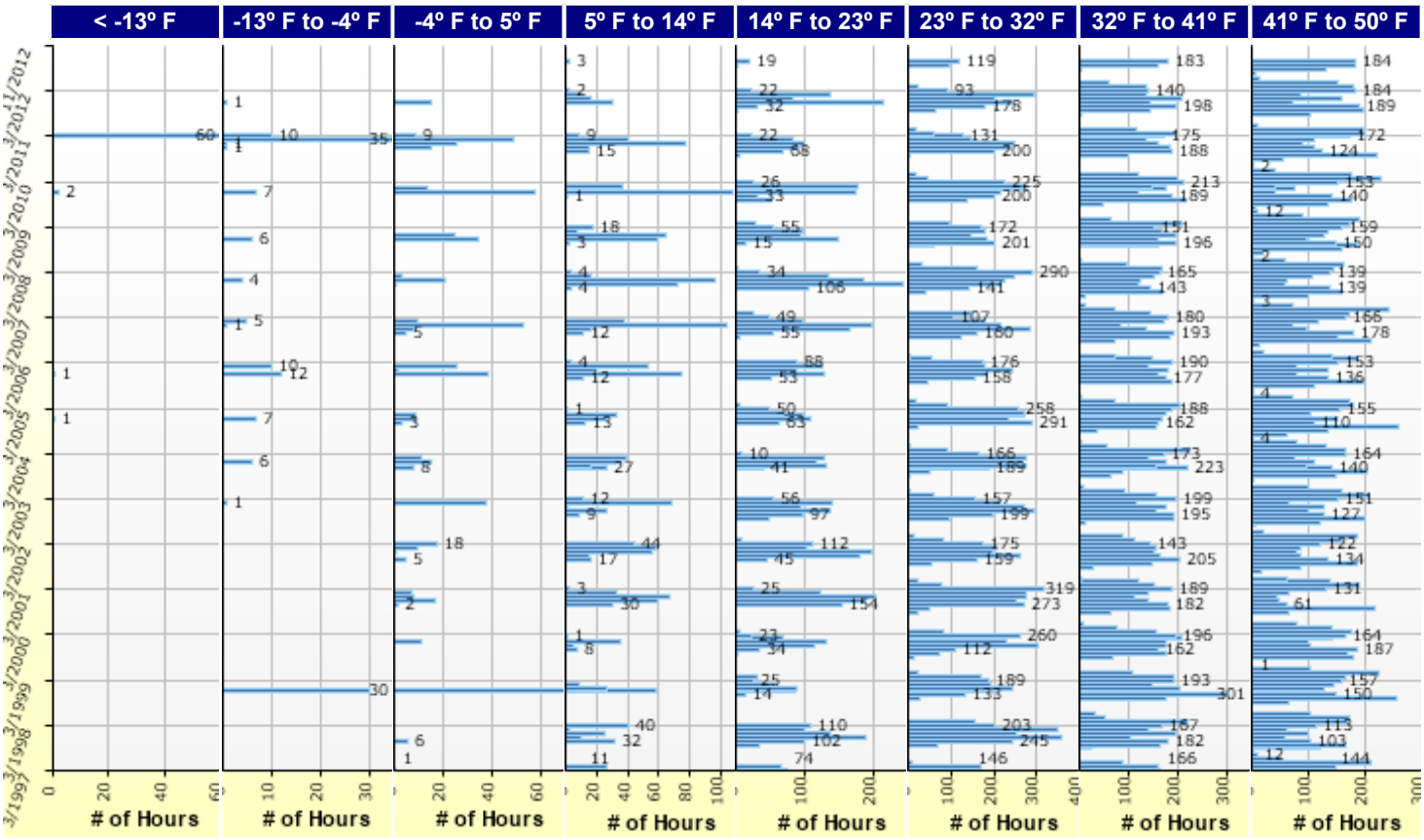


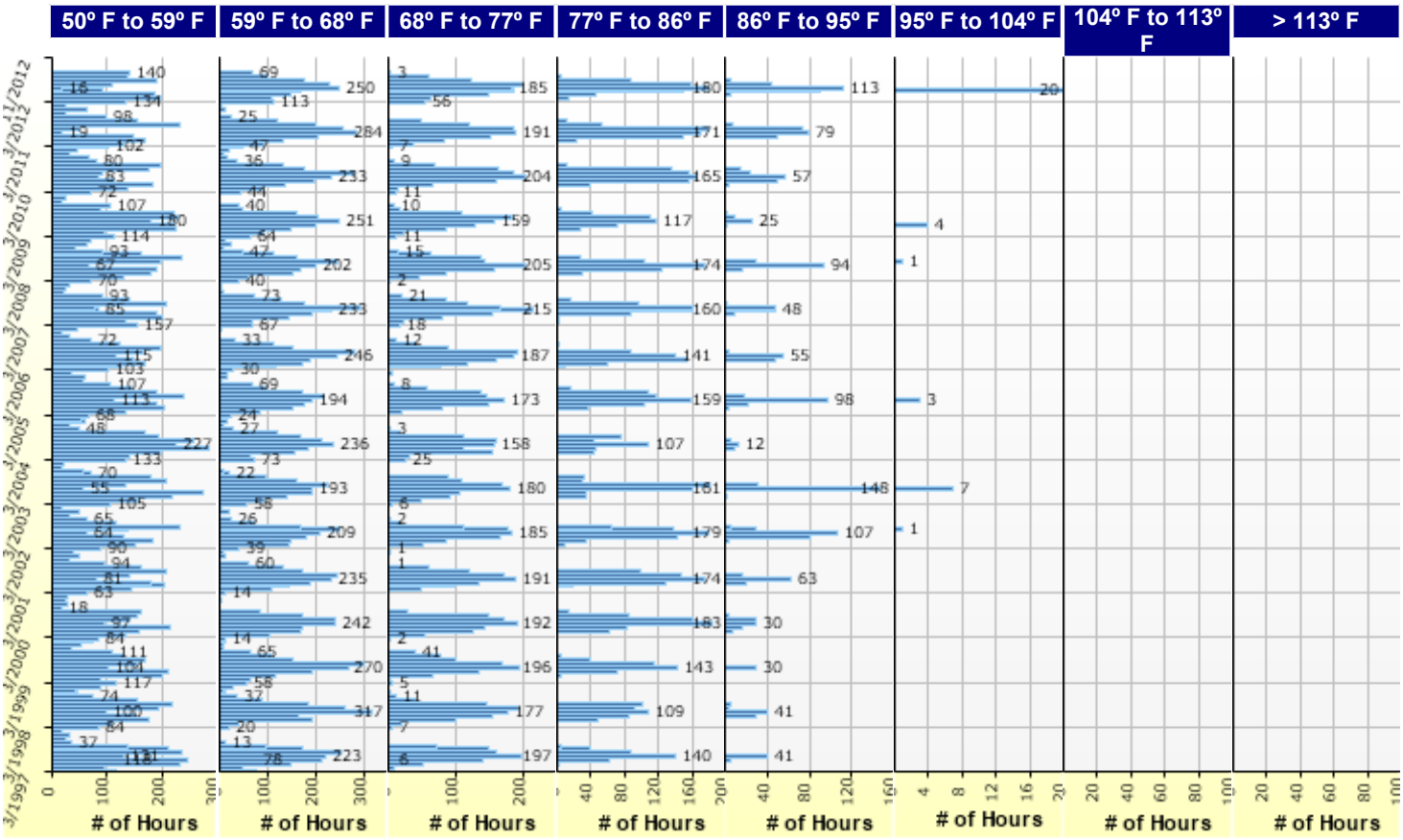






Hourly Air Temperature Distribution by Month:





Design Properties

JPCP Design Properties

Structure - ICM Properties	
PCC surface shortwave absorptivity	0.85

Doweled Joints	
Is joint doweled ?	True
Dowel diameter (in)	1.25
Dowel spacing (in)	12.00

Tied Shoulders	
Tied shoulders	False
Load transfer efficiency (%)	-

PCC joint spacing (ft)	
Is joint spacing random ?	False
Joint spacing (ft)	15.00

Widened Slab	
Is slab widened ?	False
Slab width (ft)	12.00

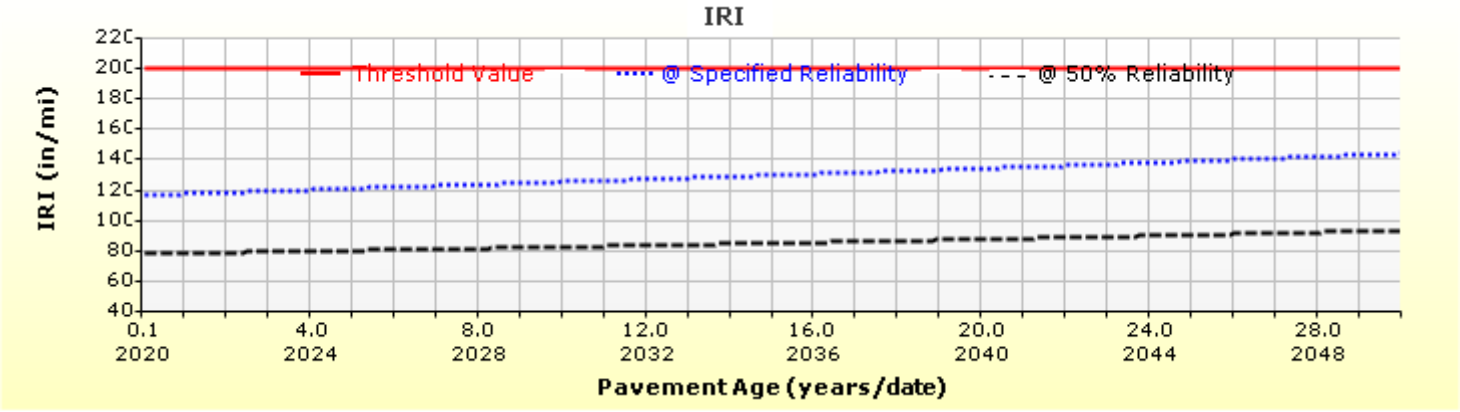
PCC-Base Contact Friction	
PCC-Base full friction contact	True
Months until friction loss	240.00

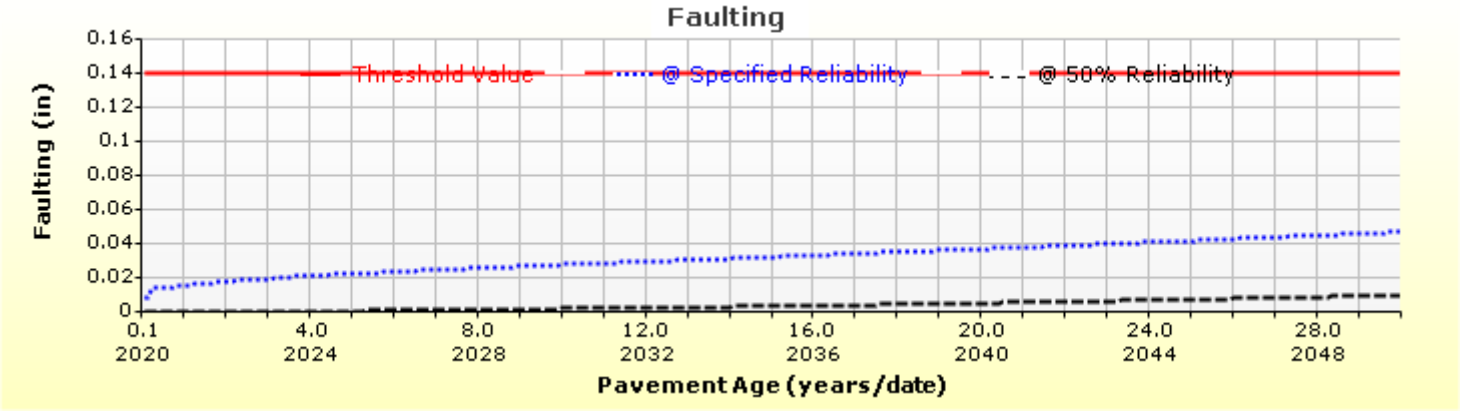
Sealant type	Preformed

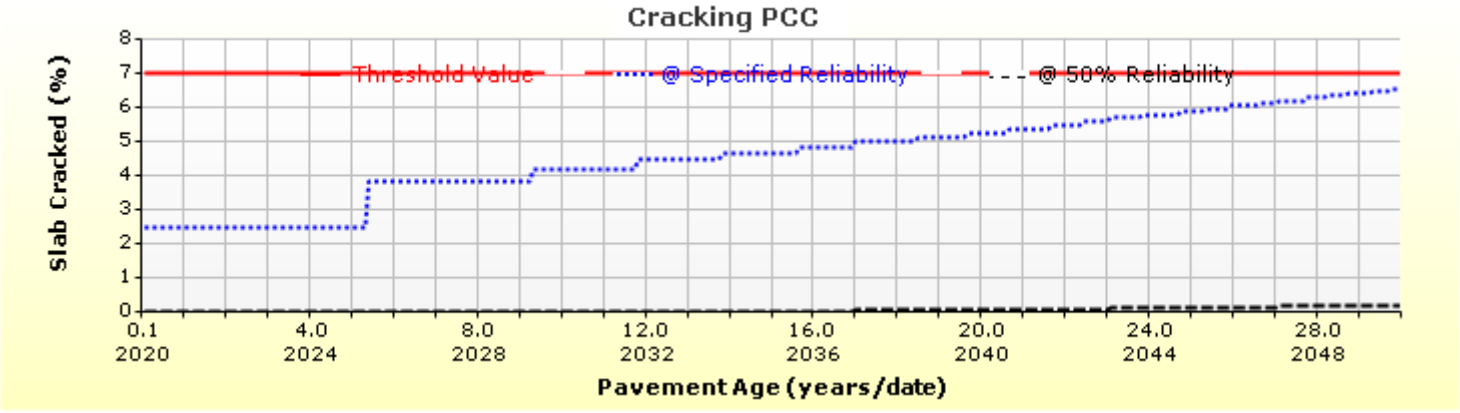
Erodibility index	5

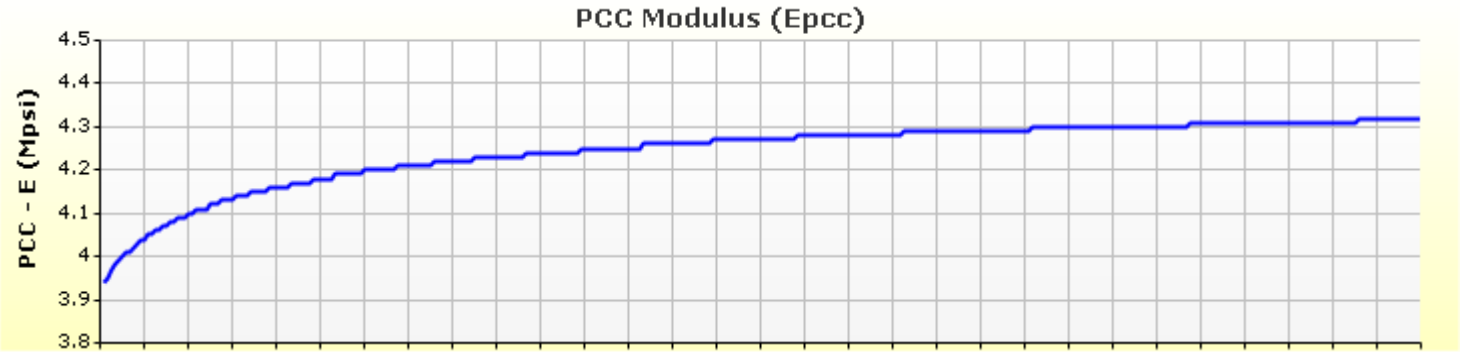
Permanent curl/warp effective temperature difference (ºF)	-10.00

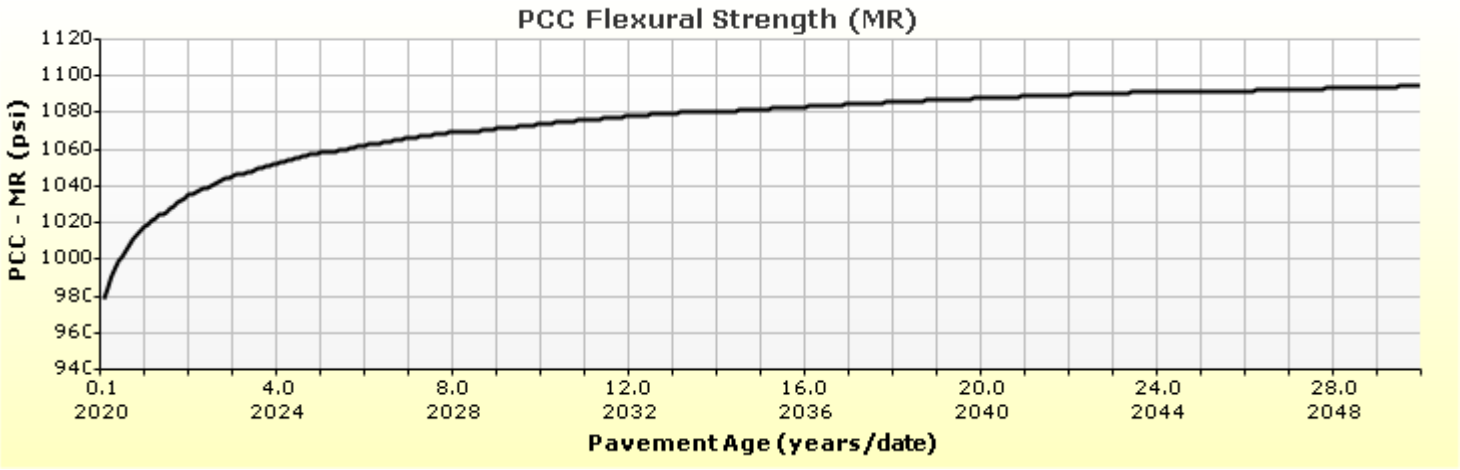
Analysis Output Charts

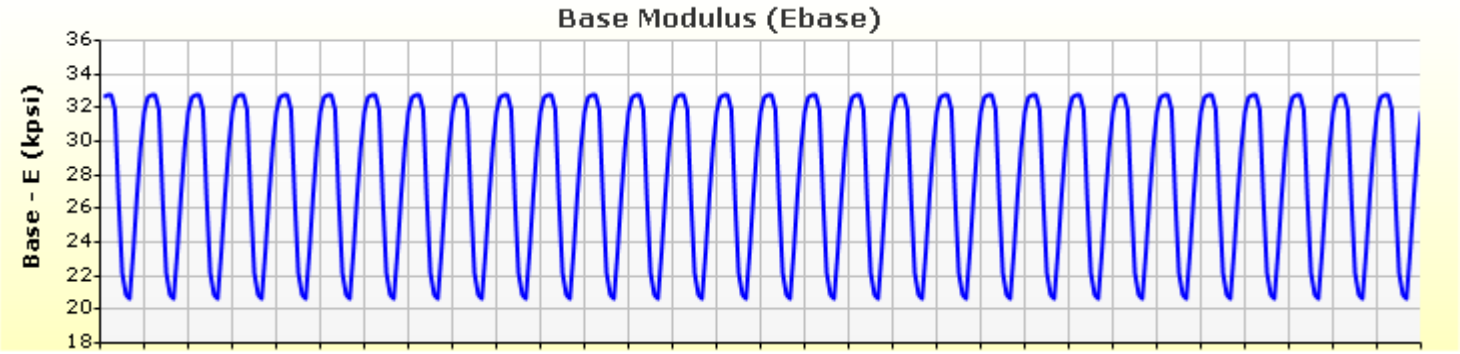


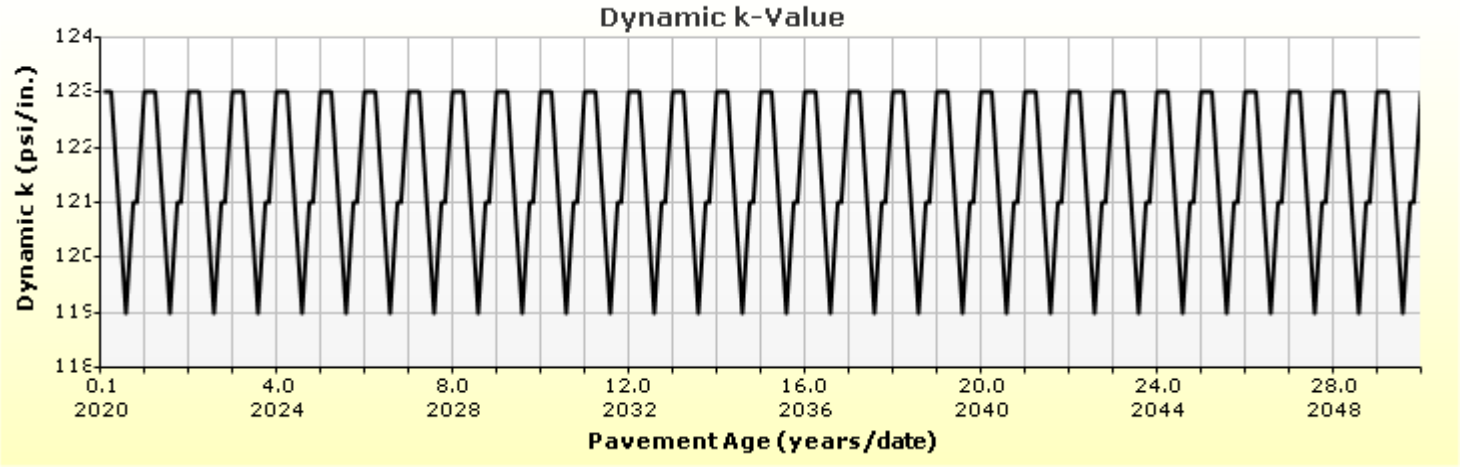


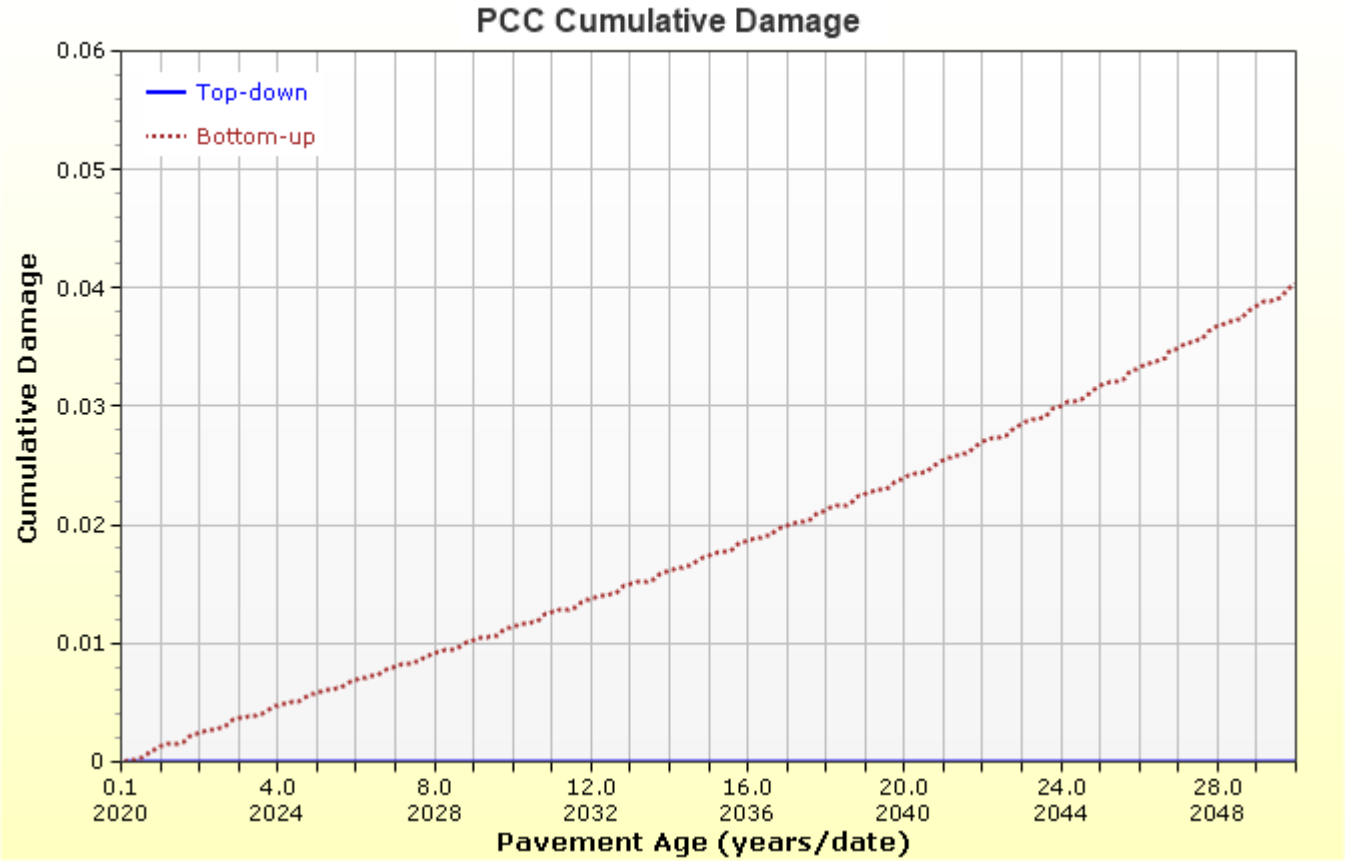


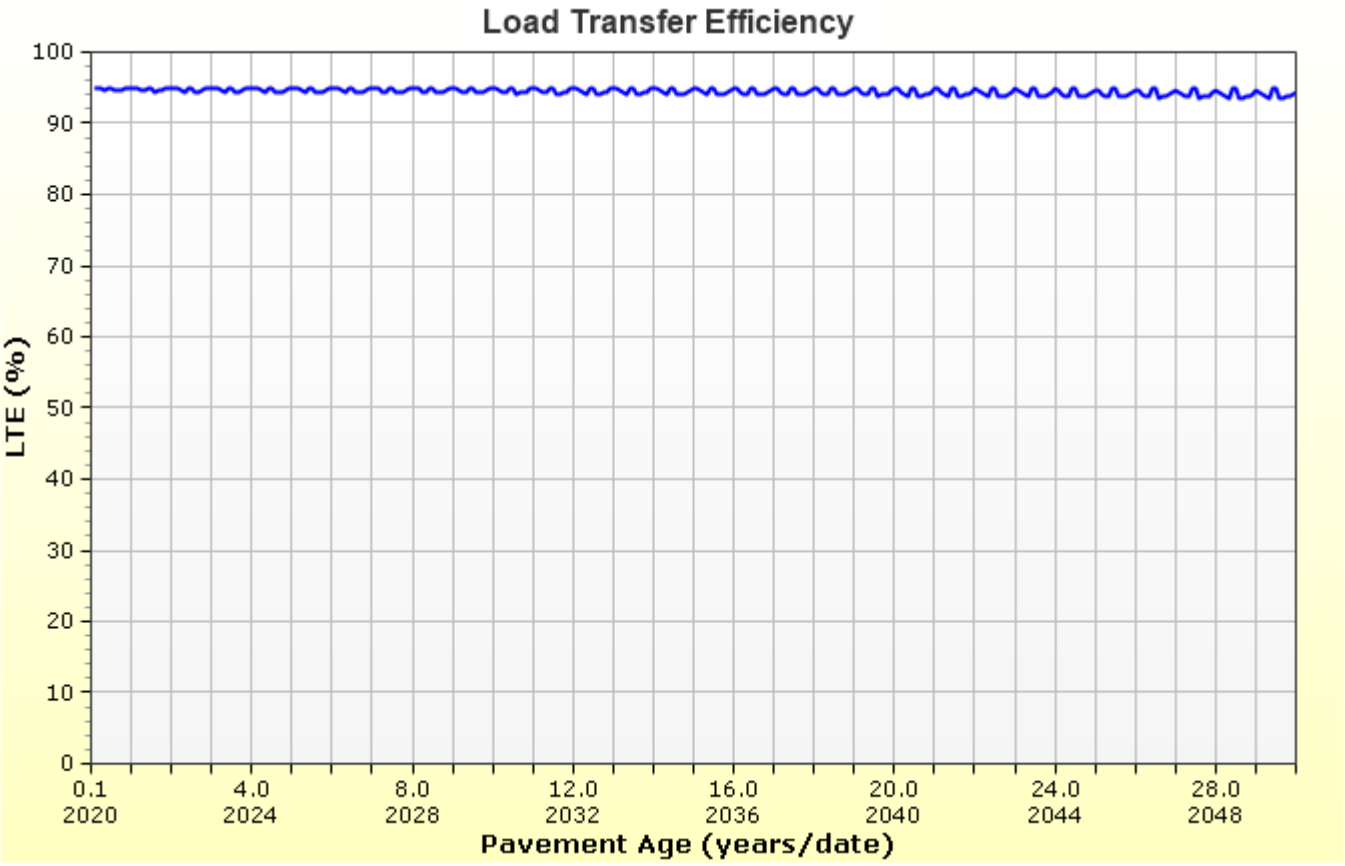

PCC Modulus (Epcc)
PCC - E (Mpsi)
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8


PCC Flexural Strength (MR)
PCC - MR (psi)
1120
1100
1080
1060
1040
1020
1000
980
960
940
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)


Base Modulus (Ebase)
Base - E (kpsi)
36
34
32
30
28
26
24
22
20
18


Dynamic k-Value
Dynamic k (psi/in.)
124
123
122
121
120
119
118
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)


PCC Cumulative Damage
Top-down
Bottom-up
Cumulative Damage
0.06
0.05
0.04
0.03
0.02
0.01
0
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)


Load Transfer Efficiency
LTE (%)
100
90
80
70
60
50
40
30
20
10
0
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)

Layer Information

Layer 1 PCC : JPCP Default

PCC	
Thickness (in)	7.5
Unit weight (pcf)	139.8
Poisson's ratio	0.2

Thermal	
PCC coefficient of thermal expansion (in/in/ºF x 10^-6)	4.72
PCC thermal conductivity (BTU/hr-ft-ºF)	1.25
PCC heat capacity (BTU/lb-ºF)	0.28

Mix		
Cement type		Type I (1)
Cementitious material content (lb/yd^3)		677
Water to cement ratio		0.44
Aggregate type		Granite (3)
PCC zero-stress temperature (ºF)	Calculated Internally?	True
	User Value	-
	Calculated Value	60.1
Ultimate shrinkage (microstrain)	Calculated Internally?	True
	User Value	-
	Calculated Value	701.5
Reversible shrinkage (%)		50
Time to develop 50% of ultimate shrinkage (days)		35
Curing method		Curing Compound

PCC strength and modulus (Input Level: 3)

28-Day PCC modulus of rupture (psi)	900.0
28-Day PCC elastic modulus (psi)	3550000.0

Identifiers

Field	Value
Display name/identifier	JPCP Default
Description of object	
Author	
Date Created	11/17/2017 1:59:42 PM
Approver	
Date approved	11/17/2017 1:59:42 PM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Layer 2 Non-stabilized Base : Class 6 ABC

Unbound	
Layer thickness (in)	6.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
22000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Class 6 ABC
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	42

Sieve

Liquid Limit	30.0
Plasticity Index	6.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	125.3
Saturated hydraulic conductivity (ft/hr)	False	2.257e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	8.3

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	12.2329
bf	1.1153
cf	0.8619
hr	244.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	12.0
#100	
#80	
#60	
#50	
#40	
#30	
#20	
#16	
#10	
#8	55.0
#4	65.0
3/8-in.	
1/2-in.	
3/4-in.	95.0
1-in.	100.0
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 3 Subgrade : A-6

Unbound	
Layer thickness (in)	24.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
7000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-6
Description of object	clayey sand
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	32

Sieve

Liquid Limit	37.0
Plasticity Index	18.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	112.9
Saturated hydraulic conductivity (ft/hr)	False	1.153e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	14.9

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	102.5522
bf	0.7198
cf	0.2545
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	47.0
#100	
#80	
#60	
#50	
#40	72.0
#30	
#20	
#16	
#10	
#8	
#4	98.0
3/8-in.	
1/2-in.	
3/4-in.	
1-in.	
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 4 Subgrade : A-6

Unbound	
Layer thickness (in)	Semi-infinite
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
7000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-6
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	33.0
Plasticity Index	16.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	107.9
Saturated hydraulic conductivity (ft/hr)	False	1.95e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	17.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	108.4091
bf	0.6801
cf	0.2161
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	63.2
#100	
#80	73.5
#60	
#50	
#40	82.4
#30	
#20	
#16	
#10	90.2
#8	
#4	93.5
3/8-in.	96.4
1/2-in.	97.4
3/4-in.	98.4
1-in.	99.0
1 1/2-in.	99.5
2-in.	99.8
2 1/2-in.	
3-in.	
3 1/2-in.	100.0

Calibration Coefficients

PCC Faulting

$$C_{12} = C_1 + (C_2 * FR^{0.25})$$
$$C_{34} = C_3 + (C_4 * FR^{0.25})$$
$$FaultMax_0 = C_{12} * \delta_{curling} * \left[\log(1 + C_5 * 5.0^{EROD}) * \log\left(P_{200} * \frac{WetDays}{p_S}\right)\right]^{C_6}$$
$$FaultMax_i = FaultMax_0 + C_7 * \sum_{j=1}^{m} DE_j * \log(1 + C_5 * 5.0^{EROD})^{C_6}$$
$$\Delta Fault_i = C_{34} * (FaultMax_{i-1} - Fault_{i-1})^2 * DE_i$$
$$C_8 = DowelDeterioration$$

C1: 0.5104	C2: 0.00838	C3: 0.00147	C4: 0.008345
C5: 5999	C6: 0.8404	C7: 5.9293	C8: 400
PCC Reliability Faulting Standard Deviation			
0.0831*Pow(FAULT,0.3426) + 0.00521			

IRI-jpcp

C1 - Cracking
C2 - Spalling
C3 - Faulting
C4 - Site Factor

C1: 0.8203	C2: 0.4417
C3: 1.4929	C4: 25.24
Reliability Standard Deviation	
5.4	

PCC Cracking

$$\log(N) = C1 \cdot \left(\frac{MR}{\sigma}\right)^{C2}$$
$$CRK = \frac{100}{1 + C4\ FD^{C5}}$$

Fatigue Coefficients		**Cracking Coefficients**	
C1: 2	C2: 1.22	C4: 0.6	C5: -2.05
PCC Reliability Cracking Standard Deviation			
Pow(57.08*CRACK,0.33) + 1.5			

Powers SB On-ramp (2)

File Name: C:\Users\darwinME\Desktop\AFK\Powers and Research\PCC\Powers SB On-ramp (2).dgpx

Design Inputs

Design Life: 30 years
Design Type: JPCP

Existing construction: -
Pavement construction: March, 2020
Traffic opening: August, 2020

Climate Data Sources (Lat/Lon): 38.812, -104.711

Design Structure

Layer type	Material Type	Thickness (in)
PCC	JPCP Default	8.0 (Optimized)
NonStabilized	Class 6 ABC	6.0
Subgrade	A-6	24.0
Subgrade	A-6	Semi-infinite

Joint Design:	
Joint spacing (ft)	15.0
Dowel diameter (in)	1.25
Slab width (ft)	12.0

Traffic

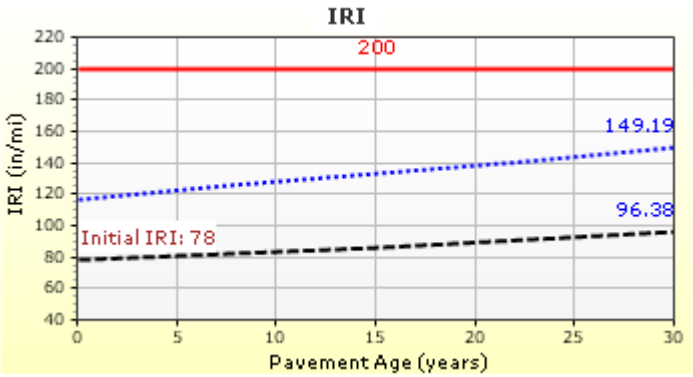
Age (year)	Heavy Trucks (cumulative)
2020 (initial)	581
2035 (15 years)	1,026,970
2050 (30 years)	2,224,570

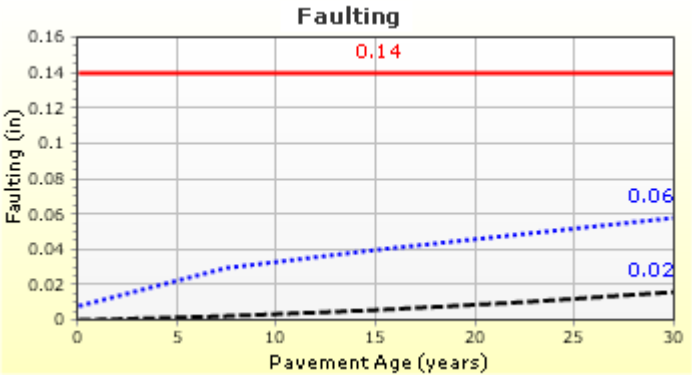
Design Outputs

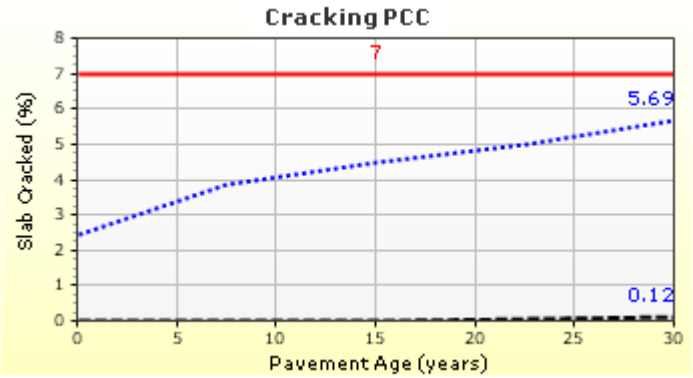
Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	200.00	149.19	95.00	99.94	Pass
Mean joint faulting (in)	0.14	0.06	95.00	100.00	Pass
JPCP transverse cracking (percent slabs)	7.00	5.69	95.00	97.89	Pass

Distress Charts



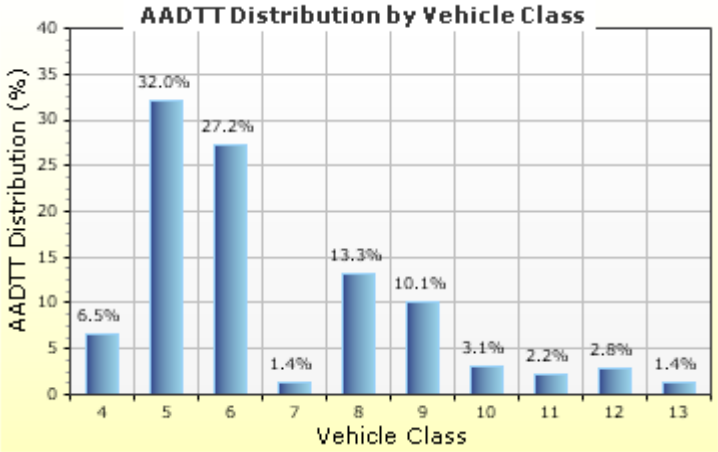


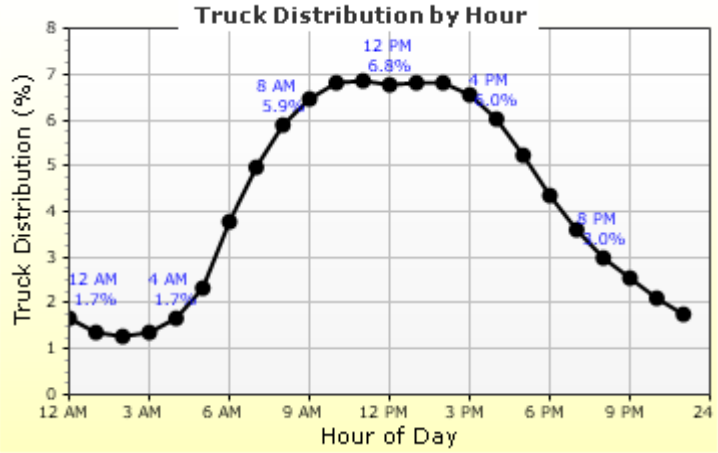


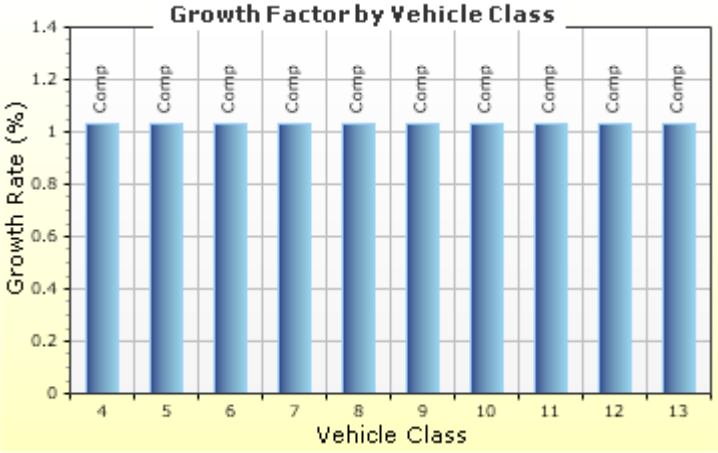
Traffic Inputs

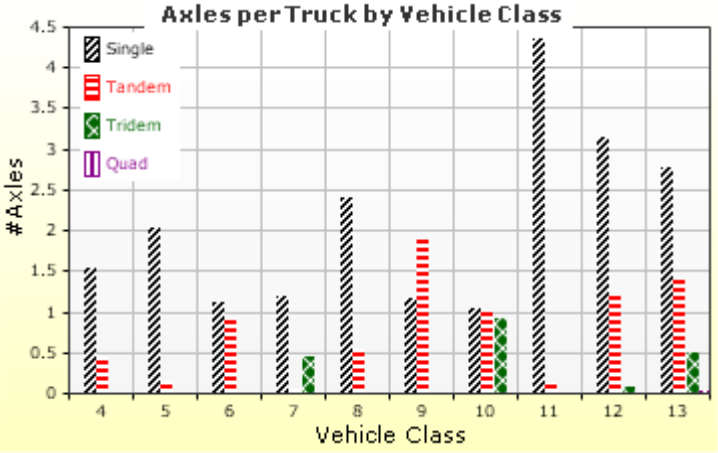
Graphical Representation of Traffic Inputs

Initial two-way AADTT:	581	Percent of trucks in design direction (%):	50.0
Number of lanes in design direction:	2	Percent of trucks in design lane (%):	60.0
		Operational speed (mph)	40.0

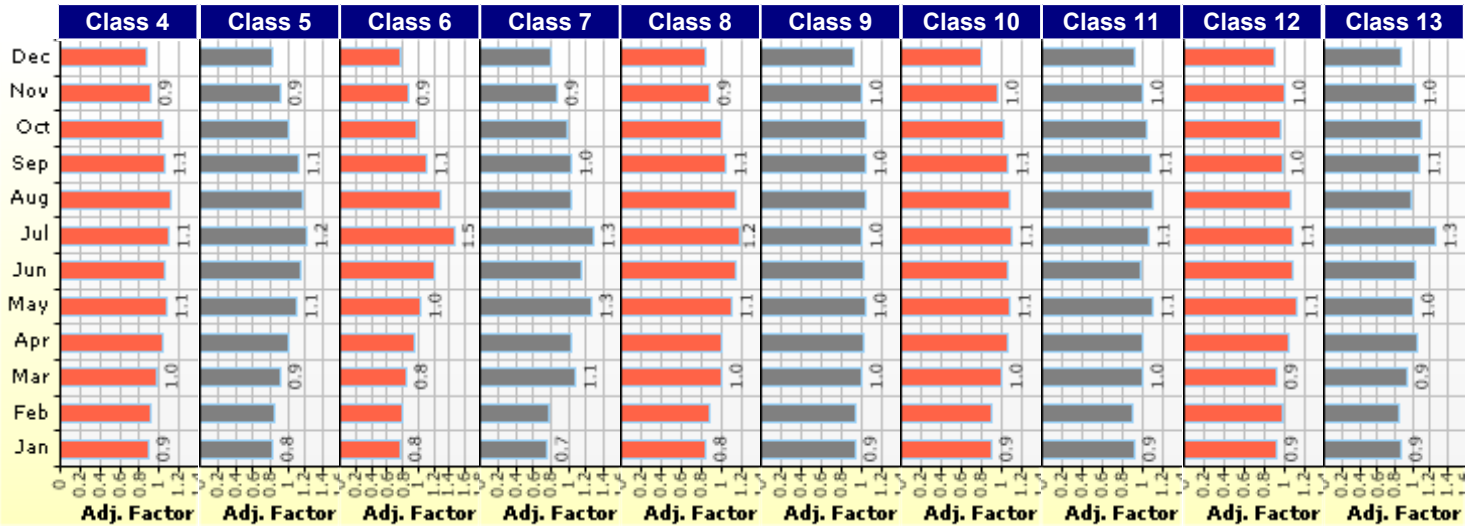








Traffic Volume Monthly Adjustment Factors



Tabular Representation of Traffic Inputs

Volume Monthly Adjustment Factors

Level 3: Default MAF

Month	Vehicle Class									
	4	5	6	7	8	9	10	11	12	13
January	0.9	0.8	0.8	0.7	0.8	0.9	0.9	0.9	0.9	0.9
February	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.8
March	1.0	0.9	0.8	1.1	1.0	1.0	1.0	1.0	0.9	0.9
April	1.0	1.0	0.9	1.0	1.0	1.0	1.1	1.0	1.0	1.1
May	1.1	1.1	1.0	1.3	1.1	1.0	1.1	1.1	1.1	1.0
June	1.1	1.1	1.2	1.1	1.1	1.0	1.1	1.0	1.1	1.0
July	1.1	1.2	1.5	1.3	1.2	1.0	1.1	1.1	1.1	1.3
August	1.1	1.2	1.3	1.0	1.1	1.0	1.1	1.1	1.1	1.0
September	1.1	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1
October	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.1
November	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0
December	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.9	0.9

Distributions by Vehicle Class

Vehicle Class	AADTT Distribution (%) (Level 3)	Growth Factor	
		Rate (%)	Function
Class 4	6.54%	1.03%	Compound
Class 5	32.02%	1.03%	Compound
Class 6	27.23%	1.03%	Compound
Class 7	1.38%	1.03%	Compound
Class 8	13.25%	1.03%	Compound
Class 9	10.07%	1.03%	Compound
Class 10	3.1%	1.03%	Compound
Class 11	2.19%	1.03%	Compound
Class 12	2.82%	1.03%	Compound
Class 13	1.4%	1.03%	Compound

Truck Distribution by Hour

Hour	Distribution (%)	Hour	Distribution (%)
12 AM	1.65%	12 PM	6.75%
1 AM	1.37%	1 PM	6.81%
2 AM	1.28%	2 PM	6.83%
3 AM	1.36%	3 PM	6.56%
4 AM	1.66%	4 PM	6.02%
5 AM	2.32%	5 PM	5.23%
6 AM	3.8%	6 PM	4.35%
7 AM	4.95%	7 PM	3.59%
8 AM	5.9%	8 PM	2.98%
9 AM	6.48%	9 PM	2.56%
10 AM	6.83%	10 PM	2.12%
11 AM	6.85%	11 PM	1.75%
		Total	100%

Axle Configuration

Traffic Wander	
Mean wheel location (in)	18.0
Traffic wander standard deviation (in)	10.0
Design lane width (ft)	12.0

Axle Configuration	
Average axle width (ft)	8.5
Dual tire spacing (in)	12.0
Tire pressure (psi)	120.0

Average Axle Spacing	
Tandem axle spacing (in)	51.6
Tridem axle spacing (in)	49.2
Quad axle spacing (in)	49.2

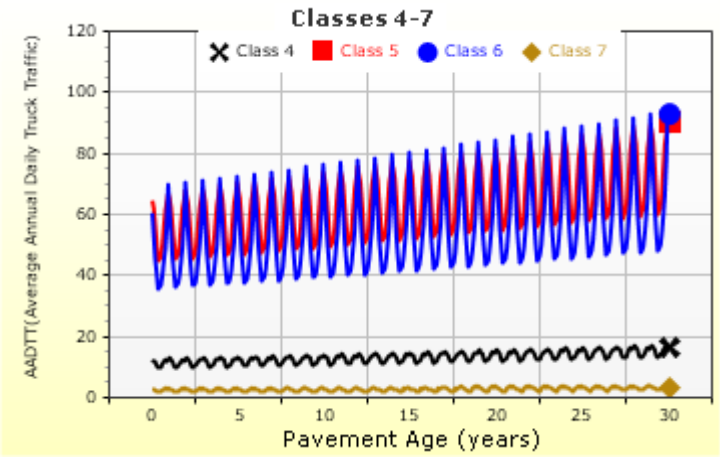
Wheelbase				
Value Type	Axle Type	Short	Medium	Long
Average spacing of axles (ft)		12.0	15.0	18.0
Percent of Trucks (%)		17.0	22.0	61.0

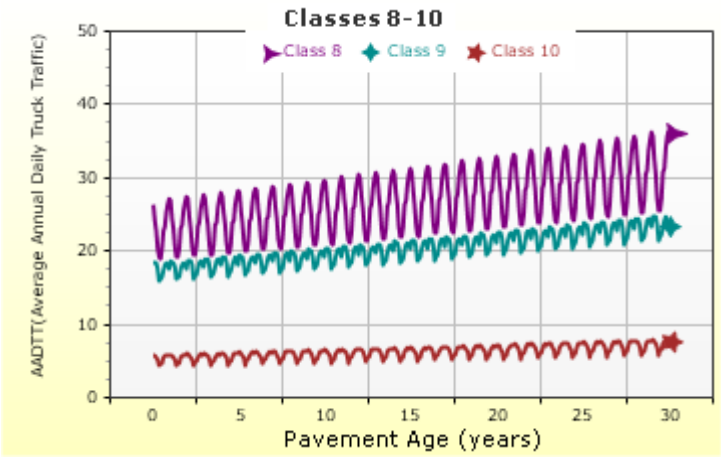
Number of Axles per Truck

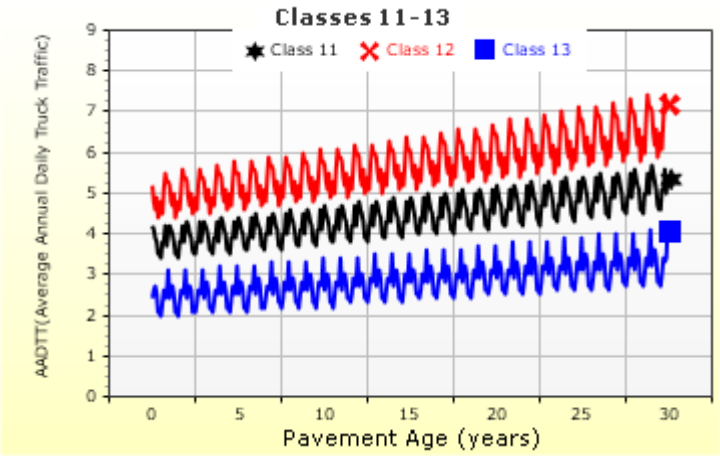
Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.53	0.45	0	0
Class 5	2.02	0.16	0.02	0
Class 6	1.12	0.93	0	0
Class 7	1.19	0.07	0.45	0.02
Class 8	2.41	0.56	0.02	0
Class 9	1.16	1.88	0.01	0
Class 10	1.05	1.01	0.93	0.02
Class 11	4.35	0.13	0	0
Class 12	3.15	1.22	0.09	0
Class 13	2.77	1.4	0.51	0.04

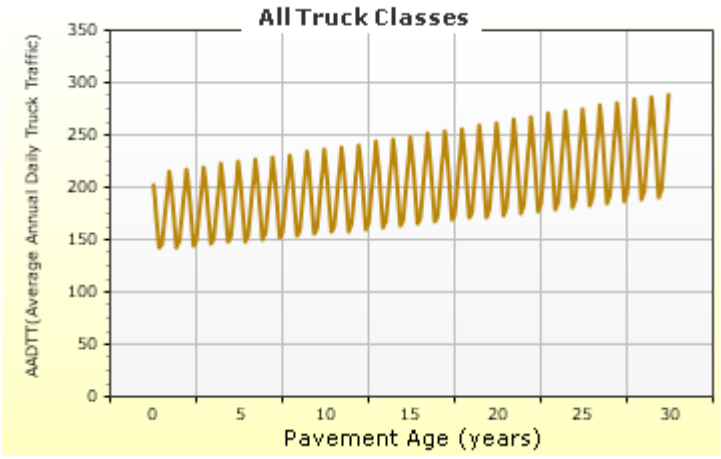
AADTT (Average Annual Daily Truck Traffic) Growth

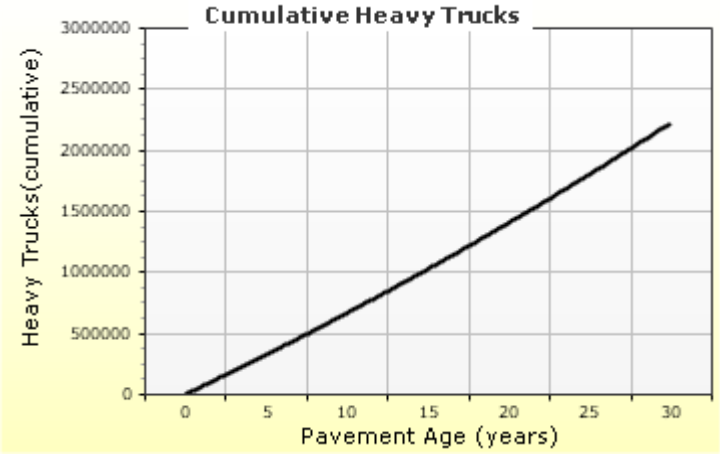
*** Traffic cap is not enforced**







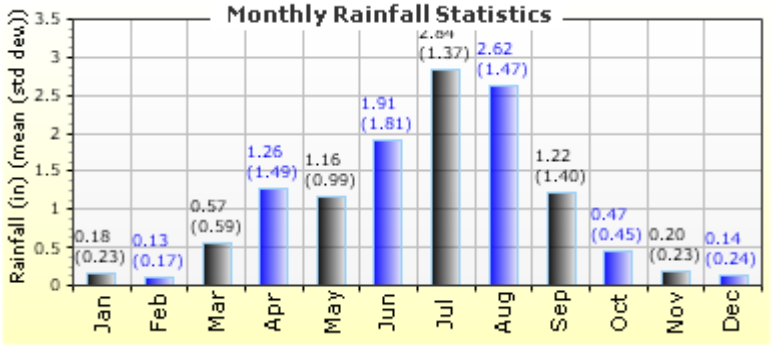




Climate Inputs

Climate Data Sources:

Climate Station Cities:	Location (lat lon elevation(ft))
COLORADO SPRINGS,	38.81200 -104.71100 6170

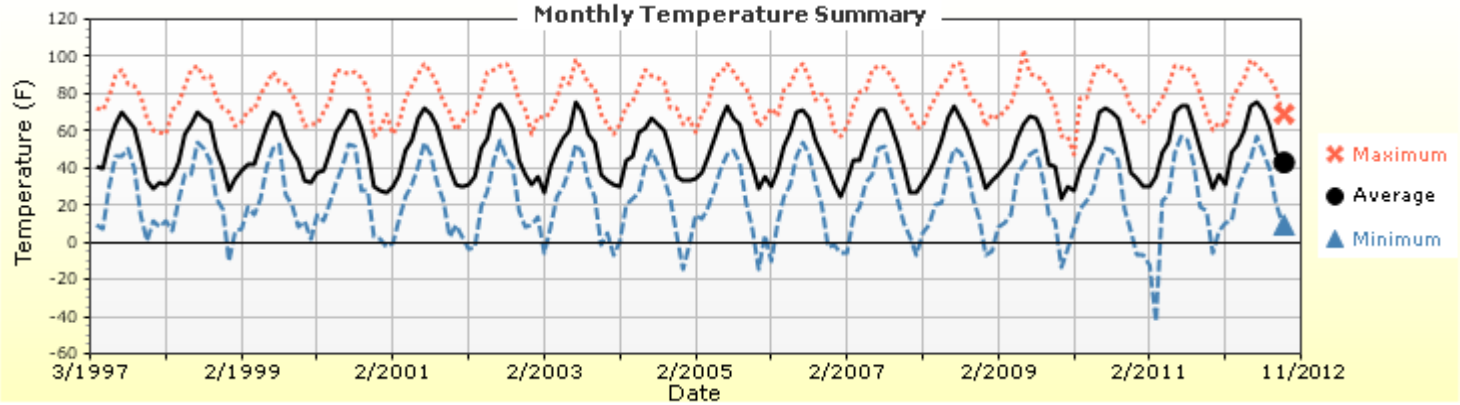


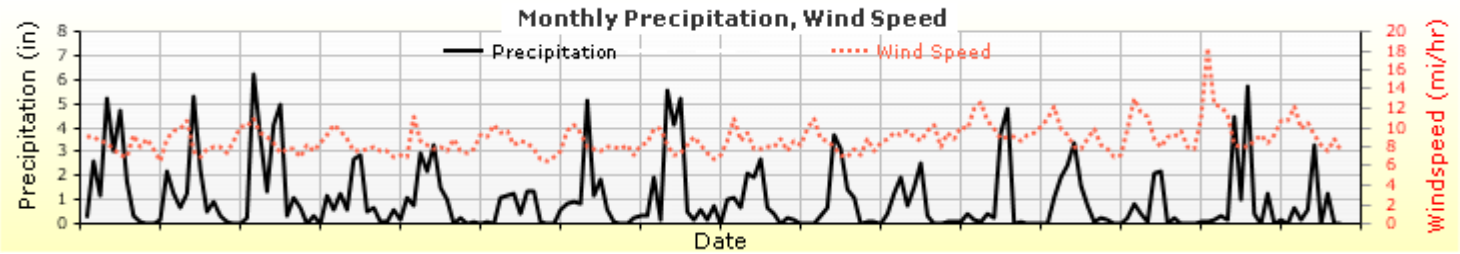
Annual Statistics:

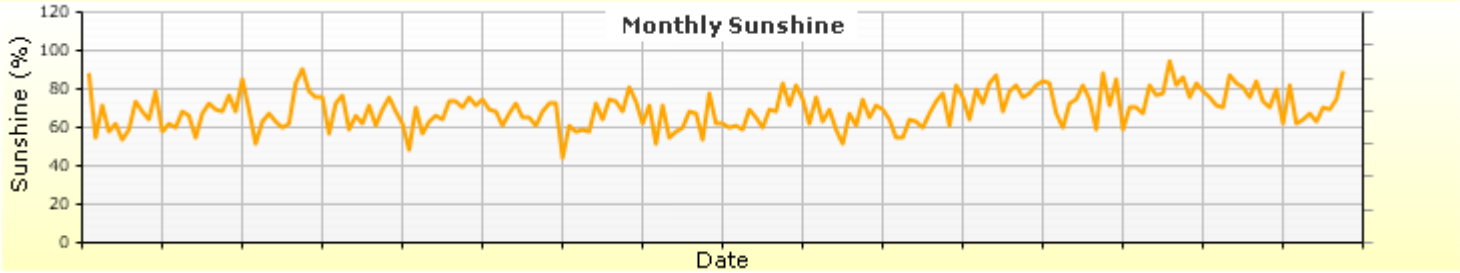
Mean annual air temperature (ºF)	49.78
Mean annual precipitation (in)	12.82
Freezing index (ºF - days)	487.57
Average annual number of freeze/thaw cycles:	131.57

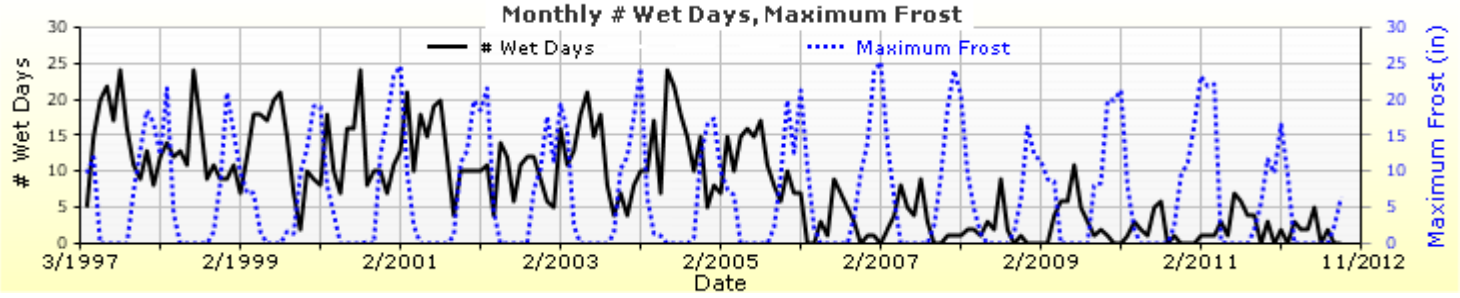
Water table depth (ft)	10.00

Monthly Climate Summary:

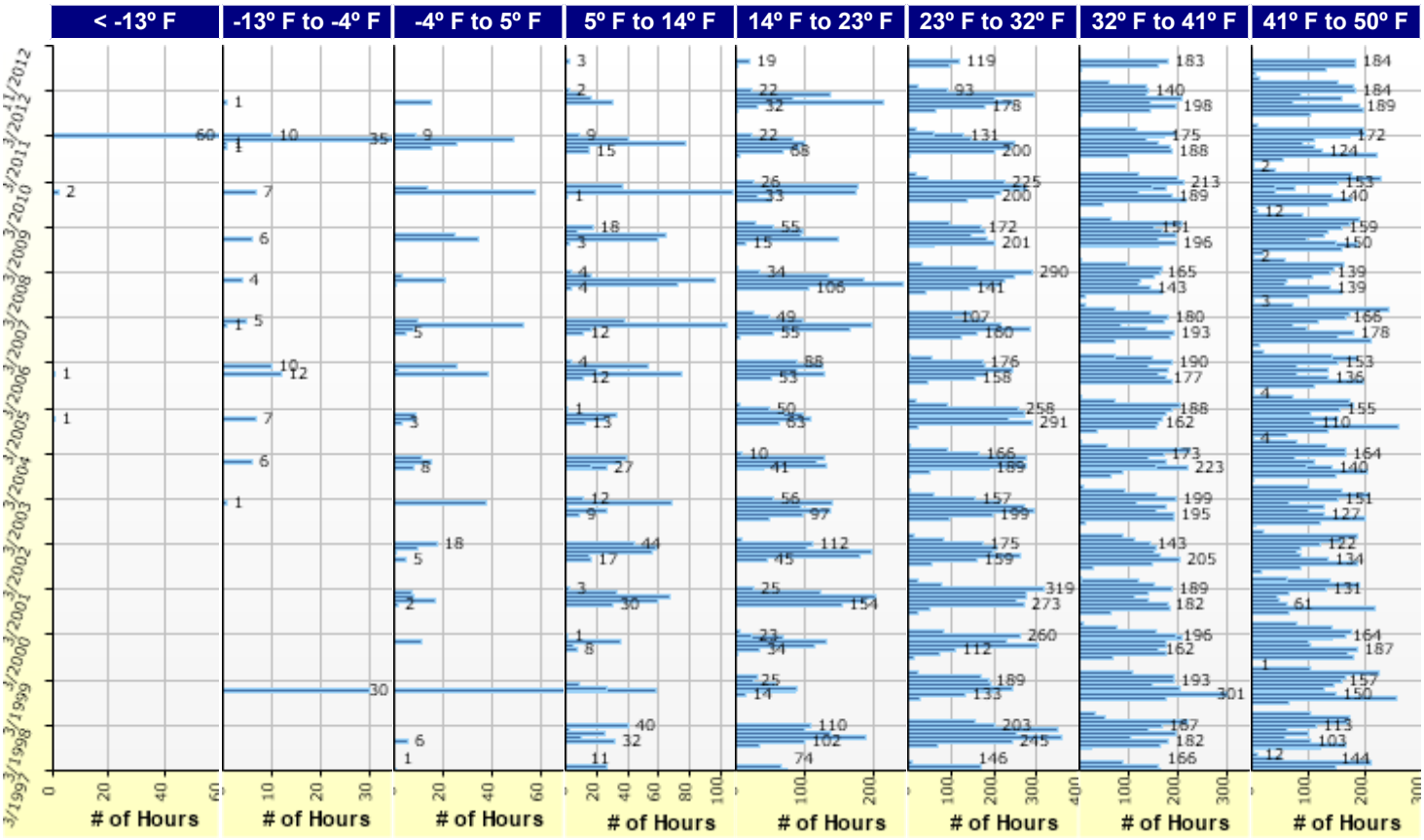


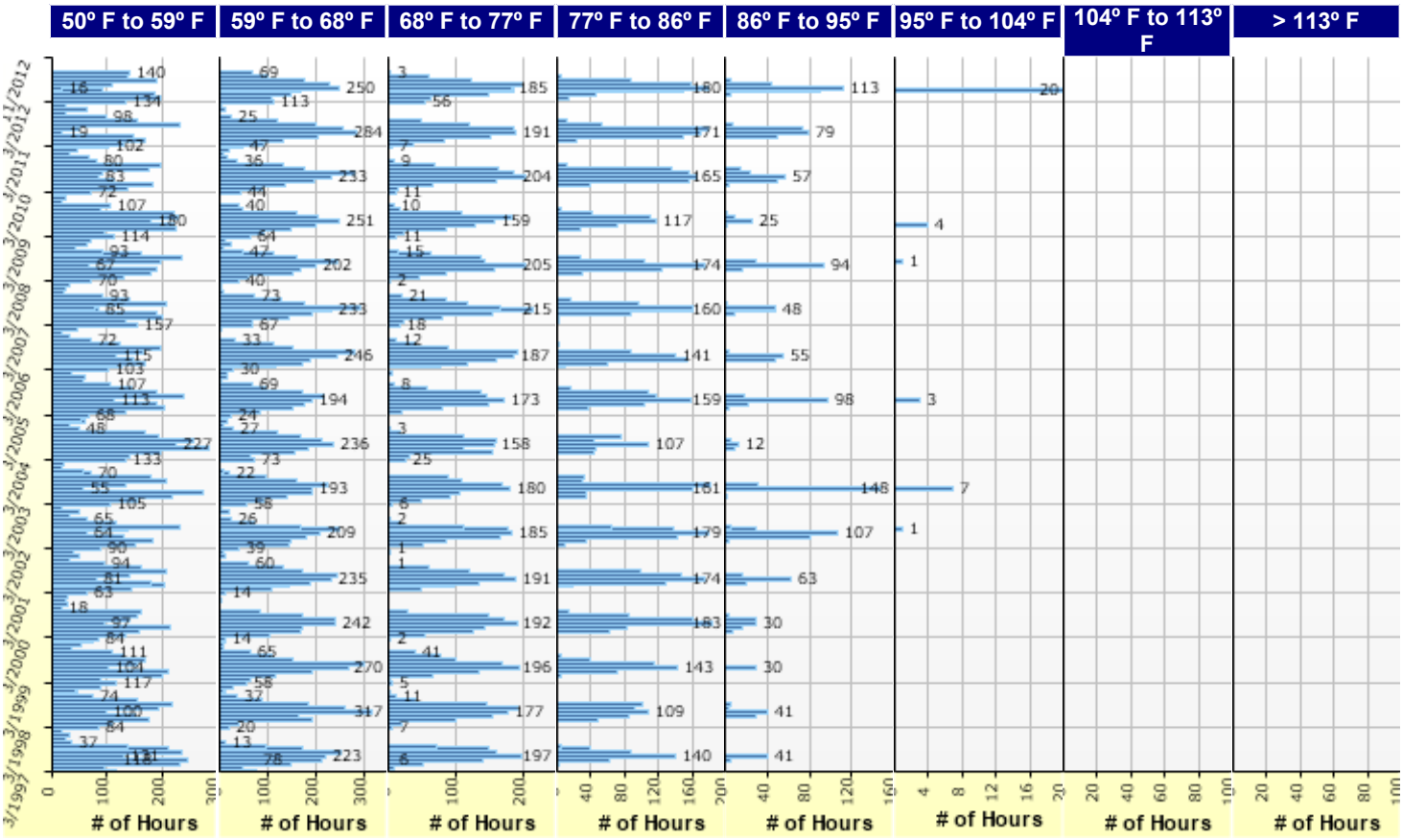






Hourly Air Temperature Distribution by Month:





Design Properties

JPCP Design Properties

Structure - ICM Properties	
PCC surface shortwave absorptivity	0.85

Doweled Joints	
Is joint doweled ?	True
Dowel diameter (in)	1.25
Dowel spacing (in)	12.00

Tied Shoulders	
Tied shoulders	False
Load transfer efficiency (%)	-

PCC joint spacing (ft)	
Is joint spacing random ?	False
Joint spacing (ft)	15.00

Widened Slab	
Is slab widened ?	False
Slab width (ft)	12.00

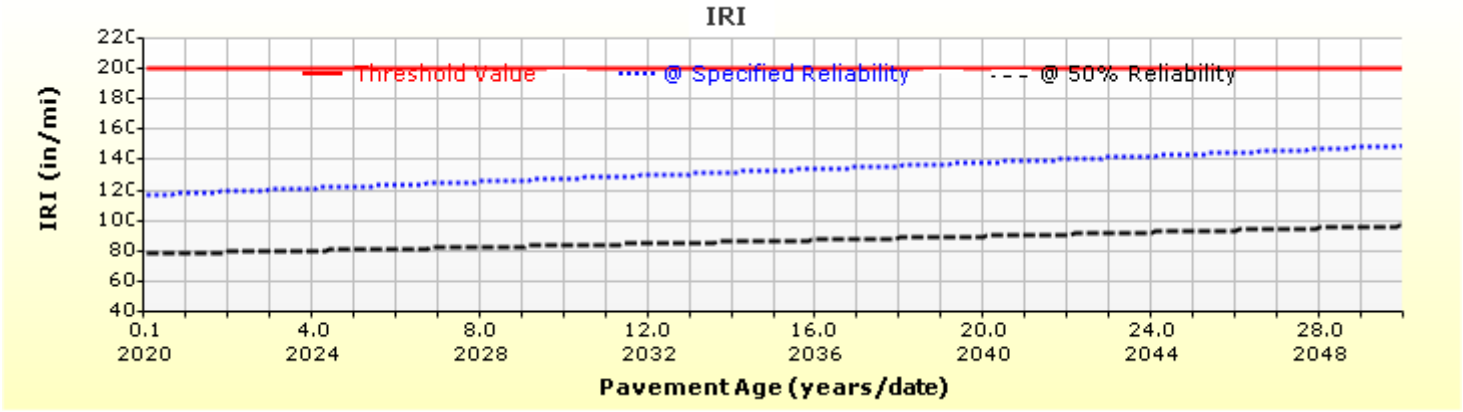
PCC-Base Contact Friction	
PCC-Base full friction contact	True
Months until friction loss	240.00

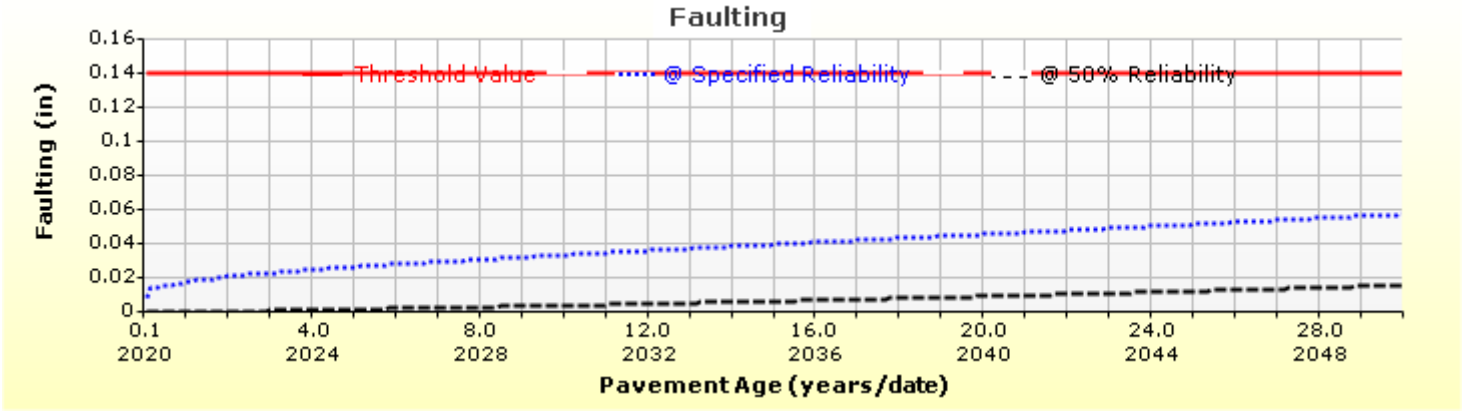
Sealant type	Preformed

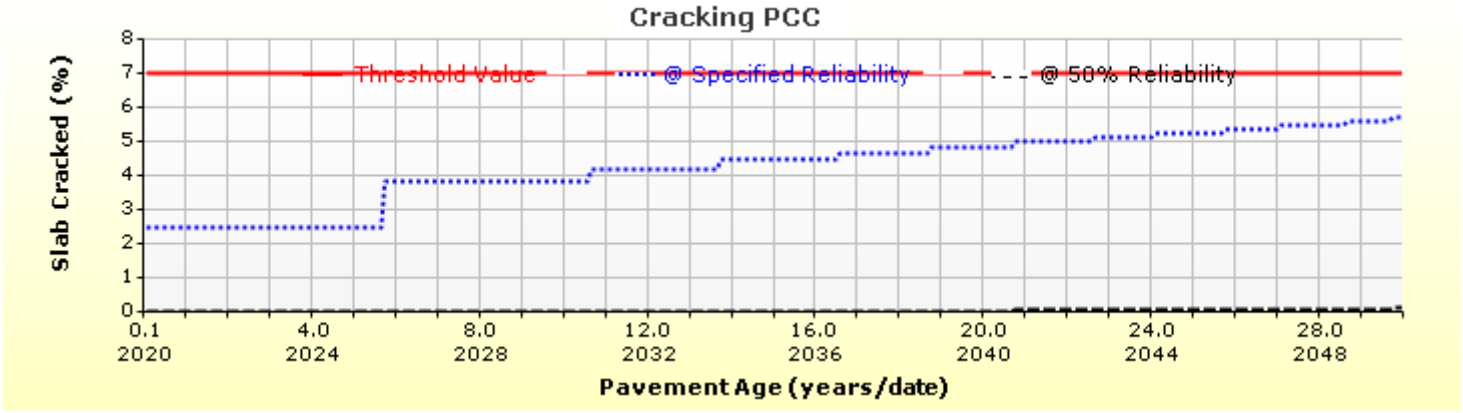
Erodibility index	5

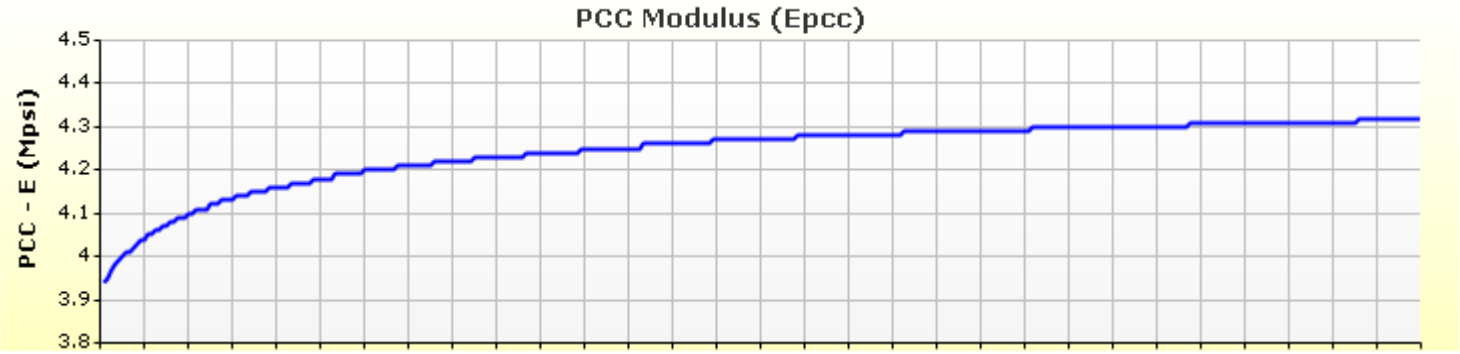
Permanent curl/warp effective temperature difference (ºF)	-10.00

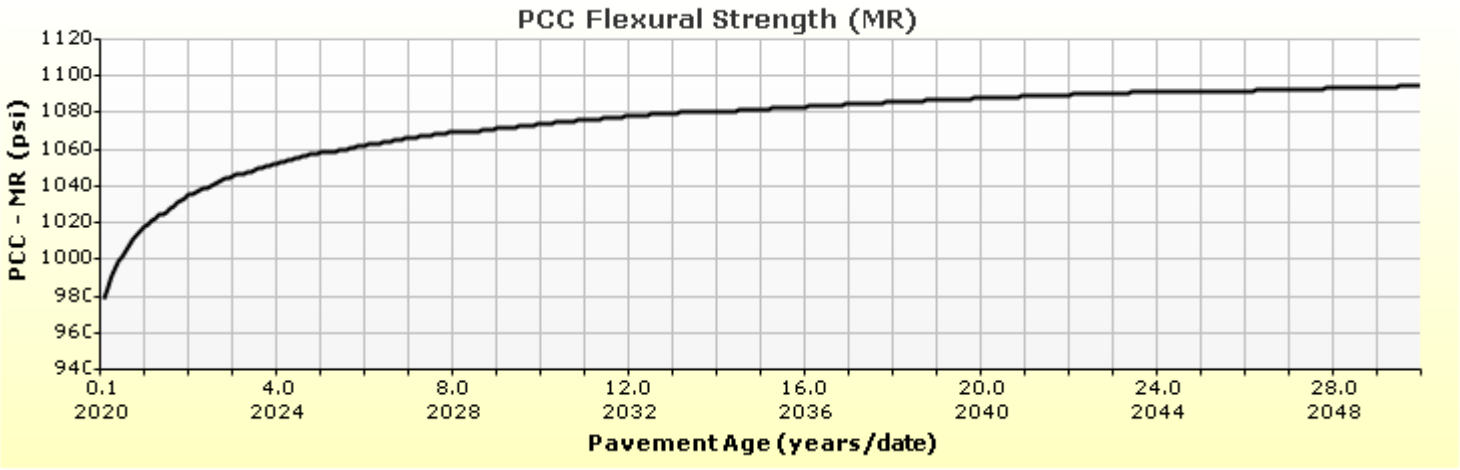
Analysis Output Charts

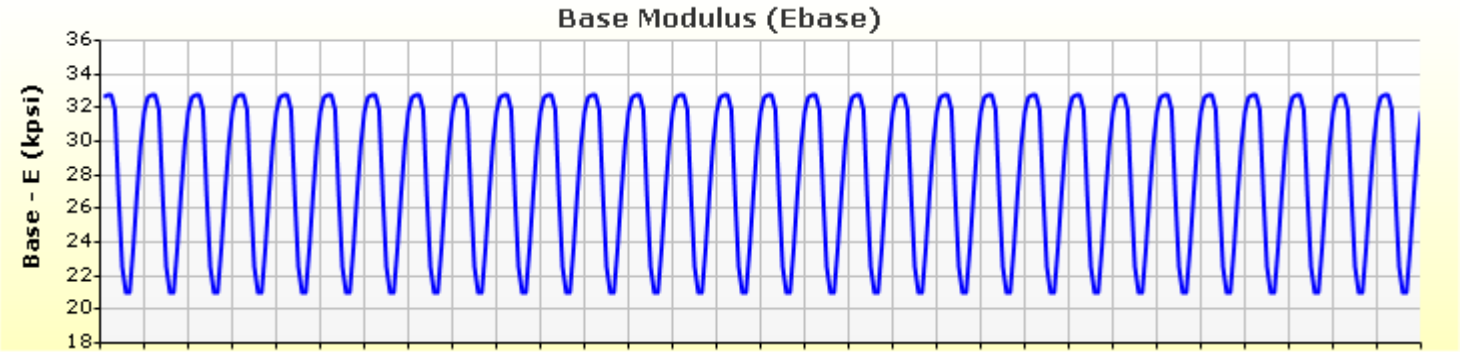


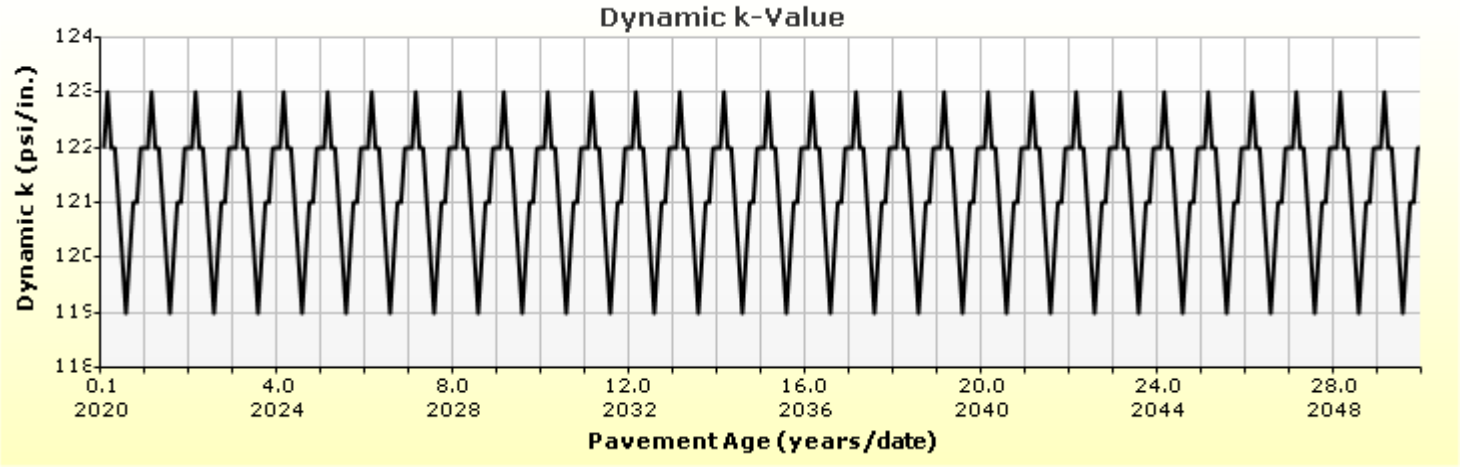


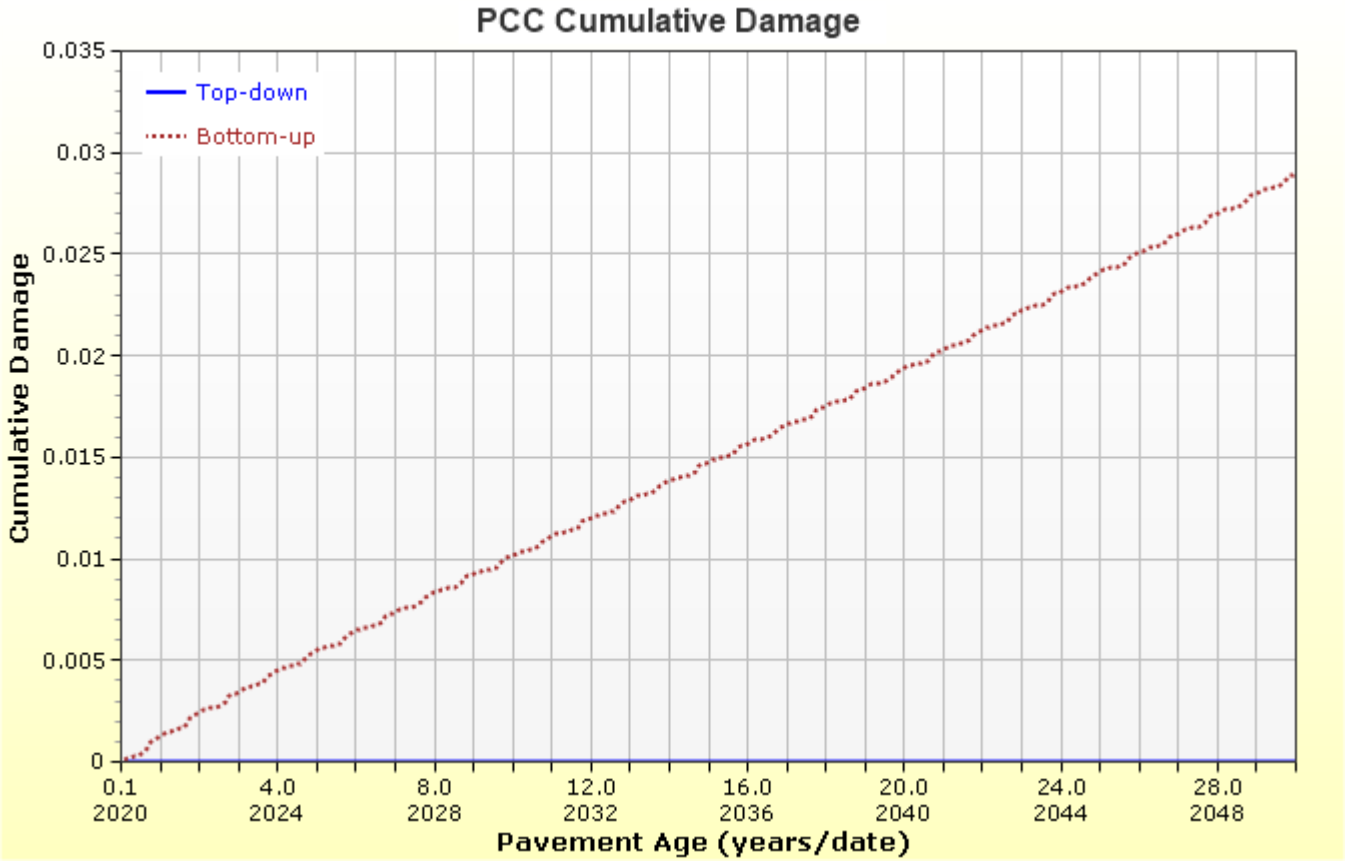


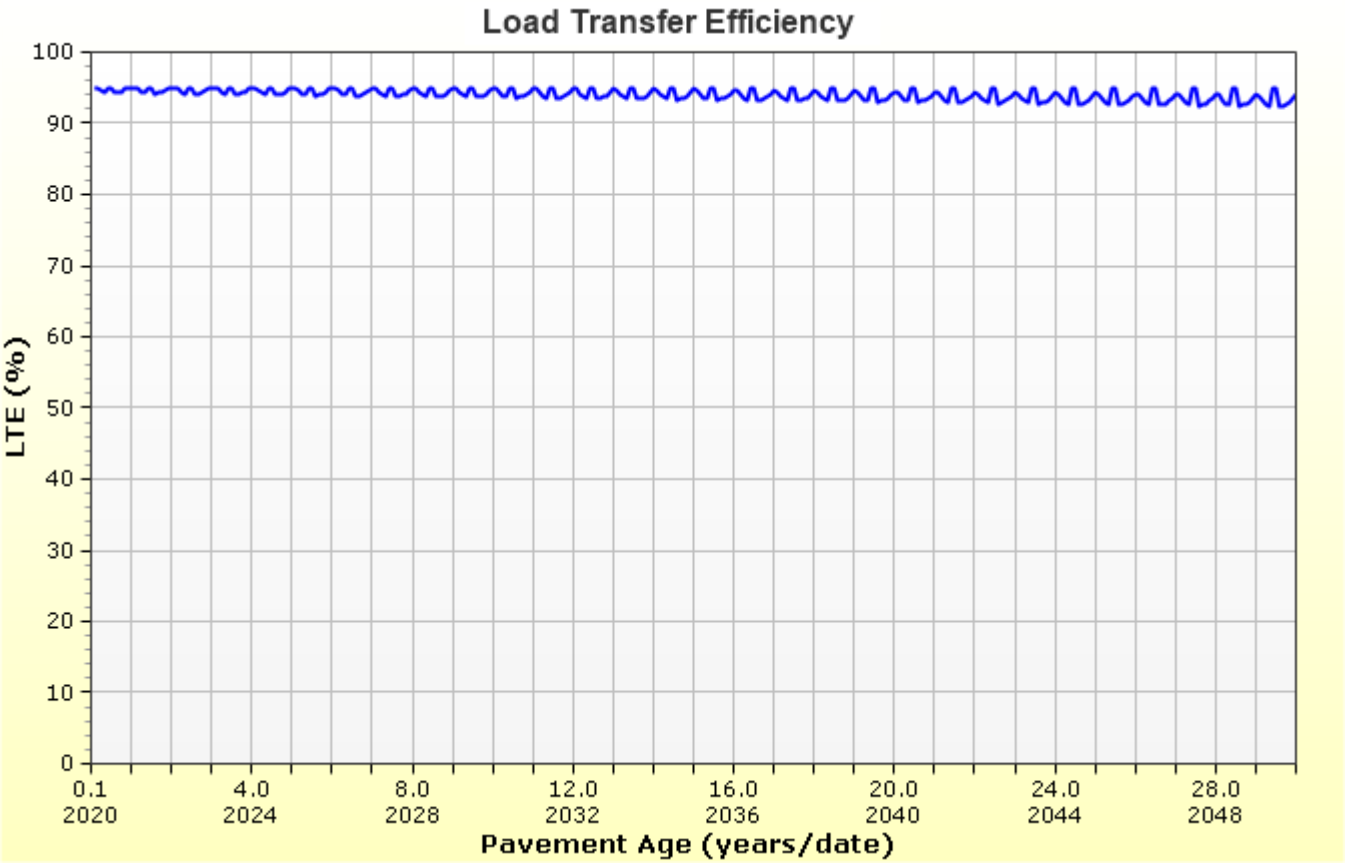

PCC Modulus (Epcc)
PCC - E (Mpsi)
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8


PCC Flexural Strength (MR)
PCC - MR (psi)
1120
1100
1080
1060
1040
1020
1000
980
960
940
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)


Base Modulus (Ebase)
Base - E (kpsi)
36
34
32
30
28
26
24
22
20
18


Dynamic k-Value
Dynamic k (psi/in.)
124
123
122
121
120
119
118
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)


PCC Cumulative Damage
Top-down
Bottom-up
Cumulative Damage
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)


Load Transfer Efficiency
LTE (%)
100
90
80
70
60
50
40
30
20
10
0
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)

Layer Information

Layer 1 PCC : JPCP Default

PCC	
Thickness (in)	8.0
Unit weight (pcf)	139.8
Poisson's ratio	0.2

Thermal	
PCC coefficient of thermal expansion (in/in/ºF x 10^-6)	4.72
PCC thermal conductivity (BTU/hr-ft-ºF)	1.25
PCC heat capacity (BTU/lb-ºF)	0.28

Mix		
Cement type		Type I (1)
Cementitious material content (lb/yd^3)		677
Water to cement ratio		0.44
Aggregate type		Granite (3)
PCC zero-stress temperature (ºF)	Calculated Internally?	True
	User Value	-
	Calculated Value	60.1
Ultimate shrinkage (microstrain)	Calculated Internally?	True
	User Value	-
	Calculated Value	701.5
Reversible shrinkage (%)		50
Time to develop 50% of ultimate shrinkage (days)		35
Curing method		Curing Compound

PCC strength and modulus (Input Level: 3)

28-Day PCC modulus of rupture (psi)	900.0
28-Day PCC elastic modulus (psi)	3550000.0

Identifiers

Field	Value
Display name/identifier	JPCP Default
Description of object	
Author	
Date Created	11/17/2017 1:59:42 PM
Approver	
Date approved	11/17/2017 1:59:42 PM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Layer 2 Non-stabilized Base : Class 6 ABC

Unbound	
Layer thickness (in)	6.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
22000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Class 6 ABC
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	42

Sieve

Liquid Limit	30.0
Plasticity Index	6.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	125.3
Saturated hydraulic conductivity (ft/hr)	False	2.257e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	8.3

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	12.2329
bf	1.1153
cf	0.8619
hr	244.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	12.0
#100	
#80	
#60	
#50	
#40	
#30	
#20	
#16	
#10	
#8	55.0
#4	65.0
3/8-in.	
1/2-in.	
3/4-in.	95.0
1-in.	100.0
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 3 Subgrade : A-6

Unbound	
Layer thickness (in)	24.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
7000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-6
Description of object	clayey sand
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	32

Sieve

Liquid Limit	37.0
Plasticity Index	18.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	112.9
Saturated hydraulic conductivity (ft/hr)	False	1.153e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	14.9

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	102.5522
bf	0.7198
cf	0.2545
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	47.0
#100	
#80	
#60	
#50	
#40	72.0
#30	
#20	
#16	
#10	
#8	
#4	98.0
3/8-in.	
1/2-in.	
3/4-in.	
1-in.	
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 4 Subgrade : A-6

Unbound	
Layer thickness (in)	Semi-infinite
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
7000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-6
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	33.0
Plasticity Index	16.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	107.9
Saturated hydraulic conductivity (ft/hr)	False	1.95e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	17.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	108.4091
bf	0.6801
cf	0.2161
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	63.2
#100	
#80	73.5
#60	
#50	
#40	82.4
#30	
#20	
#16	
#10	90.2
#8	
#4	93.5
3/8-in.	96.4
1/2-in.	97.4
3/4-in.	98.4
1-in.	99.0
1 1/2-in.	99.5
2-in.	99.8
2 1/2-in.	
3-in.	
3 1/2-in.	100.0

Calibration Coefficients

PCC Faulting

$$C_{12} = C_1 + (C_2 * FR^{0.25})$$
$$C_{34} = C_3 + (C_4 * FR^{0.25})$$
$$FaultMax_0 = C_{12} * \delta_{curling} * \left[\log(1 + C_5 * 5.0^{EROD}) * \log\left(P_{200} * \frac{WetDays}{p_S}\right)\right]^{C_6}$$
$$FaultMax_i = FaultMax_0 + C_7 * \sum_{j=1}^{m} DE_j * \log(1 + C_5 * 5.0^{EROD})^{C_6}$$
$$\Delta Fault_i = C_{34} * (FaultMax_{i-1} - Fault_{i-1})^2 * DE_i$$
$$C_8 = DowelDeterioration$$

C1: 0.5104	C2: 0.00838	C3: 0.00147	C4: 0.008345
C5: 5999	C6: 0.8404	C7: 5.9293	C8: 400
PCC Reliability Faulting Standard Deviation			
0.0831*Pow(FAULT,0.3426) + 0.00521			

IRI-jpcp

C1 - Cracking
C2 - Spalling
C3 - Faulting
C4 - Site Factor

C1: 0.8203	C2: 0.4417
C3: 1.4929	C4: 25.24
Reliability Standard Deviation	
5.4	

PCC Cracking

$$\log(N) = C1 \cdot \left(\frac{MR}{\sigma}\right)^{C2}$$
$$CRK = \frac{100}{1 + C4\ FD^{C5}}$$

Fatigue Coefficients		**Cracking Coefficients**	
C1: 2	C2: 1.22	C4: 0.6	C5: -2.05
PCC Reliability Cracking Standard Deviation			
Pow(57.08*CRACK,0.33) + 1.5			

Powers NB On-Ramp (3)

File Name: C:\Users\darwinME\Desktop\AFK\Powers and Research\PCC\Powers NB On-Ramp (3).dgpx

Design Inputs

Design Life: 30 years
Design Type: JPCP

Existing construction: -
Pavement construction: March, 2020
Traffic opening: August, 2020

Climate Data Sources (Lat/Lon): 38.812, -104.711

Design Structure

Layer type	Material Type	Thickness (in)
PCC	JPCP Default	7.5 (Optimized)
NonStabilized	Class 6 ABC	6.0
Subgrade	A-6	24.0
Subgrade	A-6	Semi-infinite

Joint Design:	
Joint spacing (ft)	15.0
Dowel diameter (in)	1.25
Slab width (ft)	12.0

Traffic

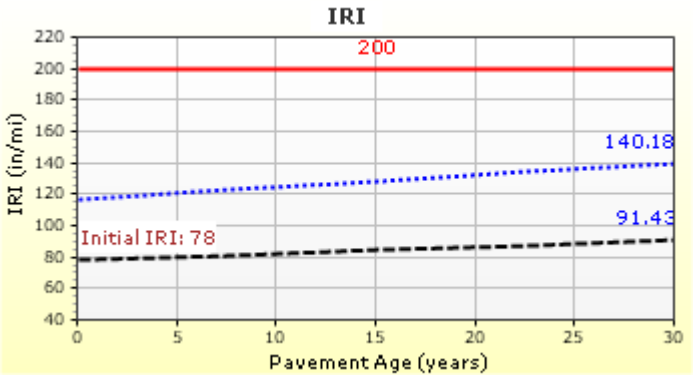
Age (year)	Heavy Trucks (cumulative)
2020 (initial)	282
2035 (15 years)	509,608
2050 (30 years)	1,131,840

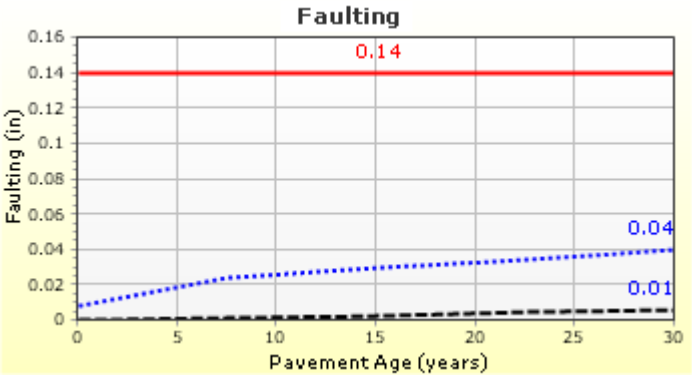
Design Outputs

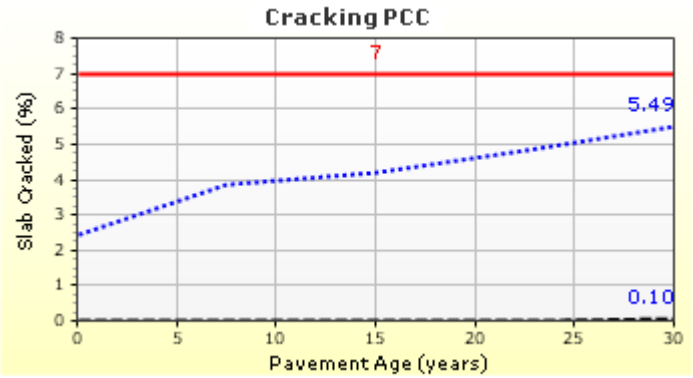
Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	200.00	140.18	95.00	99.99	Pass
Mean joint faulting (in)	0.14	0.04	95.00	100.00	Pass
JPCP transverse cracking (percent slabs)	7.00	5.49	95.00	98.24	Pass

Distress Charts



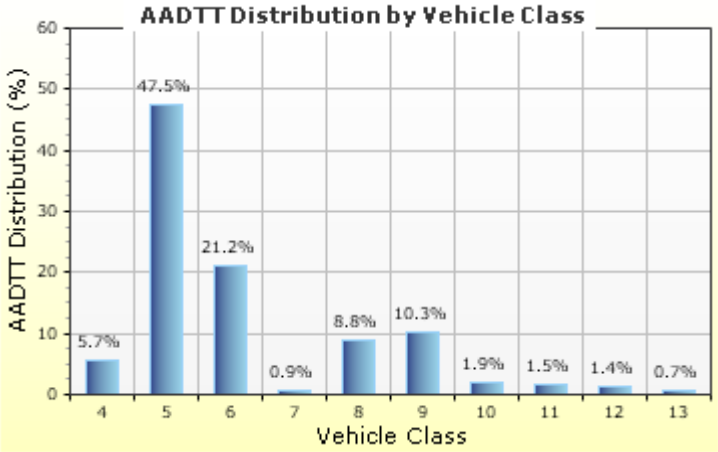


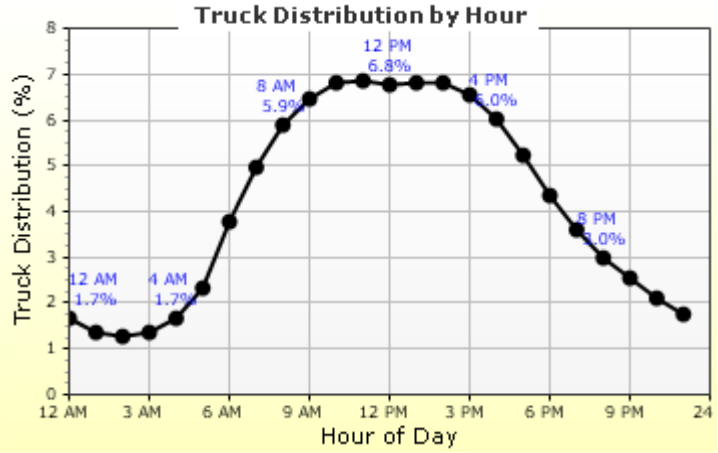


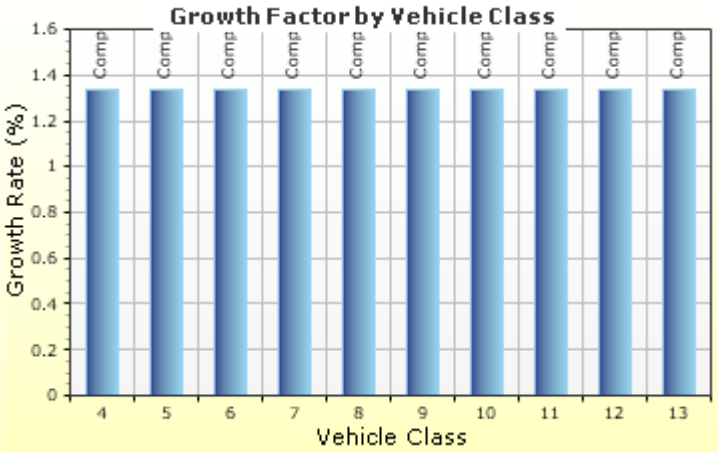
Traffic Inputs

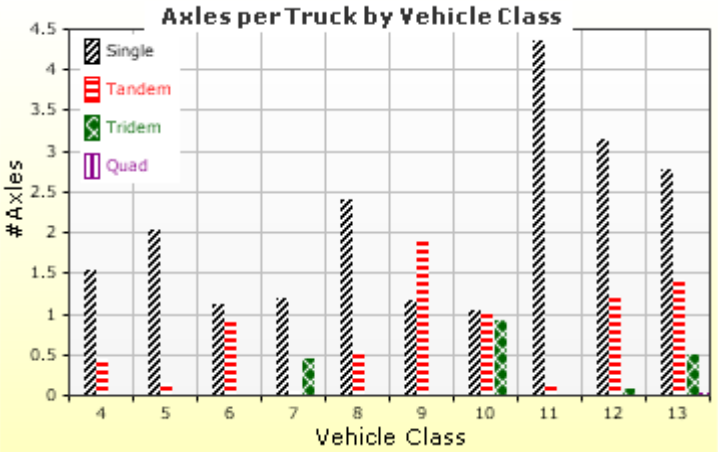
Graphical Representation of Traffic Inputs

Initial two-way AADTT:	282	Percent of trucks in design direction (%):	50.0
Number of lanes in design direction:	2	Percent of trucks in design lane (%):	60.0
		Operational speed (mph)	40.0

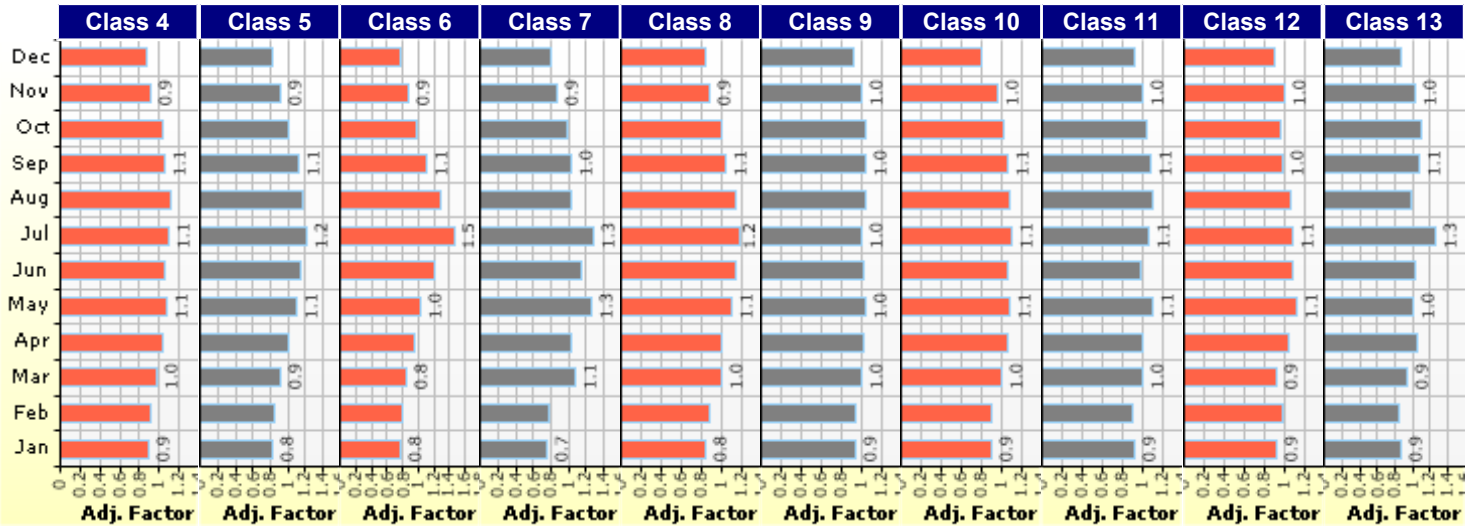








Traffic Volume Monthly Adjustment Factors



Tabular Representation of Traffic Inputs

Volume Monthly Adjustment Factors

Level 3: Default MAF

Month	Vehicle Class									
	4	5	6	7	8	9	10	11	12	13
January	0.9	0.8	0.8	0.7	0.8	0.9	0.9	0.9	0.9	0.9
February	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.8
March	1.0	0.9	0.8	1.1	1.0	1.0	1.0	1.0	0.9	0.9
April	1.0	1.0	0.9	1.0	1.0	1.0	1.1	1.0	1.0	1.1
May	1.1	1.1	1.0	1.3	1.1	1.0	1.1	1.1	1.1	1.0
June	1.1	1.1	1.2	1.1	1.1	1.0	1.1	1.0	1.1	1.0
July	1.1	1.2	1.5	1.3	1.2	1.0	1.1	1.1	1.1	1.3
August	1.1	1.2	1.3	1.0	1.1	1.0	1.1	1.1	1.1	1.0
September	1.1	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1
October	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.1
November	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0
December	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.9	0.9

Distributions by Vehicle Class

Vehicle Class	AADTT Distribution (%) (Level 3)	Growth Factor	
		Rate (%)	Function
Class 4	5.74%	1.34%	Compound
Class 5	47.46%	1.34%	Compound
Class 6	21.21%	1.34%	Compound
Class 7	0.94%	1.34%	Compound
Class 8	8.84%	1.34%	Compound
Class 9	10.31%	1.34%	Compound
Class 10	1.9%	1.34%	Compound
Class 11	1.51%	1.34%	Compound
Class 12	1.4%	1.34%	Compound
Class 13	0.69%	1.34%	Compound

Truck Distribution by Hour

Hour	Distribution (%)	Hour	Distribution (%)
12 AM	1.65%	12 PM	6.75%
1 AM	1.37%	1 PM	6.81%
2 AM	1.28%	2 PM	6.83%
3 AM	1.36%	3 PM	6.56%
4 AM	1.66%	4 PM	6.02%
5 AM	2.32%	5 PM	5.23%
6 AM	3.8%	6 PM	4.35%
7 AM	4.95%	7 PM	3.59%
8 AM	5.9%	8 PM	2.98%
9 AM	6.48%	9 PM	2.56%
10 AM	6.83%	10 PM	2.12%
11 AM	6.85%	11 PM	1.75%
		Total	100%

Axle Configuration

Traffic Wander	
Mean wheel location (in)	18.0
Traffic wander standard deviation (in)	10.0
Design lane width (ft)	12.0

Axle Configuration	
Average axle width (ft)	8.5
Dual tire spacing (in)	12.0
Tire pressure (psi)	120.0

Average Axle Spacing	
Tandem axle spacing (in)	51.6
Tridem axle spacing (in)	49.2
Quad axle spacing (in)	49.2

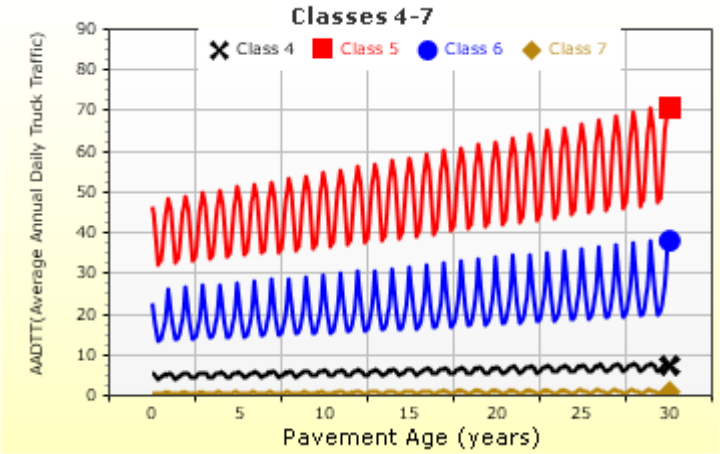
Wheelbase				
Value Type	Axle Type	Short	Medium	Long
Average spacing of axles (ft)		12.0	15.0	18.0
Percent of Trucks (%)		17.0	22.0	61.0

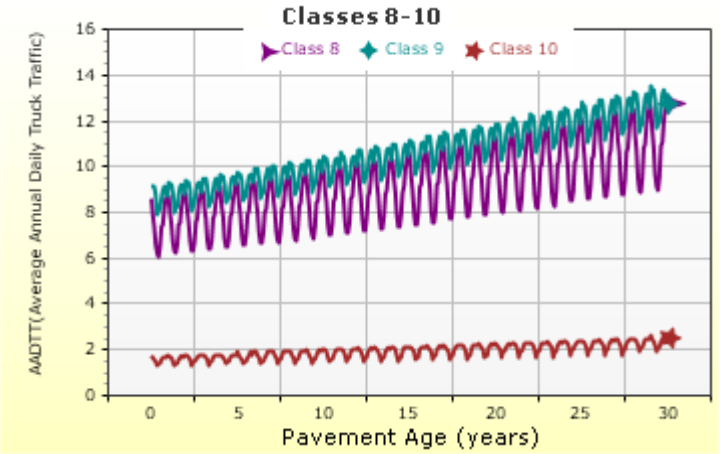
Number of Axles per Truck

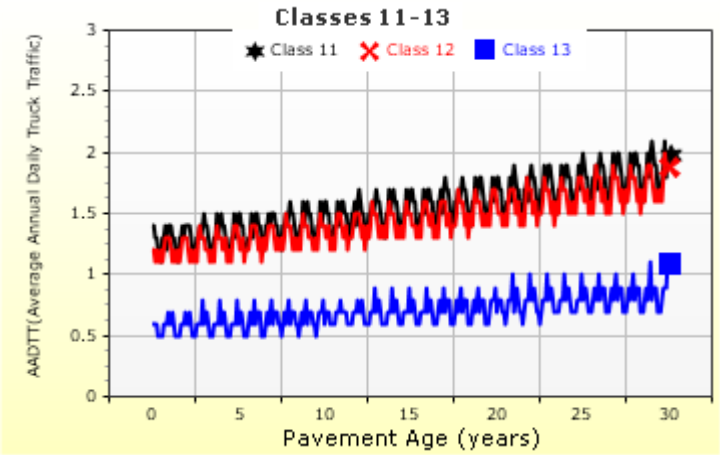
Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.53	0.45	0	0
Class 5	2.02	0.16	0.02	0
Class 6	1.12	0.93	0	0
Class 7	1.19	0.07	0.45	0.02
Class 8	2.41	0.56	0.02	0
Class 9	1.16	1.88	0.01	0
Class 10	1.05	1.01	0.93	0.02
Class 11	4.35	0.13	0	0
Class 12	3.15	1.22	0.09	0
Class 13	2.77	1.4	0.51	0.04

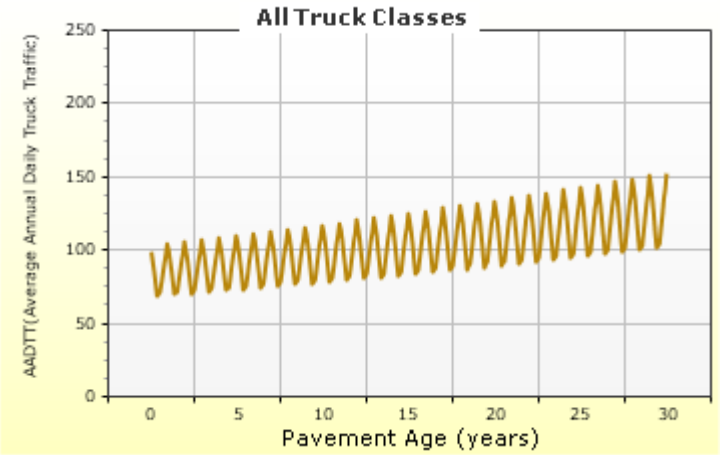
AADTT (Average Annual Daily Truck Traffic) Growth

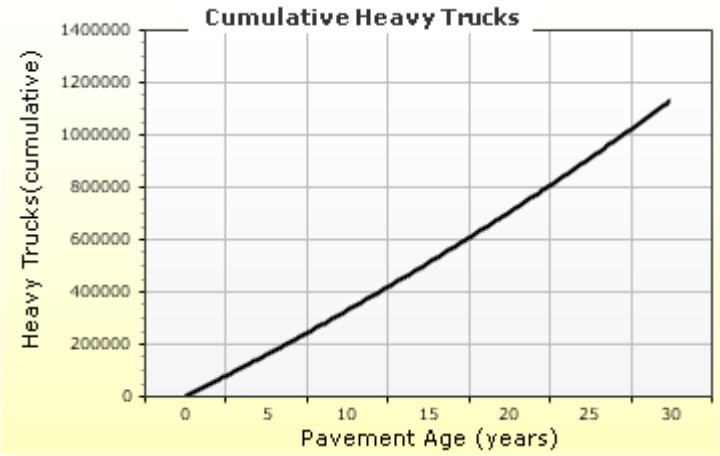
*** Traffic cap is not enforced**







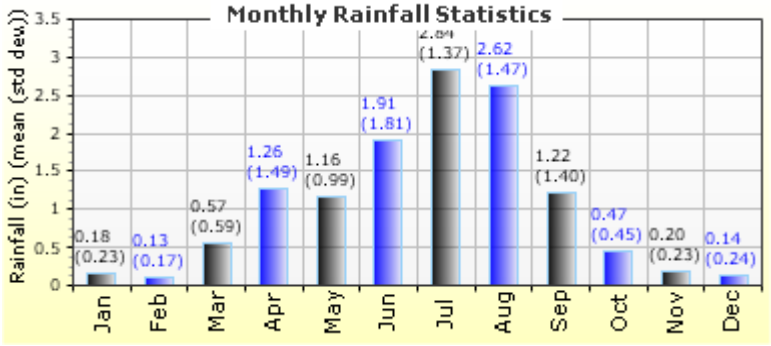




Climate Inputs

Climate Data Sources:

Climate Station Cities:	Location (lat lon elevation(ft))
COLORADO SPRINGS,	38.81200 -104.71100 6170

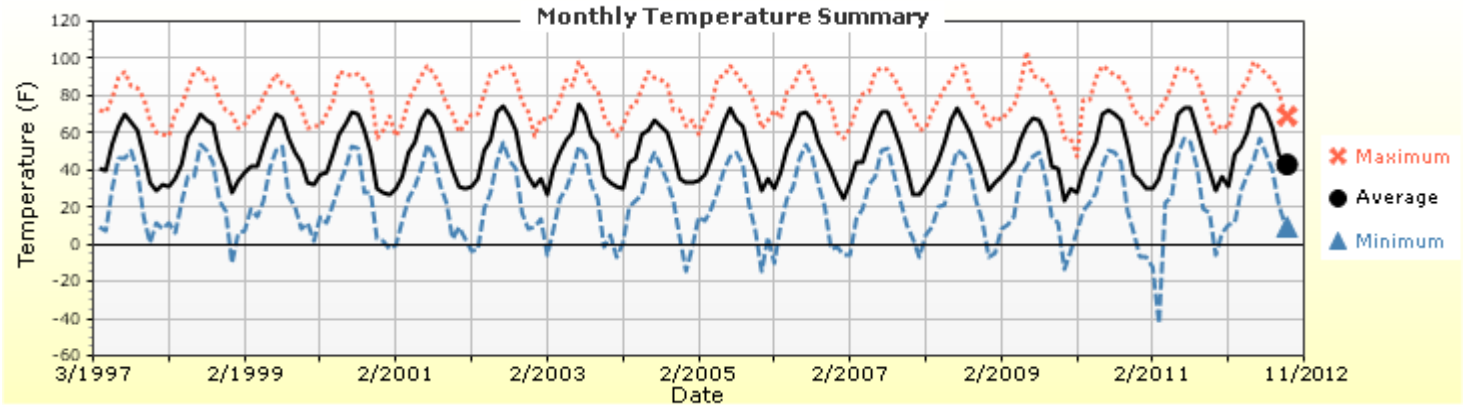


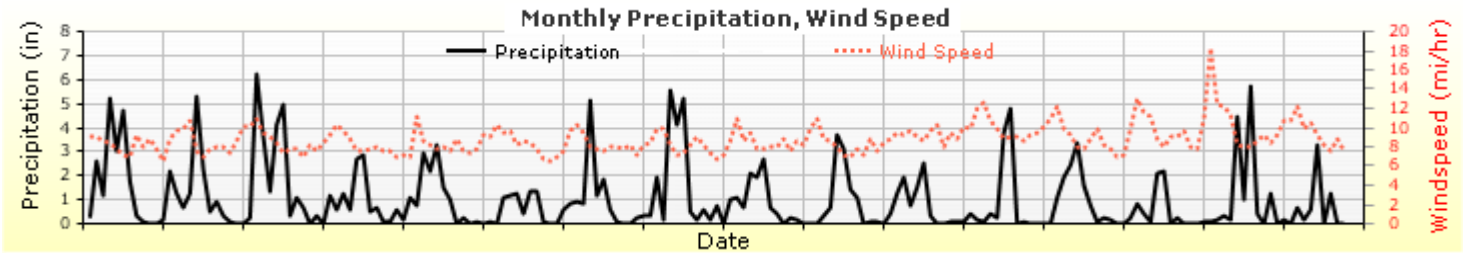
Annual Statistics:

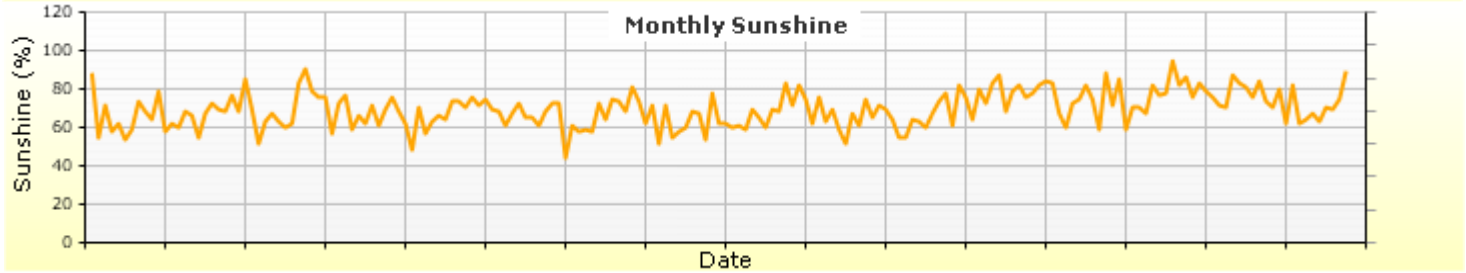
Mean annual air temperature (ºF)	49.78
Mean annual precipitation (in)	12.82
Freezing index (ºF - days)	487.57
Average annual number of freeze/thaw cycles:	131.57

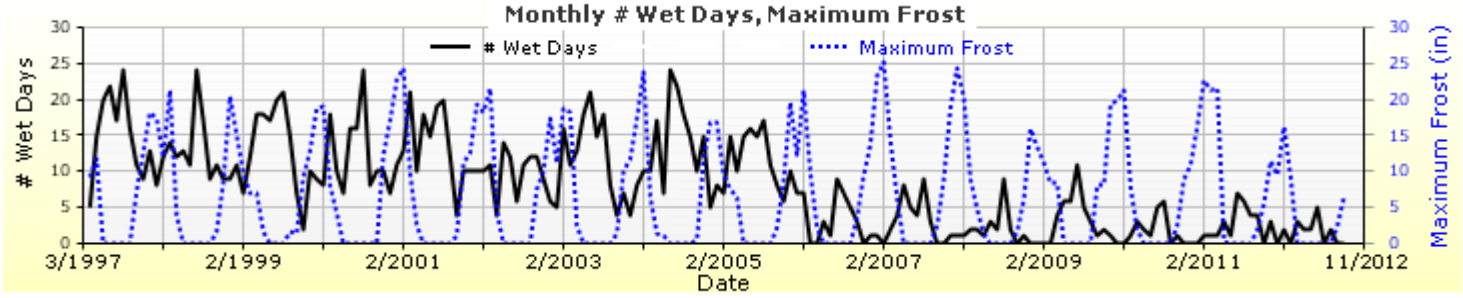
Water table depth (ft)	10.00

Monthly Climate Summary:

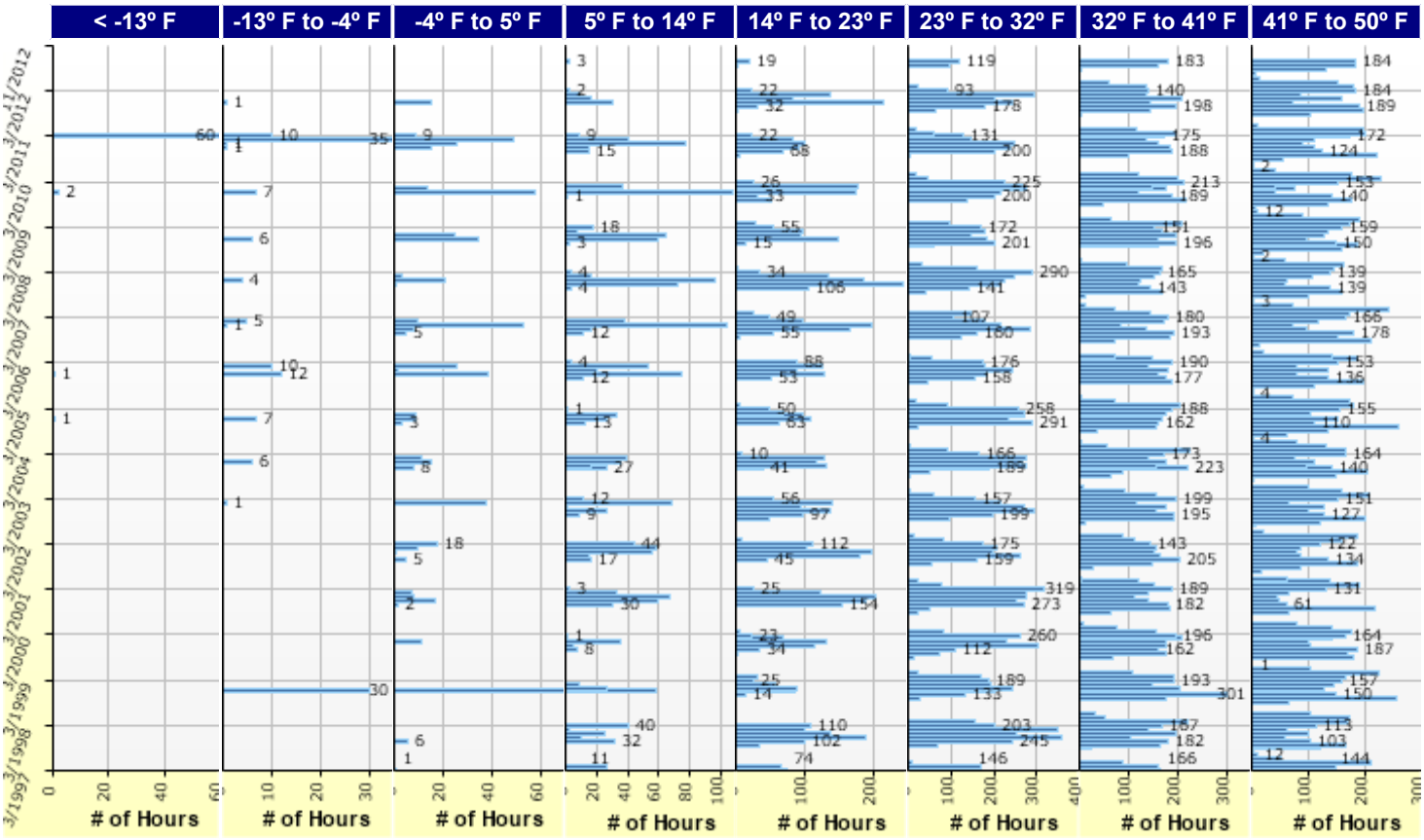


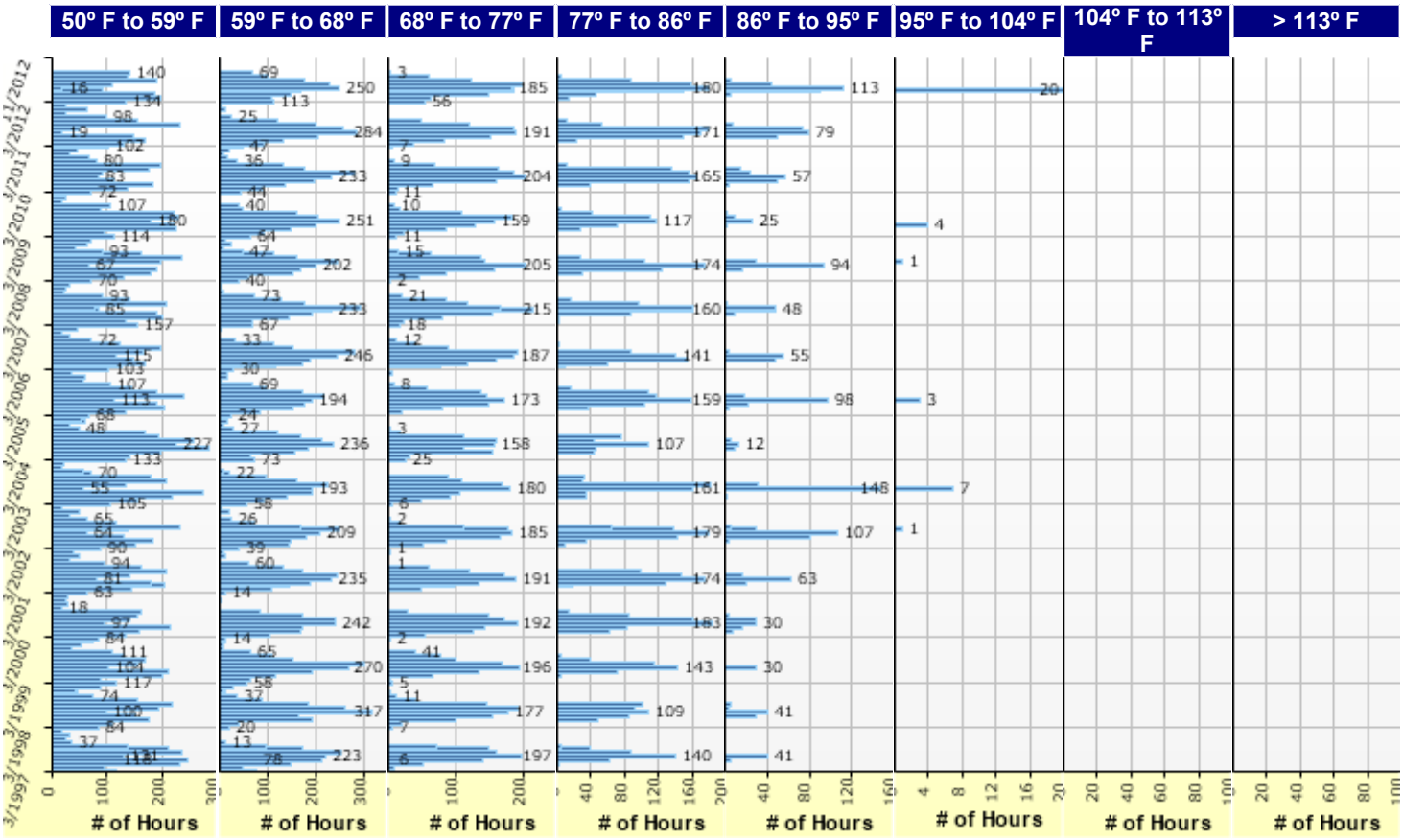






Hourly Air Temperature Distribution by Month:





Design Properties

JPCP Design Properties

Structure - ICM Properties	
PCC surface shortwave absorptivity	0.85

Doweled Joints	
Is joint doweled ?	True
Dowel diameter (in)	1.25
Dowel spacing (in)	12.00

Tied Shoulders	
Tied shoulders	False
Load transfer efficiency (%)	-

PCC joint spacing (ft)	
Is joint spacing random ?	False
Joint spacing (ft)	15.00

Widened Slab	
Is slab widened ?	False
Slab width (ft)	12.00

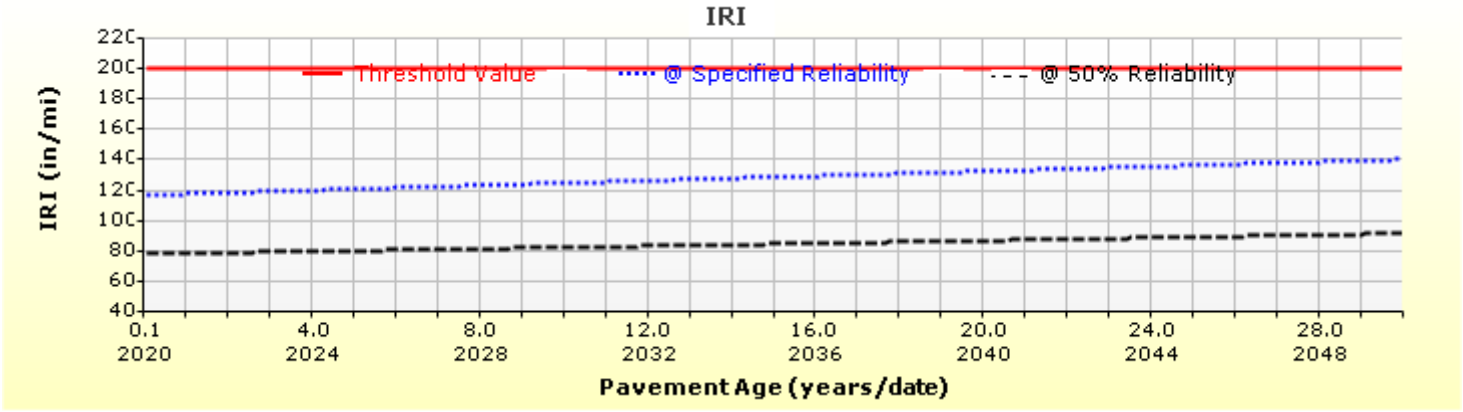
PCC-Base Contact Friction	
PCC-Base full friction contact	True
Months until friction loss	240.00

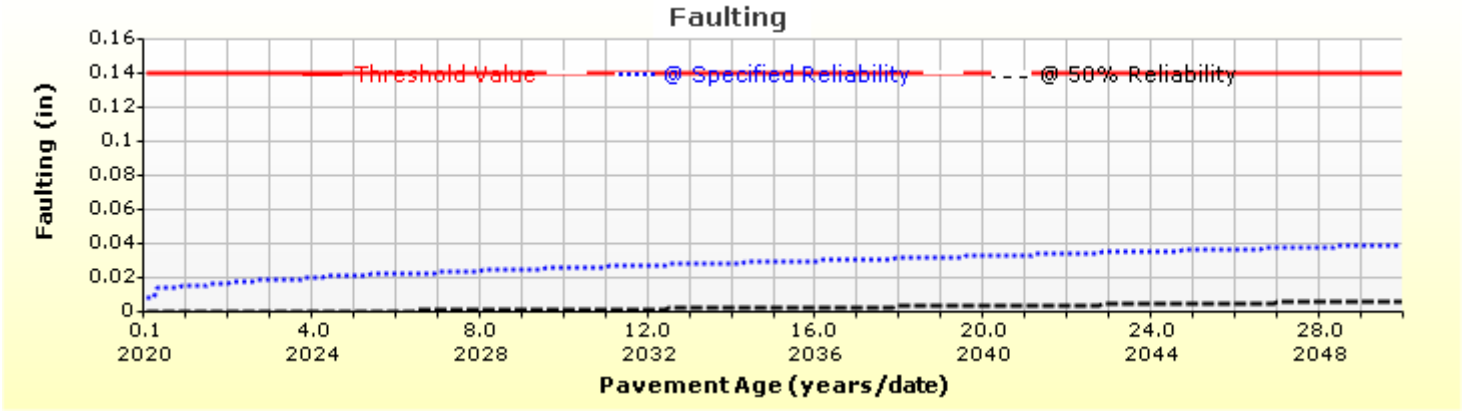
Sealant type	Preformed

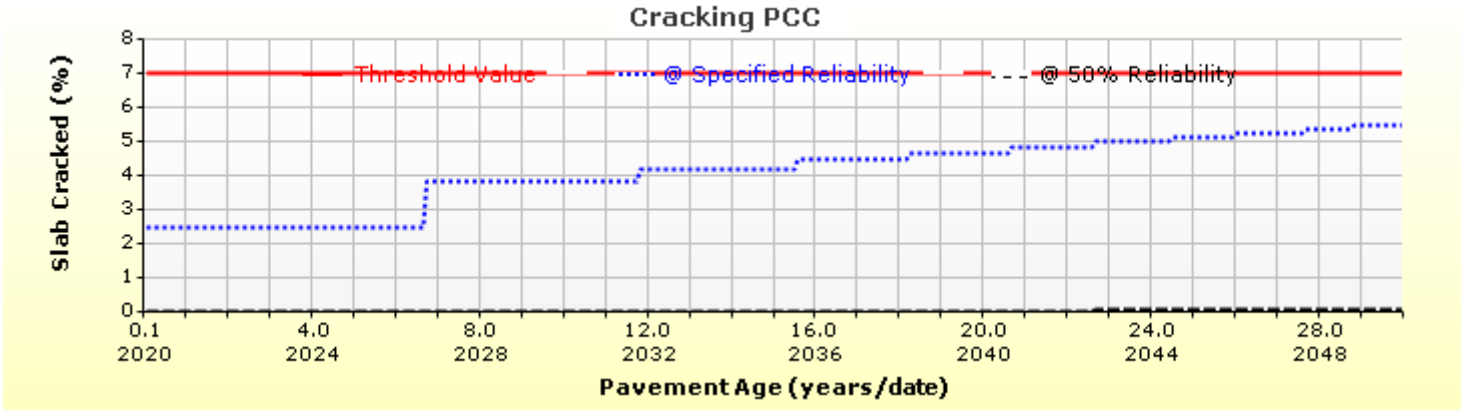
Erodibility index	5

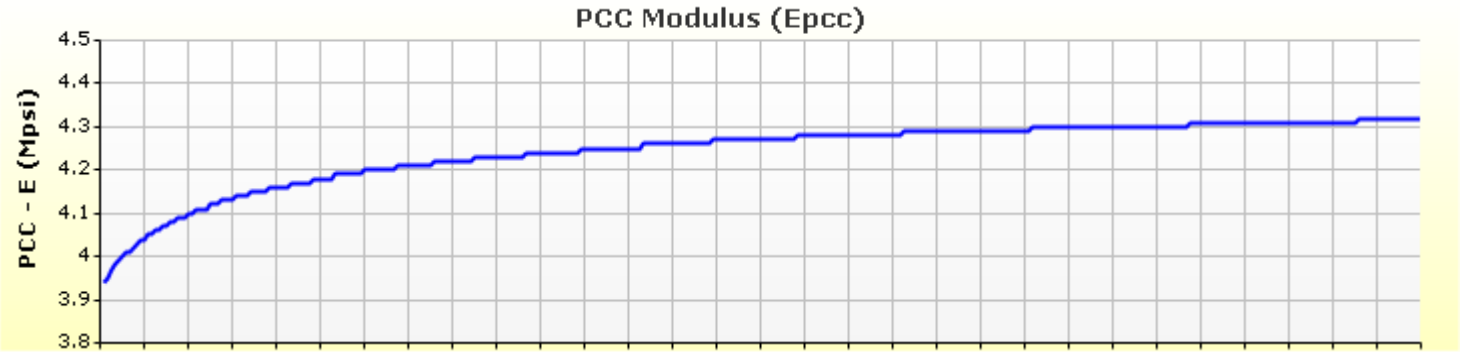
Permanent curl/warp effective temperature difference (ºF)	-10.00

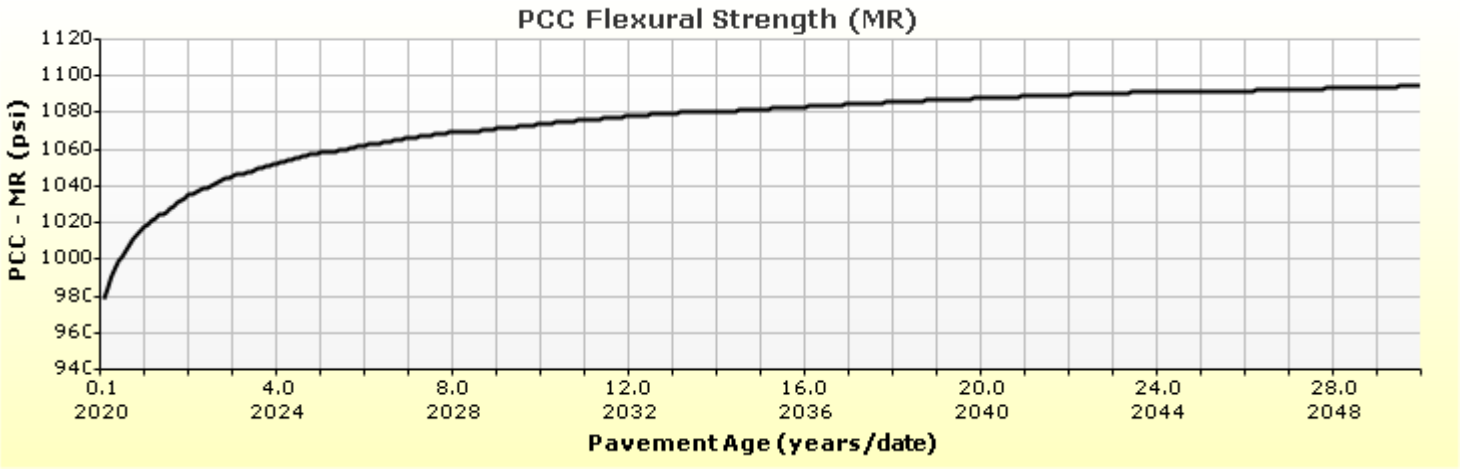
Analysis Output Charts

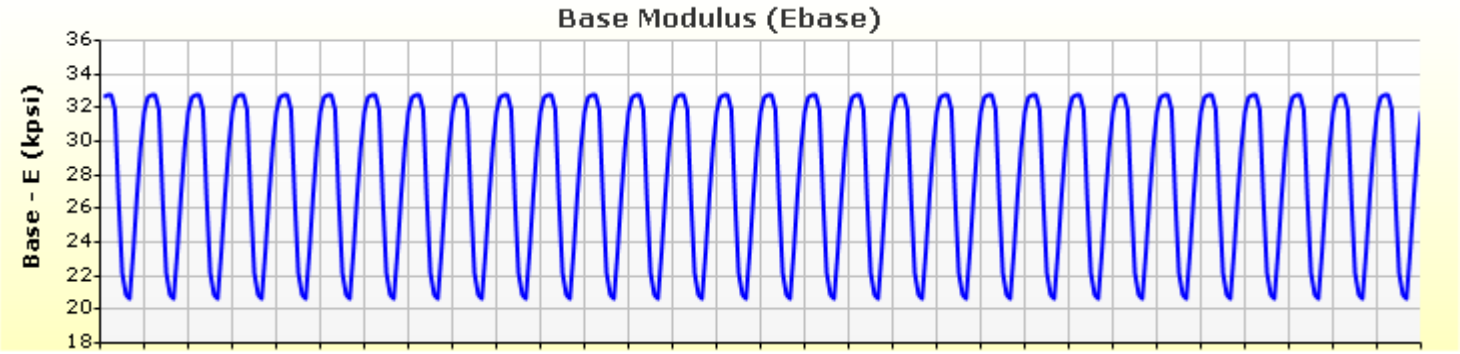


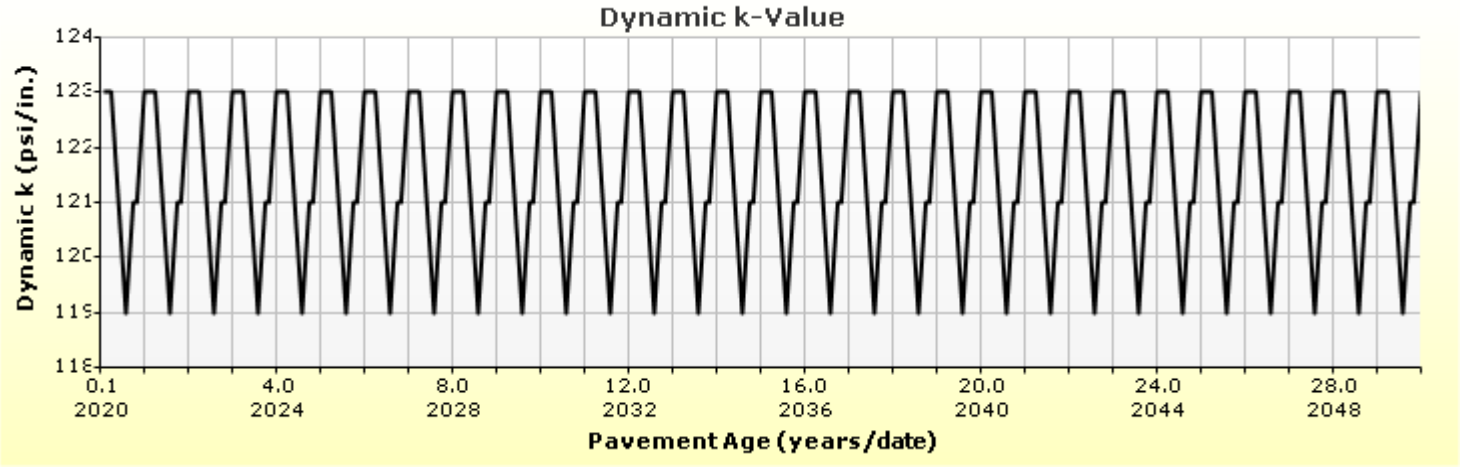


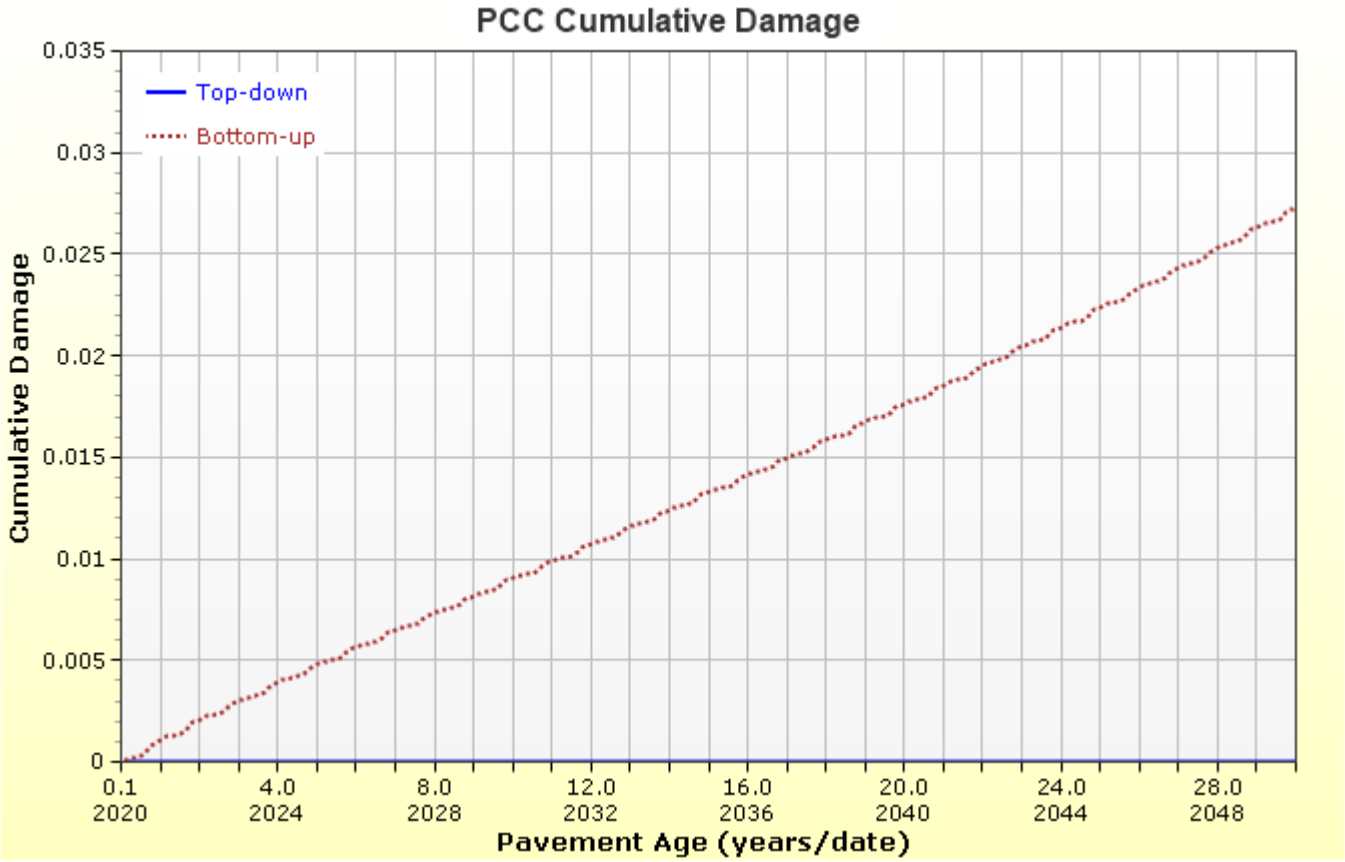


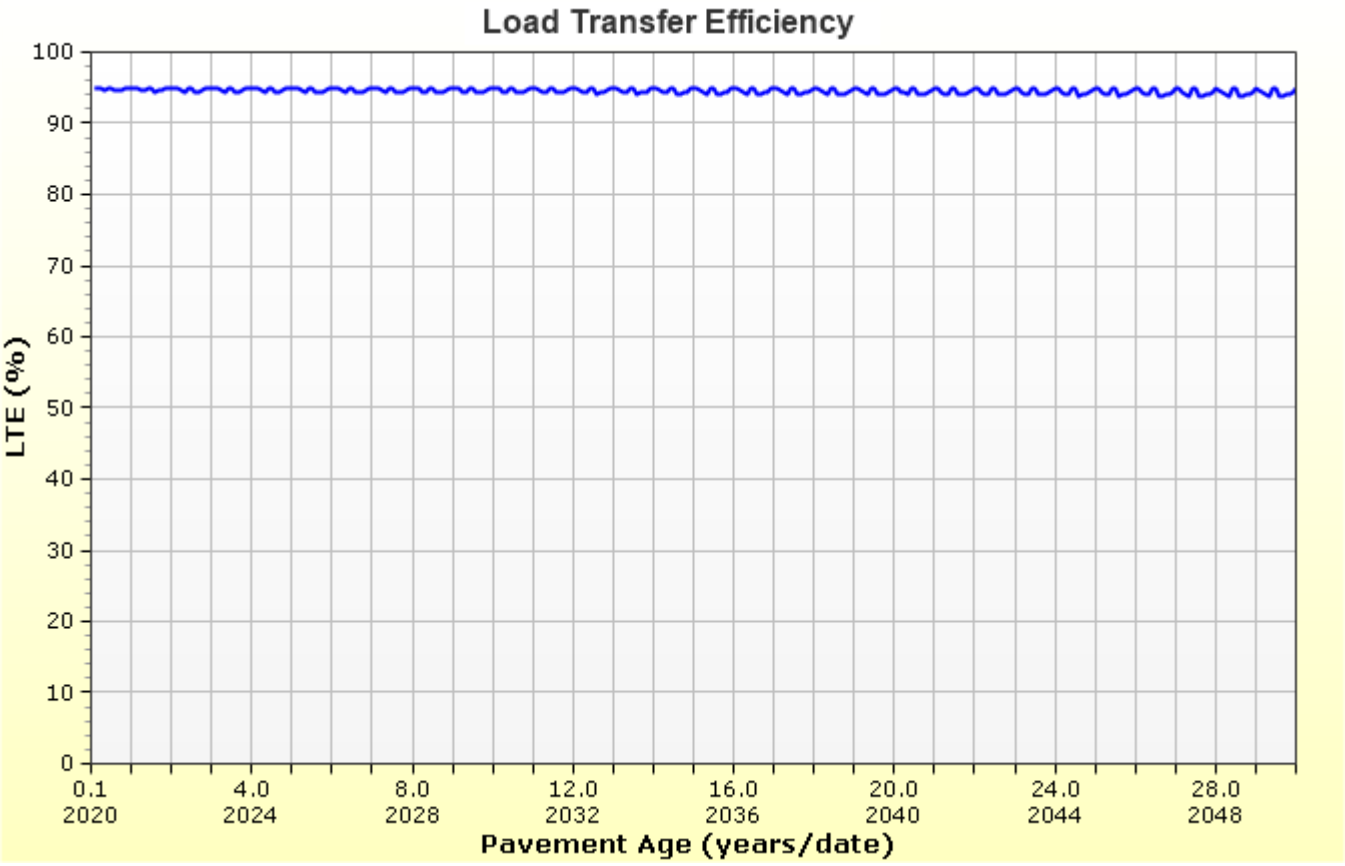

PCC Modulus (Epcc)
PCC - E (Mpsi)
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8


PCC Flexural Strength (MR)
PCC - MR (psi)
1120
1100
1080
1060
1040
1020
1000
980
960
940
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)


Base Modulus (Ebase)
Base - E (kpsi)
36
34
32
30
28
26
24
22
20
18


Dynamic k-Value
Dynamic k (psi/in.)
124
123
122
121
120
119
118
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)


PCC Cumulative Damage
Top-down
Bottom-up
Cumulative Damage
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)


Load Transfer Efficiency
LTE (%)
100
90
80
70
60
50
40
30
20
10
0
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)

Layer Information

Layer 1 PCC : JPCP Default

PCC	
Thickness (in)	7.5
Unit weight (pcf)	139.8
Poisson's ratio	0.2

Thermal	
PCC coefficient of thermal expansion (in/in/ºF x 10^-6)	4.72
PCC thermal conductivity (BTU/hr-ft-ºF)	1.25
PCC heat capacity (BTU/lb-ºF)	0.28

Mix		
Cement type		Type I (1)
Cementitious material content (lb/yd^3)		677
Water to cement ratio		0.44
Aggregate type		Granite (3)
PCC zero-stress temperature (ºF)	Calculated Internally?	True
	User Value	-
	Calculated Value	60.1
Ultimate shrinkage (microstrain)	Calculated Internally?	True
	User Value	-
	Calculated Value	701.5
Reversible shrinkage (%)		50
Time to develop 50% of ultimate shrinkage (days)		35
Curing method		Curing Compound

PCC strength and modulus (Input Level: 3)

28-Day PCC modulus of rupture (psi)	900.0
28-Day PCC elastic modulus (psi)	3550000.0

Identifiers

Field	Value
Display name/identifier	JPCP Default
Description of object	
Author	
Date Created	11/17/2017 1:59:42 PM
Approver	
Date approved	11/17/2017 1:59:42 PM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Layer 2 Non-stabilized Base : Class 6 ABC

Unbound	
Layer thickness (in)	6.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
22000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Class 6 ABC
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	42

Sieve

Liquid Limit	30.0
Plasticity Index	6.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	125.3
Saturated hydraulic conductivity (ft/hr)	False	2.257e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	8.3

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	12.2329
bf	1.1153
cf	0.8619
hr	244.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	12.0
#100	
#80	
#60	
#50	
#40	
#30	
#20	
#16	
#10	
#8	55.0
#4	65.0
3/8-in.	
1/2-in.	
3/4-in.	95.0
1-in.	100.0
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 3 Subgrade : A-6

Unbound	
Layer thickness (in)	24.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
7000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-6
Description of object	clayey sand
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	32

Sieve

Liquid Limit	37.0
Plasticity Index	18.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	112.9
Saturated hydraulic conductivity (ft/hr)	False	1.153e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	14.9

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	102.5522
bf	0.7198
cf	0.2545
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	47.0
#100	
#80	
#60	
#50	
#40	72.0
#30	
#20	
#16	
#10	
#8	
#4	98.0
3/8-in.	
1/2-in.	
3/4-in.	
1-in.	
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 4 Subgrade : A-6

Unbound	
Layer thickness (in)	Semi-infinite
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
7000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-6
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	33.0
Plasticity Index	16.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	107.9
Saturated hydraulic conductivity (ft/hr)	False	1.95e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	17.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	108.4091
bf	0.6801
cf	0.2161
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	63.2
#100	
#80	73.5
#60	
#50	
#40	82.4
#30	
#20	
#16	
#10	90.2
#8	
#4	93.5
3/8-in.	96.4
1/2-in.	97.4
3/4-in.	98.4
1-in.	99.0
1 1/2-in.	99.5
2-in.	99.8
2 1/2-in.	
3-in.	
3 1/2-in.	100.0

Calibration Coefficients

PCC Faulting

$$C_{12} = C_1 + (C_2 * FR^{0.25})$$
$$C_{34} = C_3 + (C_4 * FR^{0.25})$$
$$FaultMax_0 = C_{12} * \delta_{curling} * \left[\log(1 + C_5 * 5.0^{EROD}) * \log\left(P_{200} * \frac{WetDays}{p_S}\right)\right]^{C_6}$$
$$FaultMax_i = FaultMax_0 + C_7 * \sum_{j=1}^{m} DE_j * \log(1 + C_5 * 5.0^{EROD})^{C_6}$$
$$\Delta Fault_i = C_{34} * (FaultMax_{i-1} - Fault_{i-1})^2 * DE_i$$
$$C_8 = DowelDeterioration$$

C1: 0.5104	C2: 0.00838	C3: 0.00147	C4: 0.008345
C5: 5999	C6: 0.8404	C7: 5.9293	C8: 400
PCC Reliability Faulting Standard Deviation			
0.0831*Pow(FAULT,0.3426) + 0.00521			

IRI-jpcp

C1 - Cracking
C2 - Spalling
C3 - Faulting
C4 - Site Factor

C1: 0.8203	C2: 0.4417
C3: 1.4929	C4: 25.24
Reliability Standard Deviation	
5.4	

PCC Cracking

$$\log(N) = C1 \cdot \left(\frac{MR}{\sigma}\right)^{C2}$$
$$CRK = \frac{100}{1 + C4\ FD^{C5}}$$

Fatigue Coefficients		**Cracking Coefficients**	
C1: 2	C2: 1.22	C4: 0.6	C5: -2.05
PCC Reliability Cracking Standard Deviation			
Pow(57.08*CRACK,0.33) + 1.5			

Powers NB Off-Ramp (4)

File Name: C:\Users\darwinME\Desktop\AFK\Powers and Research\PCC\Powers NB Off-Ramp (4).dgpx

Design Inputs

Design Life: 30 years
Design Type: JPCP

Existing construction: -
Pavement construction: March, 2020
Traffic opening: August, 2020

Climate Data Sources (Lat/Lon): 38.812, -104.711

Design Structure

Layer type	Material Type	Thickness (in)
PCC	JPCP Default	7.5 (Optimized)
NonStabilized	Class 6 ABC	6.0
Subgrade	A-6	24.0
Subgrade	A-6	Semi-infinite

Joint Design:	
Joint spacing (ft)	15.0
Dowel diameter (in)	1.25
Slab width (ft)	12.0

Traffic

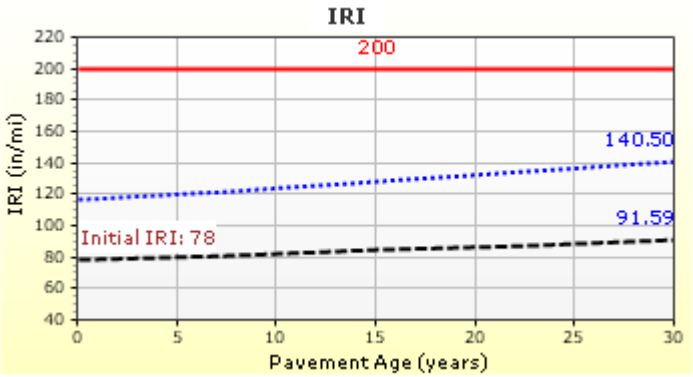
Age (year)	Heavy Trucks (cumulative)
2020 (initial)	189
2035 (15 years)	391,161
2050 (30 years)	1,019,480

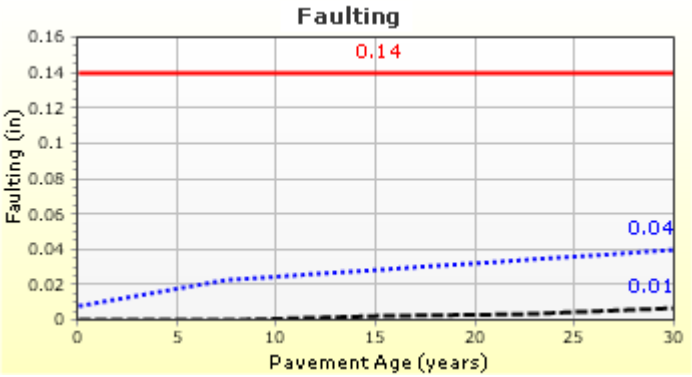
Design Outputs

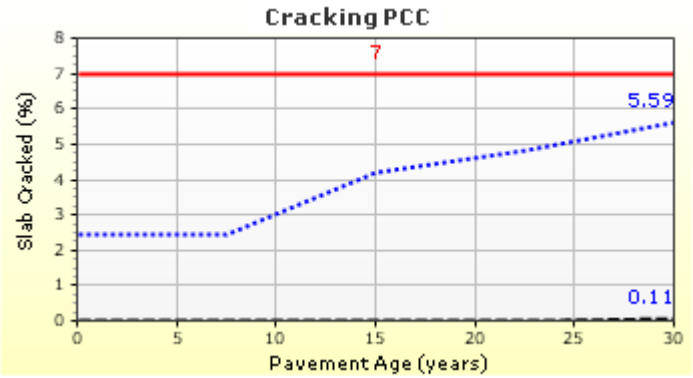
Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	200.00	140.50	95.00	99.99	Pass
Mean joint faulting (in)	0.14	0.04	95.00	100.00	Pass
JPCP transverse cracking (percent slabs)	7.00	5.59	95.00	98.06	Pass

Distress Charts



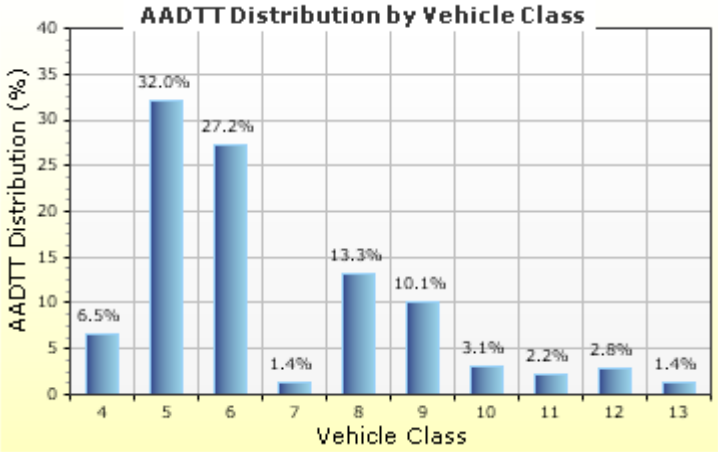


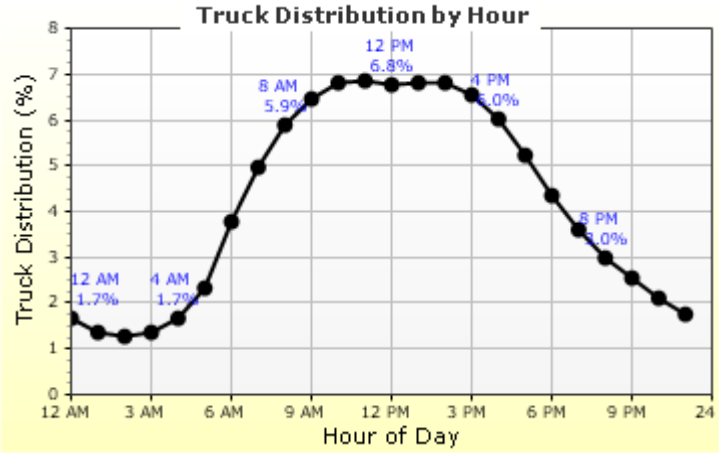


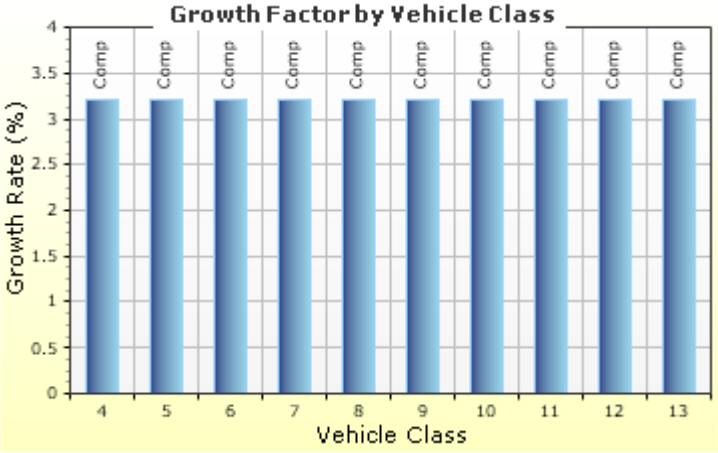
Traffic Inputs

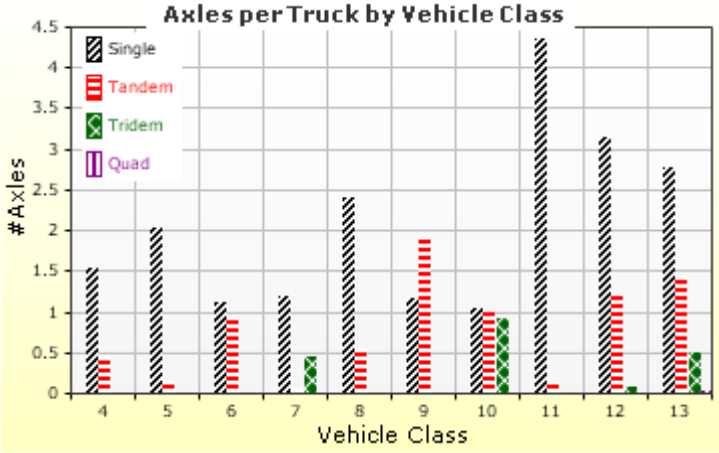
Graphical Representation of Traffic Inputs

Initial two-way AADTT:	189	Percent of trucks in design direction (%):	50.0
Number of lanes in design direction:	2	Percent of trucks in design lane (%):	60.0
		Operational speed (mph)	40.0

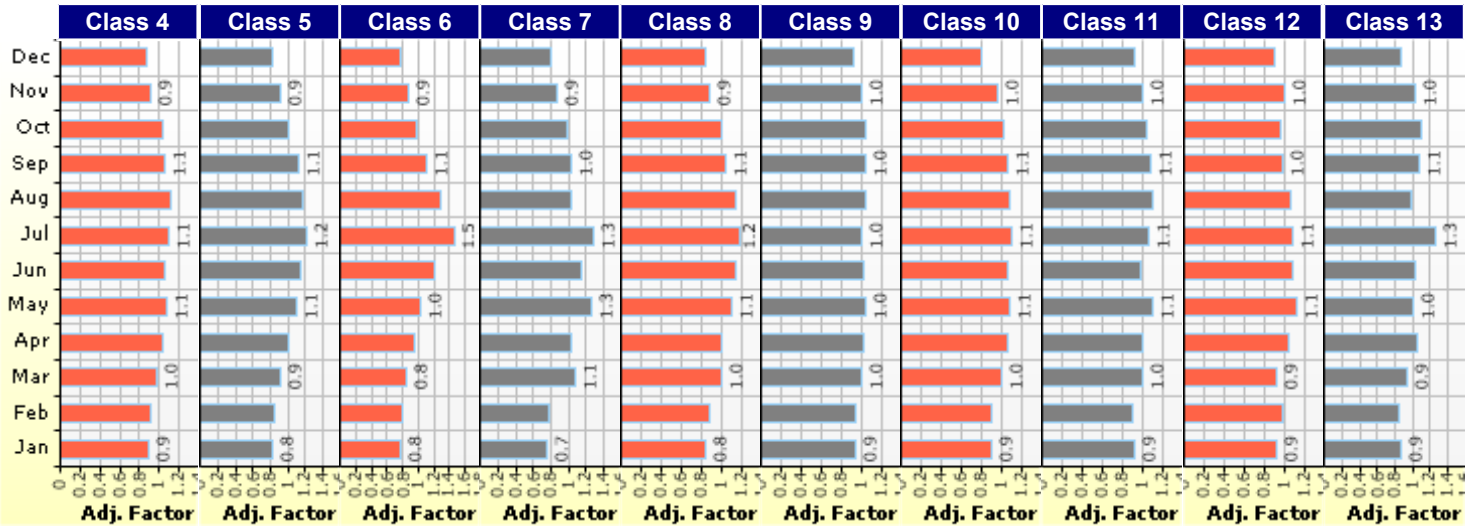








Traffic Volume Monthly Adjustment Factors



Tabular Representation of Traffic Inputs

Volume Monthly Adjustment Factors

Level 3: Default MAF

Month	Vehicle Class									
	4	5	6	7	8	9	10	11	12	13
January	0.9	0.8	0.8	0.7	0.8	0.9	0.9	0.9	0.9	0.9
February	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.8
March	1.0	0.9	0.8	1.1	1.0	1.0	1.0	1.0	0.9	0.9
April	1.0	1.0	0.9	1.0	1.0	1.0	1.1	1.0	1.0	1.1
May	1.1	1.1	1.0	1.3	1.1	1.0	1.1	1.1	1.1	1.0
June	1.1	1.1	1.2	1.1	1.1	1.0	1.1	1.0	1.1	1.0
July	1.1	1.2	1.5	1.3	1.2	1.0	1.1	1.1	1.1	1.3
August	1.1	1.2	1.3	1.0	1.1	1.0	1.1	1.1	1.1	1.0
September	1.1	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1
October	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.1
November	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0
December	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.9	0.9

Distributions by Vehicle Class

Vehicle Class	AADTT Distribution (%) (Level 3)	Growth Factor	
		Rate (%)	Function
Class 4	6.54%	3.21%	Compound
Class 5	32.02%	3.21%	Compound
Class 6	27.23%	3.21%	Compound
Class 7	1.38%	3.21%	Compound
Class 8	13.25%	3.21%	Compound
Class 9	10.07%	3.21%	Compound
Class 10	3.1%	3.21%	Compound
Class 11	2.19%	3.21%	Compound
Class 12	2.82%	3.21%	Compound
Class 13	1.4%	3.21%	Compound

Truck Distribution by Hour

Hour	Distribution (%)	Hour	Distribution (%)
12 AM	1.65%	12 PM	6.75%
1 AM	1.37%	1 PM	6.81%
2 AM	1.28%	2 PM	6.83%
3 AM	1.36%	3 PM	6.56%
4 AM	1.66%	4 PM	6.02%
5 AM	2.32%	5 PM	5.23%
6 AM	3.8%	6 PM	4.35%
7 AM	4.95%	7 PM	3.59%
8 AM	5.9%	8 PM	2.98%
9 AM	6.48%	9 PM	2.56%
10 AM	6.83%	10 PM	2.12%
11 AM	6.85%	11 PM	1.75%
		Total	100%

Axle Configuration

Traffic Wander	
Mean wheel location (in)	18.0
Traffic wander standard deviation (in)	10.0
Design lane width (ft)	12.0

Axle Configuration	
Average axle width (ft)	8.5
Dual tire spacing (in)	12.0
Tire pressure (psi)	120.0

Average Axle Spacing	
Tandem axle spacing (in)	51.6
Tridem axle spacing (in)	49.2
Quad axle spacing (in)	49.2

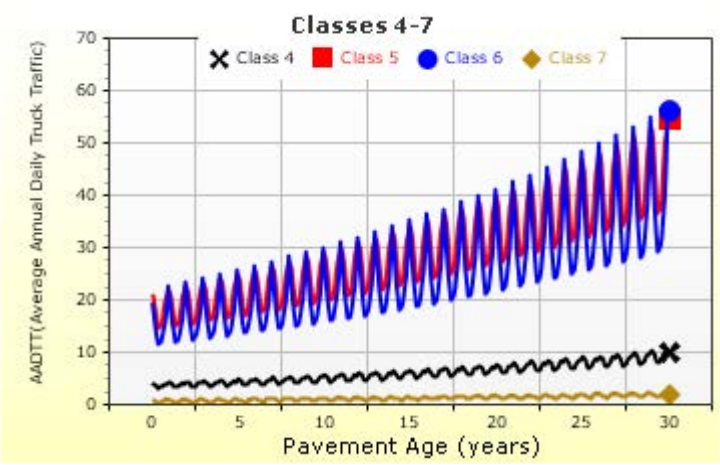
Wheelbase				
Value Type	Axle Type	Short	Medium	Long
Average spacing of axles (ft)		12.0	15.0	18.0
Percent of Trucks (%)		17.0	22.0	61.0

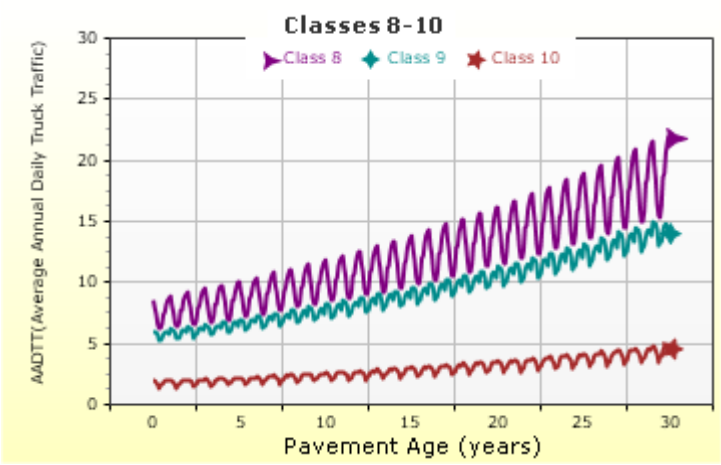
Number of Axles per Truck

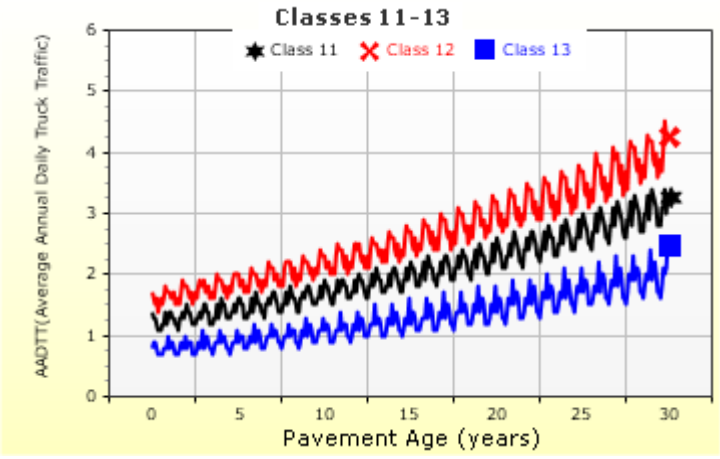
Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.53	0.45	0	0
Class 5	2.02	0.16	0.02	0
Class 6	1.12	0.93	0	0
Class 7	1.19	0.07	0.45	0.02
Class 8	2.41	0.56	0.02	0
Class 9	1.16	1.88	0.01	0
Class 10	1.05	1.01	0.93	0.02
Class 11	4.35	0.13	0	0
Class 12	3.15	1.22	0.09	0
Class 13	2.77	1.4	0.51	0.04

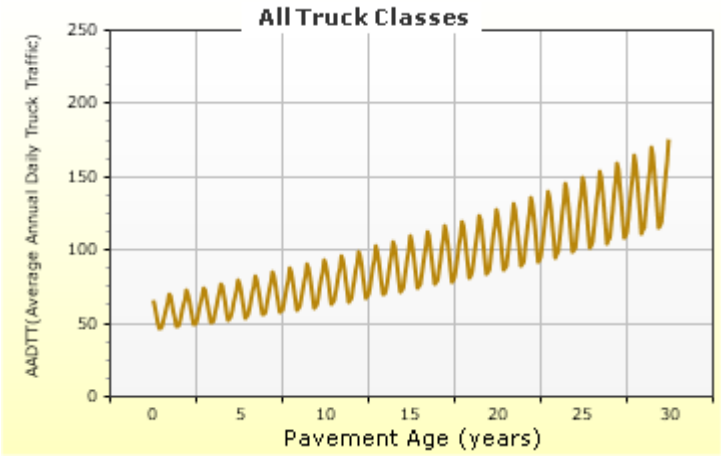
AADTT (Average Annual Daily Truck Traffic) Growth

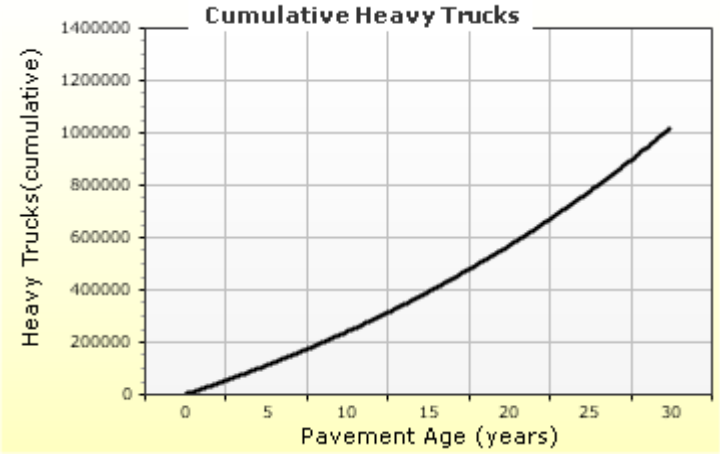
*** Traffic cap is not enforced**







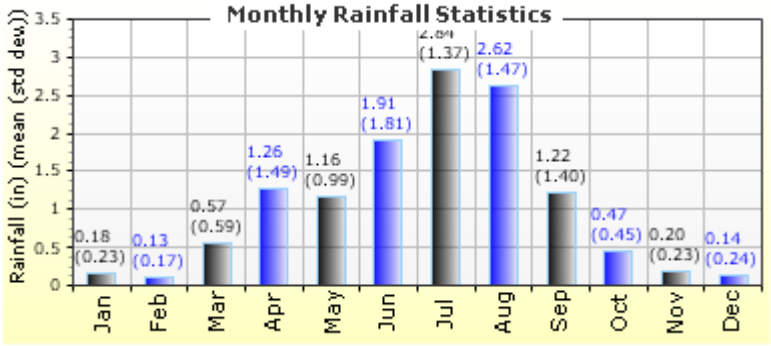




Climate Inputs

Climate Data Sources:

Climate Station Cities:	Location (lat lon elevation(ft))
COLORADO SPRINGS,	38.81200 -104.71100 6170

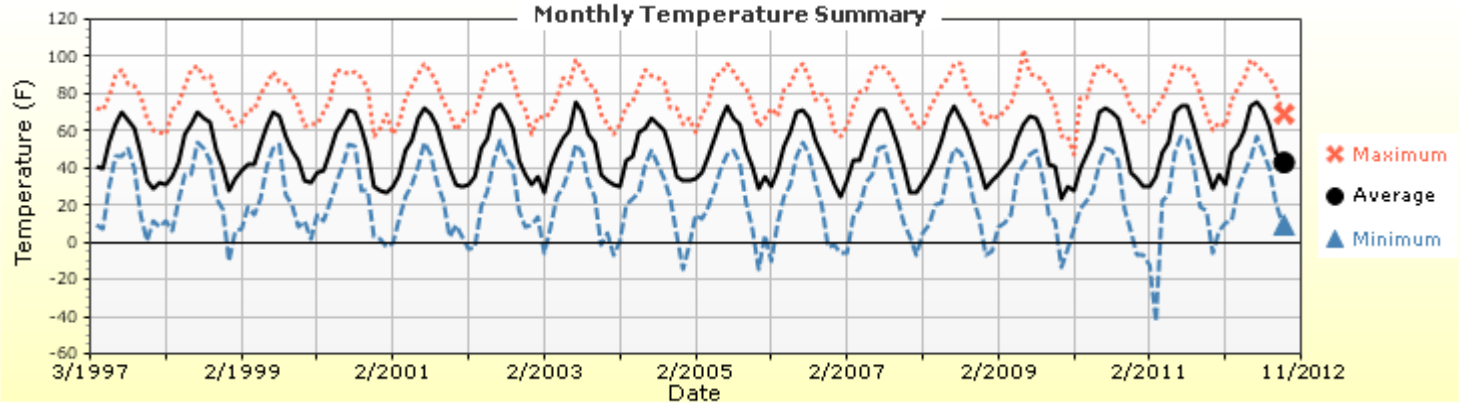


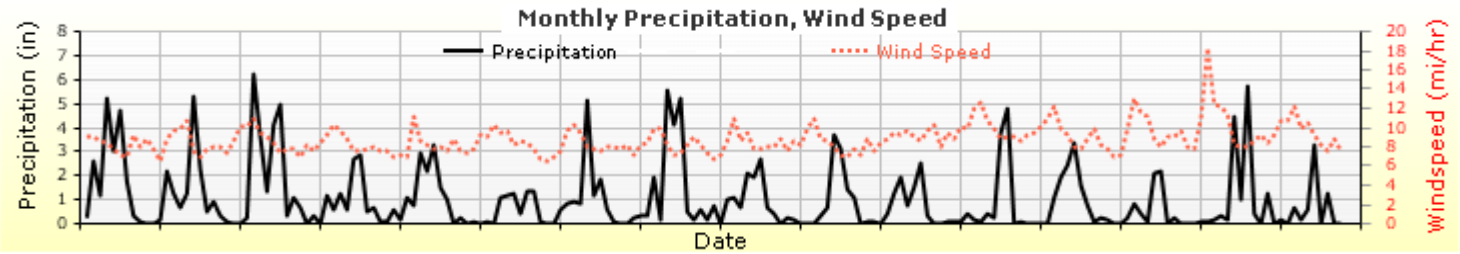
Annual Statistics:

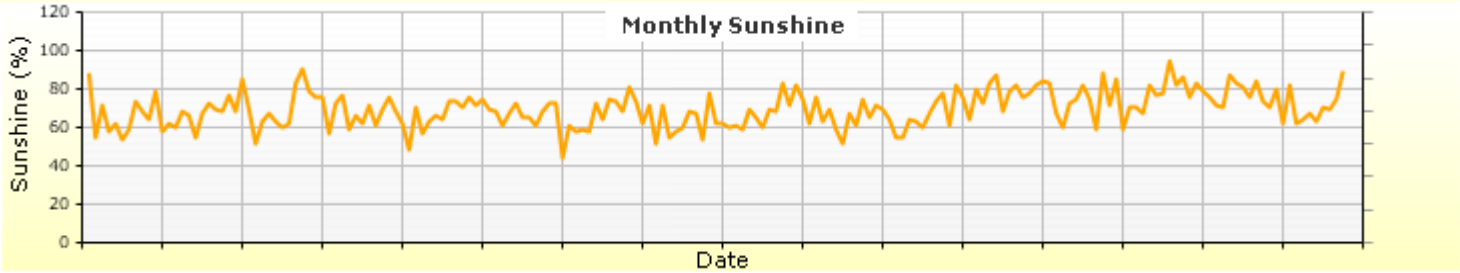
Mean annual air temperature (ºF)	49.78
Mean annual precipitation (in)	12.82
Freezing index (ºF - days)	487.57
Average annual number of freeze/thaw cycles:	131.57

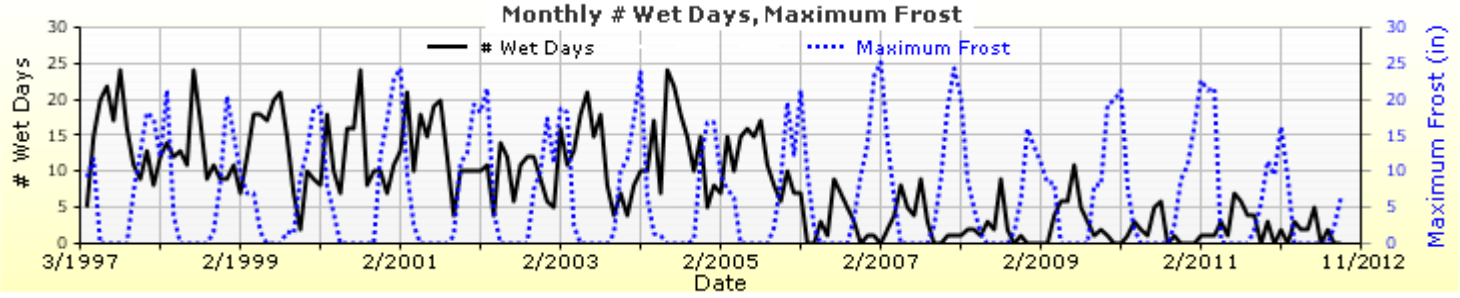
Water table depth (ft)	10.00

Monthly Climate Summary:

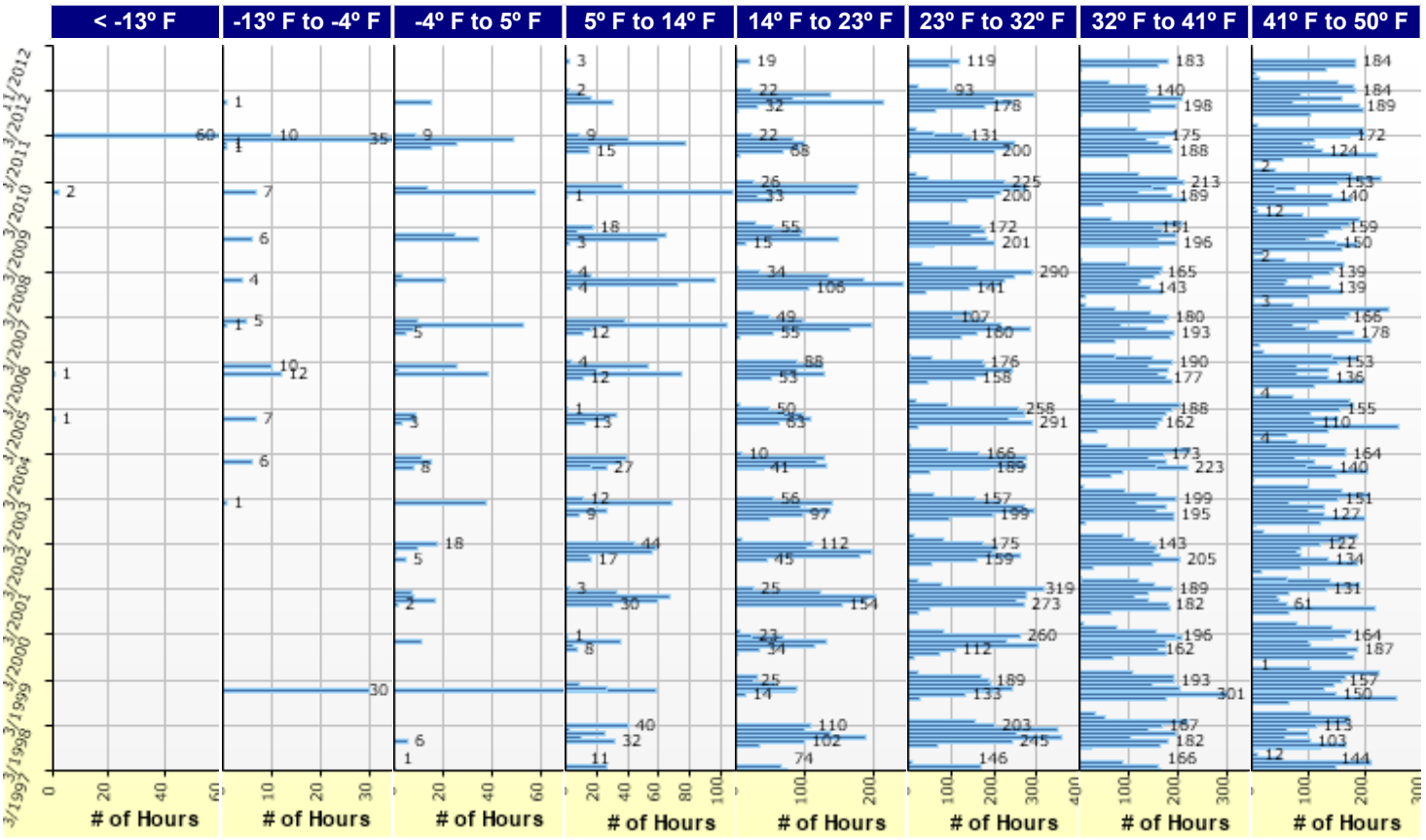


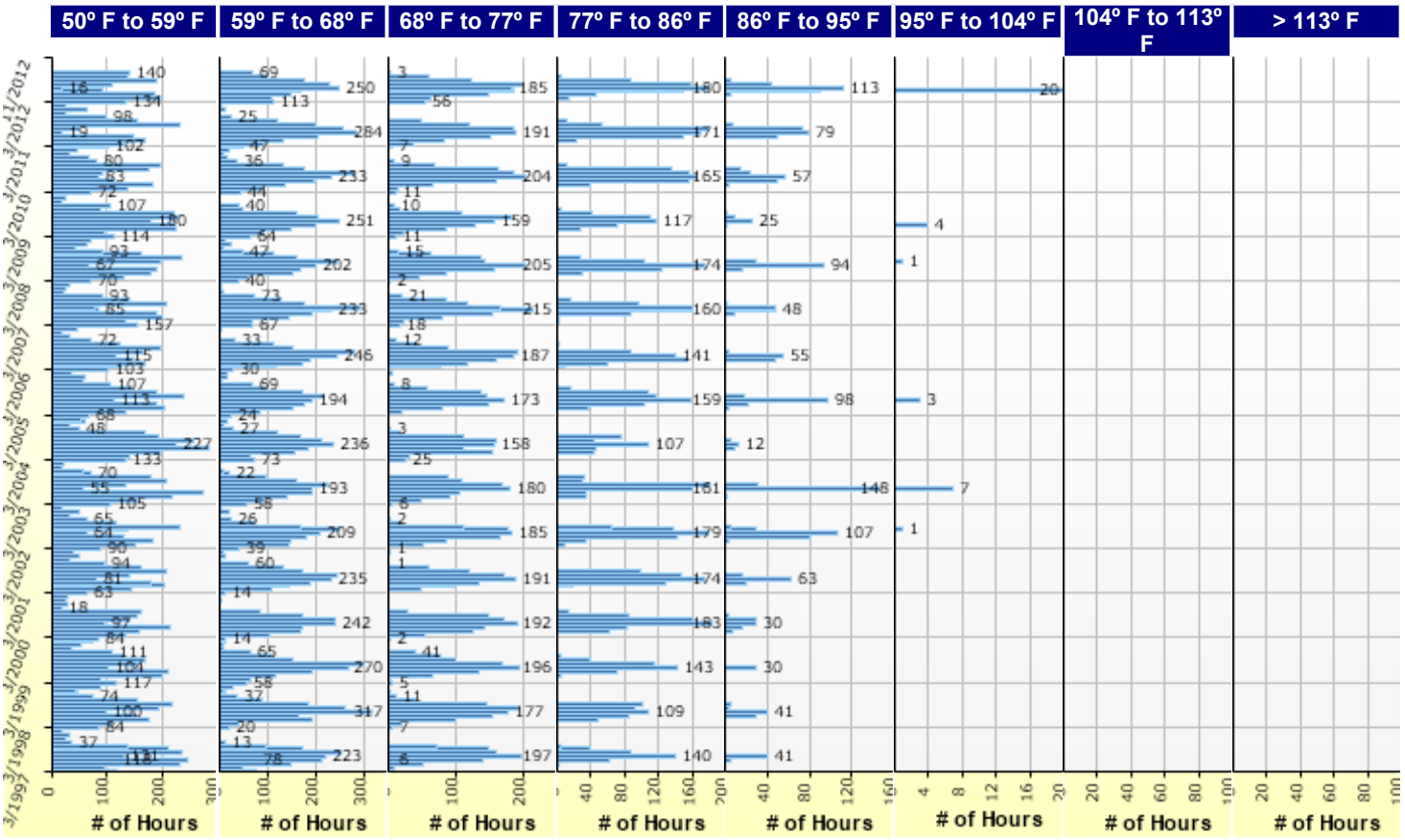






Hourly Air Temperature Distribution by Month:





Design Properties

JPCP Design Properties

Structure - ICM Properties	
PCC surface shortwave absorptivity	0.85

Doweled Joints	
Is joint doweled ?	True
Dowel diameter (in)	1.25
Dowel spacing (in)	12.00

Tied Shoulders	
Tied shoulders	False
Load transfer efficiency (%)	-

PCC joint spacing (ft)	
Is joint spacing random ?	False
Joint spacing (ft)	15.00

Widened Slab	
Is slab widened ?	False
Slab width (ft)	12.00

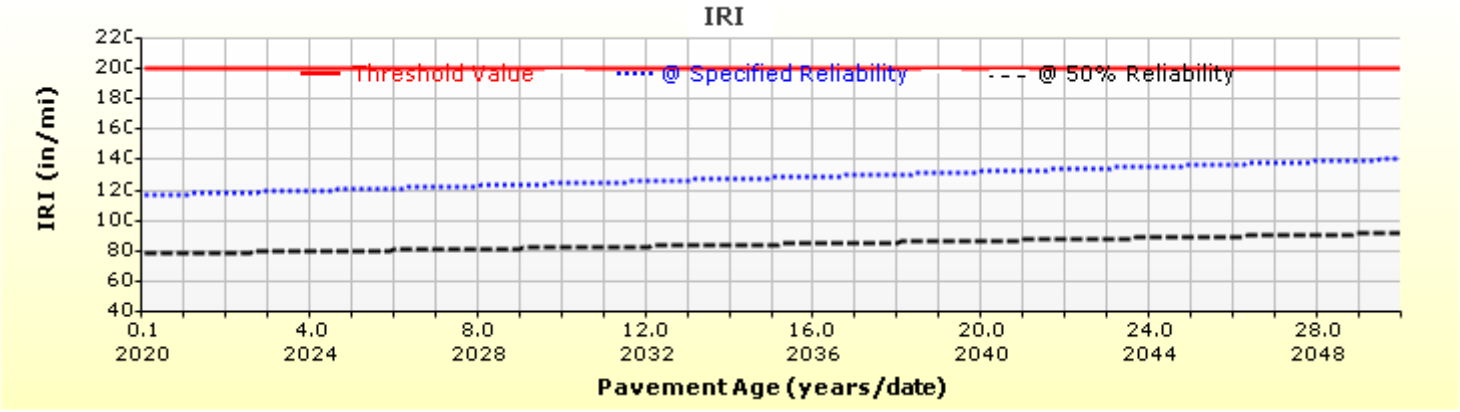
PCC-Base Contact Friction	
PCC-Base full friction contact	True
Months until friction loss	240.00

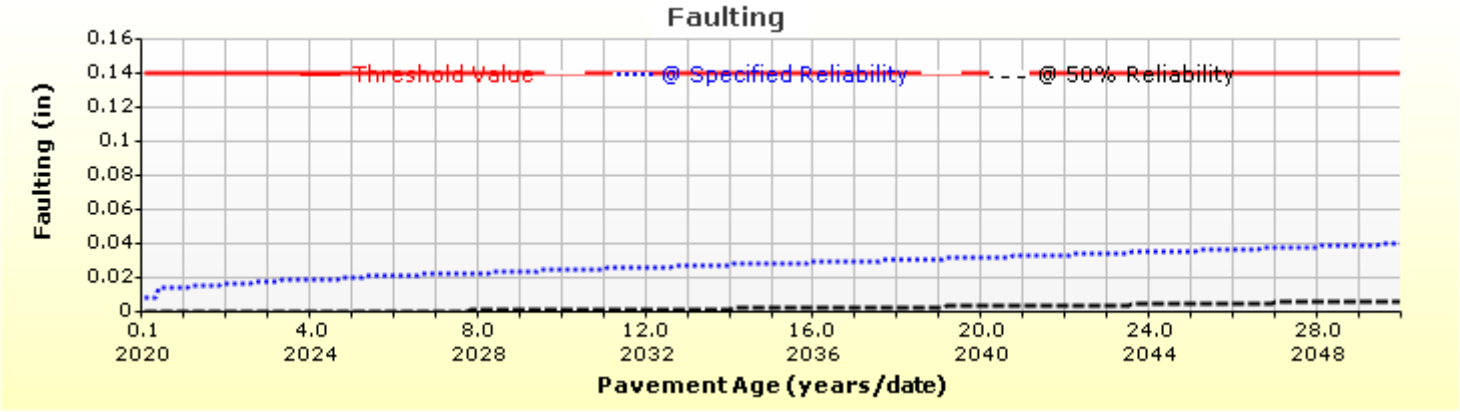
Sealant type	Preformed

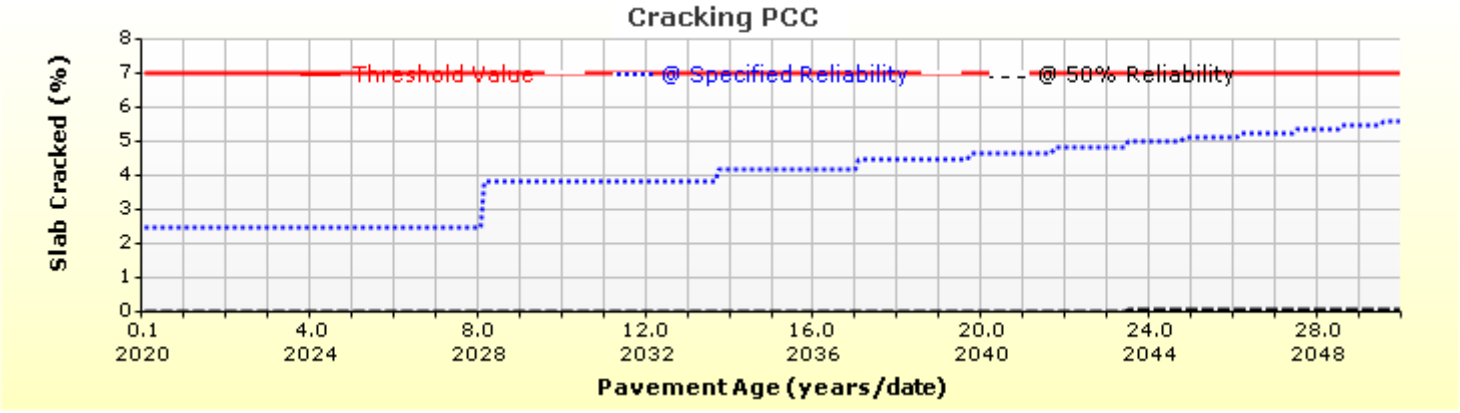
Erodibility index	5

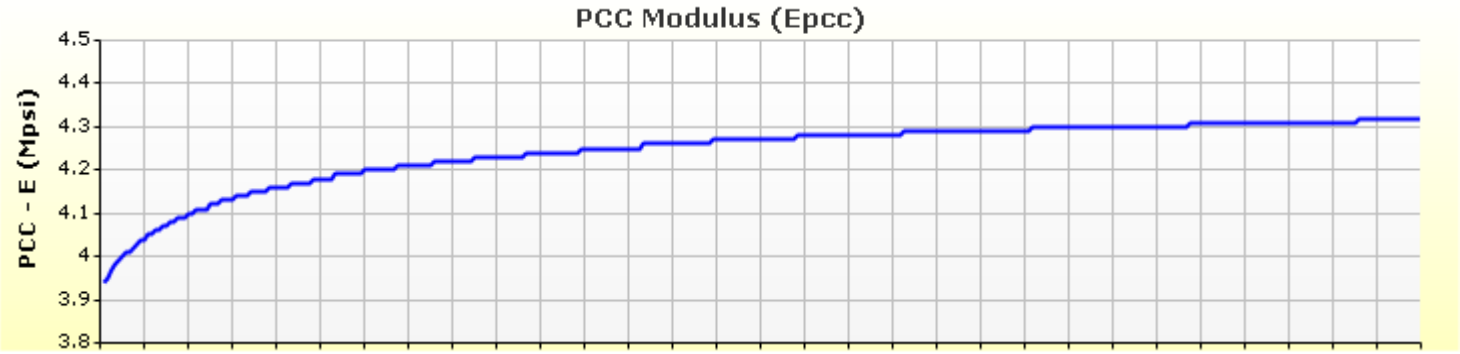
Permanent curl/warp effective temperature difference (ºF)	-10.00

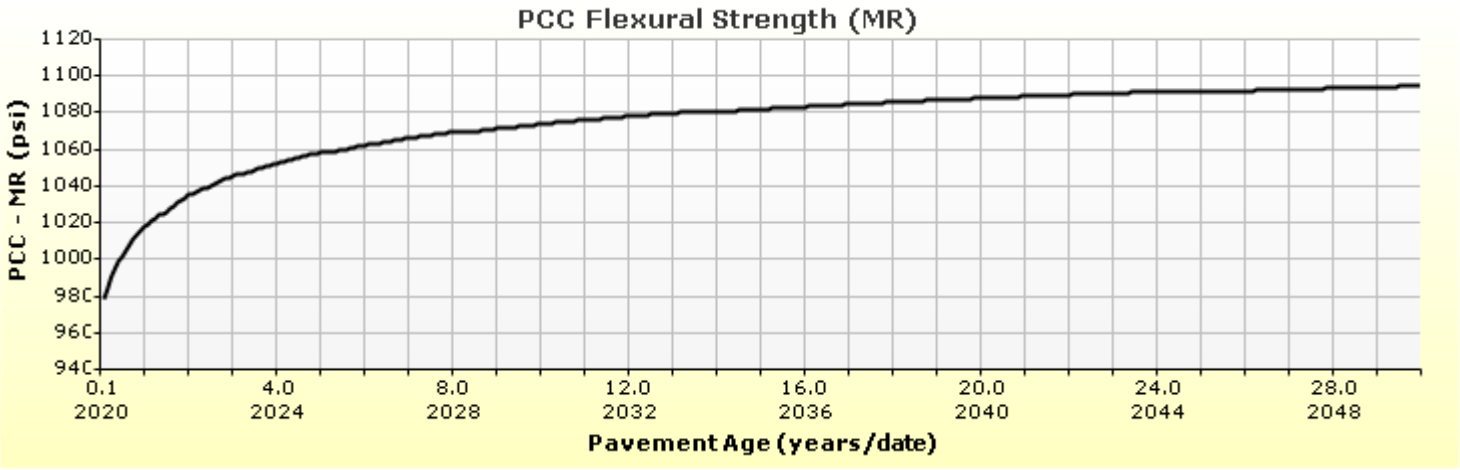
Analysis Output Charts

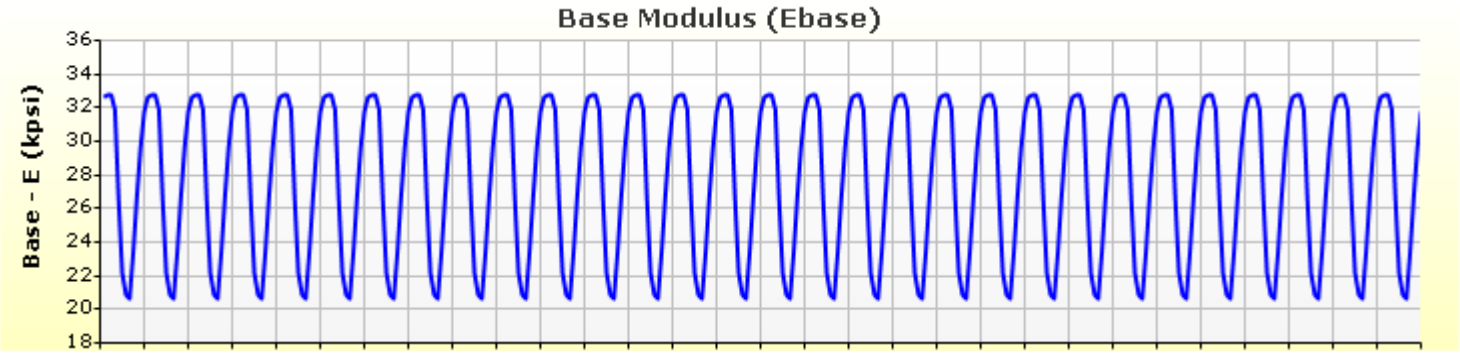


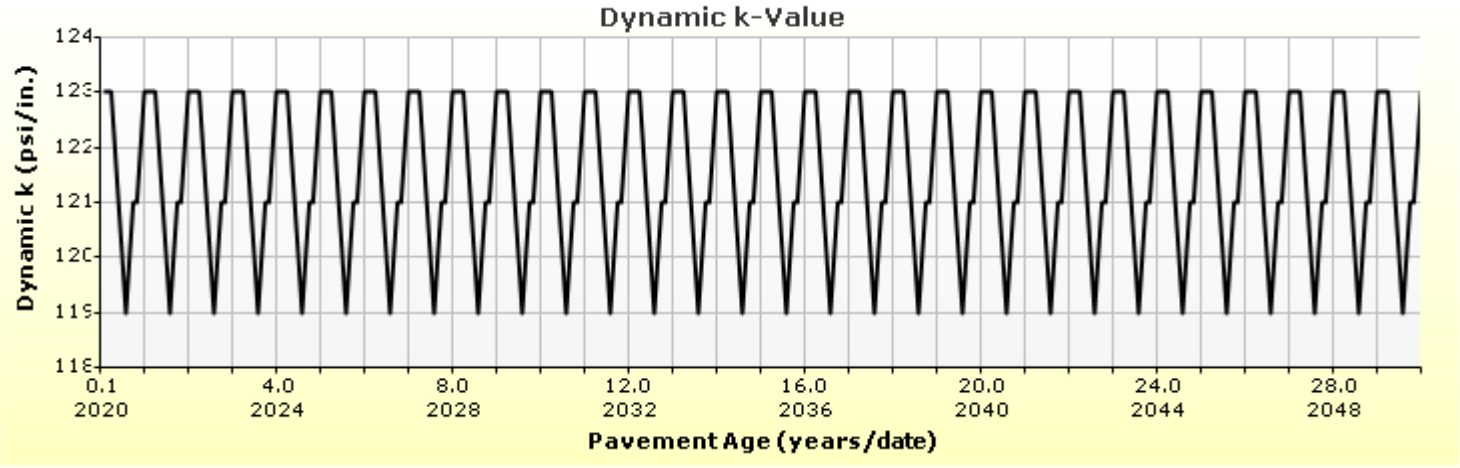


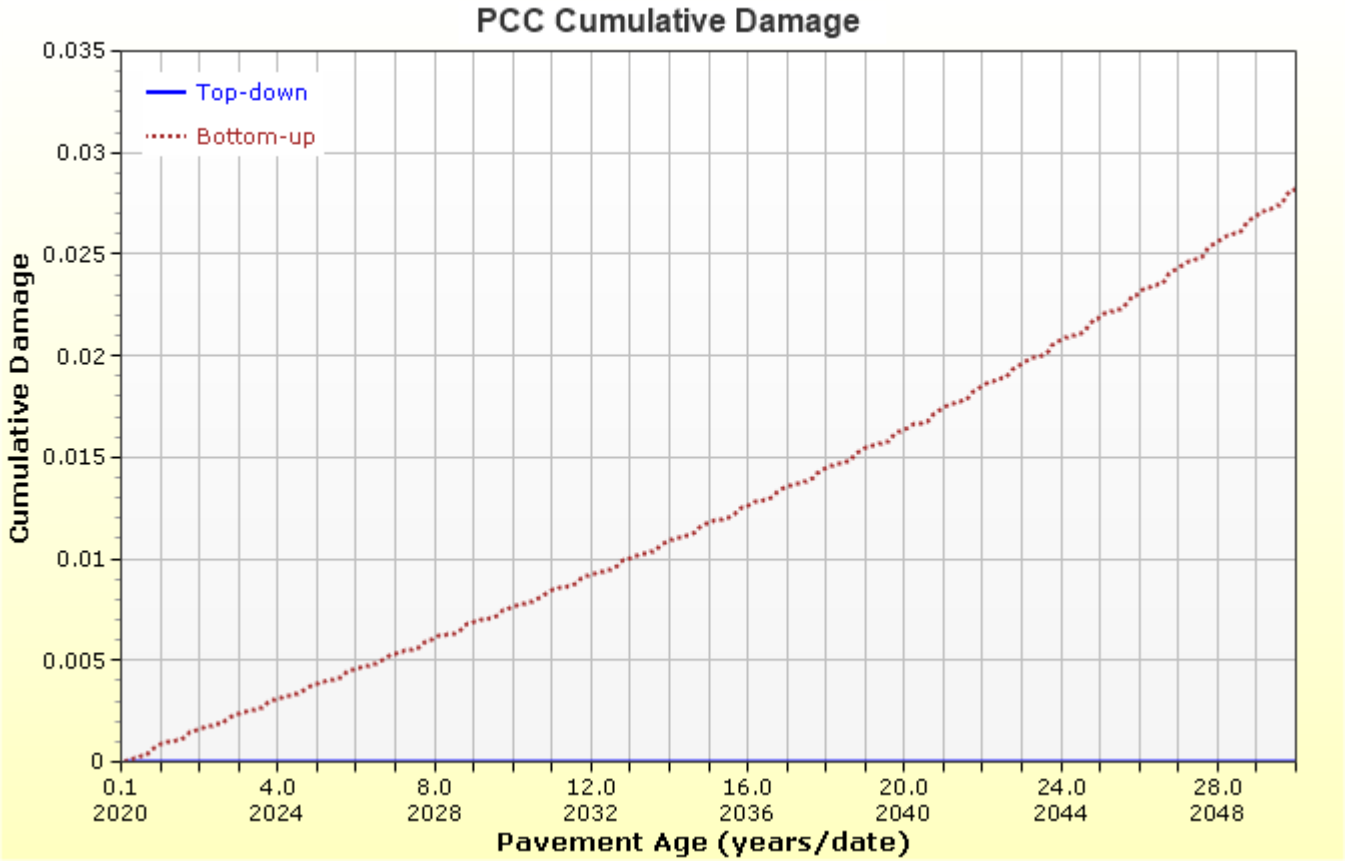


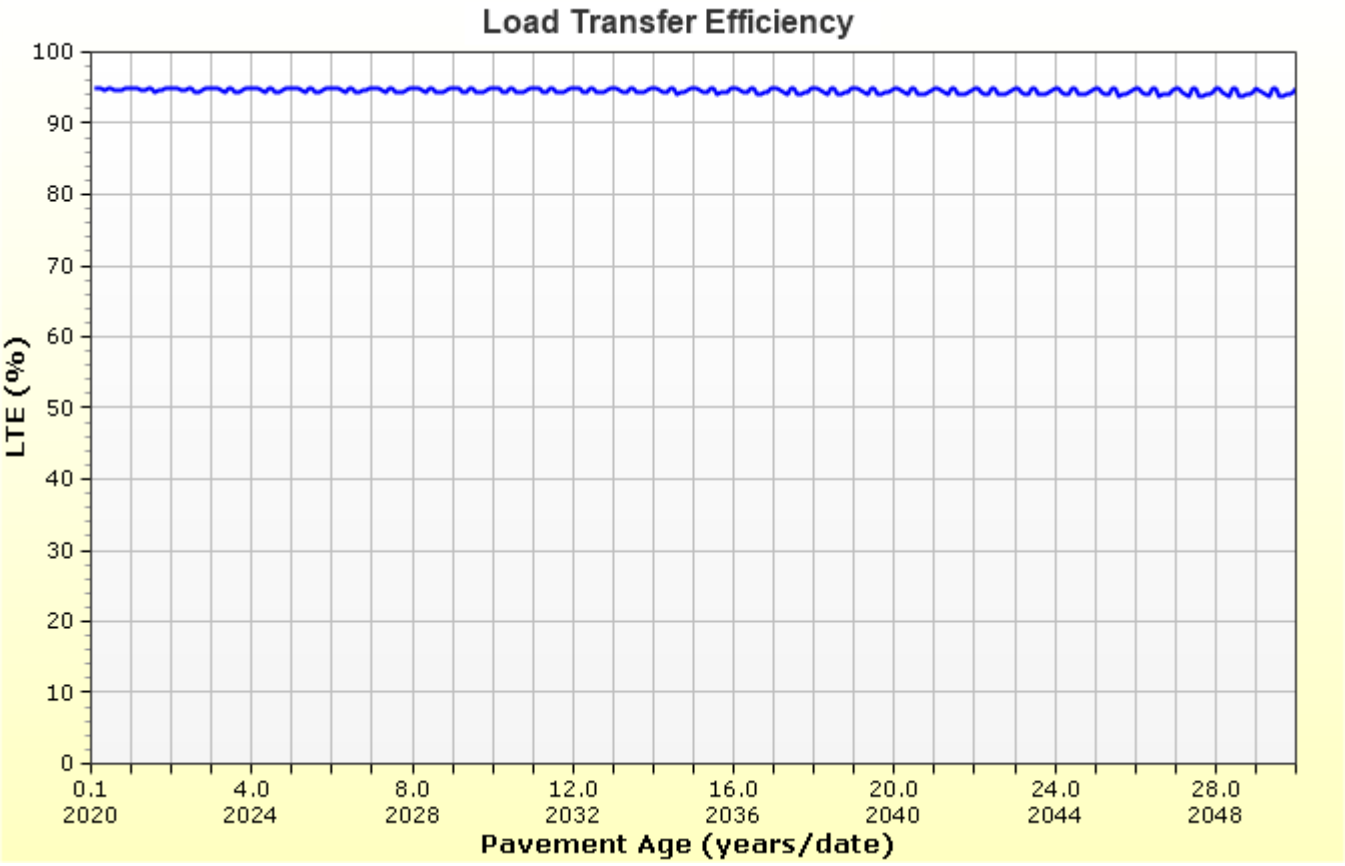

PCC Modulus (Epcc)
PCC - E (Mpsi)
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8


PCC Flexural Strength (MR)
PCC - MR (psi)
1120
1100
1080
1060
1040
1020
1000
980
960
940
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)


Base Modulus (Ebase)
Base - E (kpsi)
36
34
32
30
28
26
24
22
20
18


Dynamic k-Value
Dynamic k (psi/in.)
124
123
122
121
120
119
118
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)


PCC Cumulative Damage
Top-down
Bottom-up
Cumulative Damage
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)


Load Transfer Efficiency
LTE (%)
100
90
80
70
60
50
40
30
20
10
0
0.1
2020
4.0
2024
8.0
2028
12.0
2032
16.0
2036
20.0
2040
24.0
2044
28.0
2048
Pavement Age (years/date)

Layer Information

Layer 1 PCC : JPCP Default

PCC	
Thickness (in)	7.5
Unit weight (pcf)	139.8
Poisson's ratio	0.2

Thermal	
PCC coefficient of thermal expansion (in/in/ºF x 10^-6)	4.72
PCC thermal conductivity (BTU/hr-ft-ºF)	1.25
PCC heat capacity (BTU/lb-ºF)	0.28

Mix		
Cement type		Type I (1)
Cementitious material content (lb/yd^3)		677
Water to cement ratio		0.44
Aggregate type		Granite (3)
PCC zero-stress temperature (ºF)	Calculated Internally?	True
	User Value	-
	Calculated Value	60.1
Ultimate shrinkage (microstrain)	Calculated Internally?	True
	User Value	-
	Calculated Value	701.5
Reversible shrinkage (%)		50
Time to develop 50% of ultimate shrinkage (days)		35
Curing method		Curing Compound

PCC strength and modulus (Input Level: 3)

28-Day PCC modulus of rupture (psi)	900.0
28-Day PCC elastic modulus (psi)	3550000.0

Identifiers

Field	Value
Display name/identifier	JPCP Default
Description of object	
Author	
Date Created	11/17/2017 1:59:42 PM
Approver	
Date approved	11/17/2017 1:59:42 PM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Layer 2 Non-stabilized Base : Class 6 ABC

Unbound	
Layer thickness (in)	6.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
22000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Class 6 ABC
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	42

Sieve

Liquid Limit	30.0
Plasticity Index	6.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	125.3
Saturated hydraulic conductivity (ft/hr)	False	2.257e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	8.3

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	12.2329
bf	1.1153
cf	0.8619
hr	244.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	12.0
#100	
#80	
#60	
#50	
#40	
#30	
#20	
#16	
#10	
#8	55.0
#4	65.0
3/8-in.	
1/2-in.	
3/4-in.	95.0
1-in.	100.0
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 3 Subgrade : A-6

Unbound	
Layer thickness (in)	24.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
7000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-6
Description of object	clayey sand
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	32

Sieve

Liquid Limit	37.0
Plasticity Index	18.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	112.9
Saturated hydraulic conductivity (ft/hr)	False	1.153e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	14.9

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	102.5522
bf	0.7198
cf	0.2545
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	47.0
#100	
#80	
#60	
#50	
#40	72.0
#30	
#20	
#16	
#10	
#8	
#4	98.0
3/8-in.	
1/2-in.	
3/4-in.	
1-in.	
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 4 Subgrade : A-6

Unbound	
Layer thickness (in)	Semi-infinite
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 2)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
7000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	A-6
Description of object	Default material
Author	AASHTO
Date Created	1/1/2011 12:00:00 AM
Approver	
Date approved	1/1/2011 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	33.0
Plasticity Index	16.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	107.9
Saturated hydraulic conductivity (ft/hr)	False	1.95e-05
Specific gravity of solids	False	2.7
Water Content (%)	False	17.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	108.4091
bf	0.6801
cf	0.2161
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	63.2
#100	
#80	73.5
#60	
#50	
#40	82.4
#30	
#20	
#16	
#10	90.2
#8	
#4	93.5
3/8-in.	96.4
1/2-in.	97.4
3/4-in.	98.4
1-in.	99.0
1 1/2-in.	99.5
2-in.	99.8
2 1/2-in.	
3-in.	
3 1/2-in.	100.0

Calibration Coefficients

PCC Faulting

$$C_{12} = C_1 + (C_2 * FR^{0.25})$$
$$C_{34} = C_3 + (C_4 * FR^{0.25})$$
$$FaultMax_0 = C_{12} * \delta_{curling} * \left[\log(1 + C_5 * 5.0^{EROD}) * \log\left(P_{200} * \frac{WetDays}{p_S}\right)\right]^{C_6}$$
$$FaultMax_i = FaultMax_0 + C_7 * \sum_{j=1}^{m} DE_j * \log(1 + C_5 * 5.0^{EROD})^{C_6}$$
$$\Delta Fault_i = C_{34} * (FaultMax_{i-1} - Fault_{i-1})^2 * DE_i$$
$$C_8 = DowelDeterioration$$

C1: 0.5104	C2: 0.00838	C3: 0.00147	C4: 0.008345
C5: 5999	C6: 0.8404	C7: 5.9293	C8: 400
PCC Reliability Faulting Standard Deviation			
0.0831*Pow(FAULT,0.3426) + 0.00521			

IRI-jpcp

C1 - Cracking
C2 - Spalling
C3 - Faulting
C4 - Site Factor

C1: 0.8203	C2: 0.4417
C3: 1.4929	C4: 25.24
Reliability Standard Deviation	
5.4	

PCC Cracking

$$\log(N) = C1 \cdot \left(\frac{MR}{\sigma}\right)^{C2}$$
$$CRK = \frac{100}{1 + C4\ FD^{C5}}$$

Fatigue Coefficients		**Cracking Coefficients**	
C1: 2	C2: 1.22	C4: 0.6	C5: -2.05
PCC Reliability Cracking Standard Deviation			
Pow(57.08*CRACK,0.33) + 1.5			

APPENDIX B

AASHTOWare DARWin Pavement Design Output
For Research Parkway

Kumar & Associates, Inc.

PAVEMENT DESIGN PARAMETERS

Research Parkway

Project No.: 17-2-183.A

Flexible Pavements		
20-Year 18-kip (ESAL)	West of Powers	3,861,700
	East of Powers	3,284,270
Serviceability Index	Initial	4.5
	Terminal	2.5
Reliability level		95
Overall standard deviation		0.44
Roadbed resilient modulus, M_r (psi)	R=4 (on-site)	2,928
Drainage coefficient		1
Structural coefficient	HMA	0.44
	ABC	0.12

Rigid Pavements		
30-Year 18-kip (ESAL)	West of Powers	7,882,905
	East of Powers	6,704,685
Serviceability Index	Initial	4.5
	Terminal	2.5
28-day mean PCC Modulus of Rupture		650 psi
28-day mean Elastic Modulus of Slab		3,500,000 psi
Mean effective k-value (pci)	R=4 (on-site)	50
Reliability level		95
Overall standard deviation		0.34
Load transfer coefficent (No reinforcement)		4.2
Drainage coefficient		1

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

Kumar & Associates
6735 Kumar Heights
Colorado Springs, CO 80918
USA

Flexible Structural Design Module

17-2-183.A
Research - W. of Powers
Composite HMA/ABC

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	3,861,700
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	2,928 psi
Stage Construction	1
Calculated Design Structural Number	5.86 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	10.25	-	4.51
2	ABC	0.12	1	12	-	1.44
Total	-	-	-	22.25	-	5.95

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Kumar & Associates
6735 Kumar Heights
Colorado Springs, CO 80918
USA

Flexible Structural Design Module

17-2-183.A
Research - E. of Powers
Composite HMA/ABC

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	3,284,270
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	2,928 psi
Stage Construction	1
Calculated Design Structural Number	5.74 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	10	-	4.40
2	ABC	0.12	1	12	-	1.44
Total	-	-	-	22.00	-	5.84

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Kumar & Associates
6735 Kumar Heights
Colorado Springs, CO 80918
USA

Rigid Structural Design Module

17-2-183.A
Research- W. of Powers
JPCP

Rigid Structural Design

Pavement Type	JPCP
18-kip ESALs Over Initial Performance Period	7,882,905
Initial Serviceability	4.5
Terminal Serviceability	2.5
28-day Mean PCC Modulus of Rupture	650 psi
28-day Mean Elastic Modulus of Slab	3,500,000 psi
Mean Effective k-value	50 psi/in
Reliability Level	95 %
Overall Standard Deviation	0.34
Load Transfer Coefficient, J	4.2
Overall Drainage Coefficient, Cd	1
Calculated Design Thickness	11.98 in -> Rec. 12.25"

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Kumar & Associates
6735 Kumar Heights
Colorado Springs, CO 80918
USA

Rigid Structural Design Module

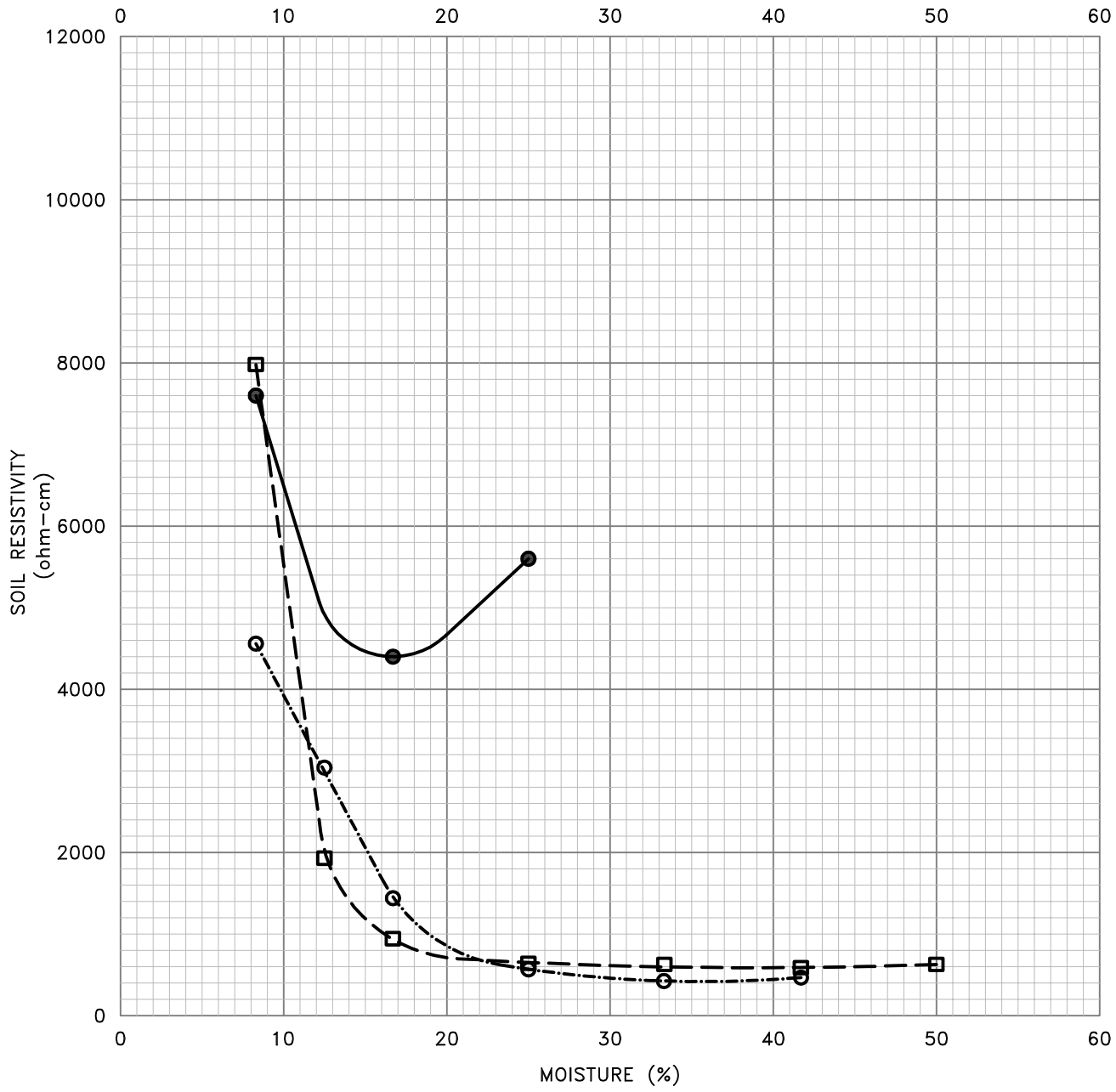
17-2-183.A
Research - E. of Powers
JPCP

Rigid Structural Design

Pavement Type	JPCP
18-kip ESALs Over Initial Performance Period	6,704,685
Initial Serviceability	4.5
Terminal Serviceability	2.5
28-day Mean PCC Modulus of Rupture	650 psi
28-day Mean Elastic Modulus of Slab	3,500,000 psi
Mean Effective k-value	50 psi/in
Reliability Level	95 %
Overall Standard Deviation	0.34
Load Transfer Coefficient, J	4.2
Overall Drainage Coefficient, Cd	1
Calculated Design Thickness	11.70 in → Rec. 12"

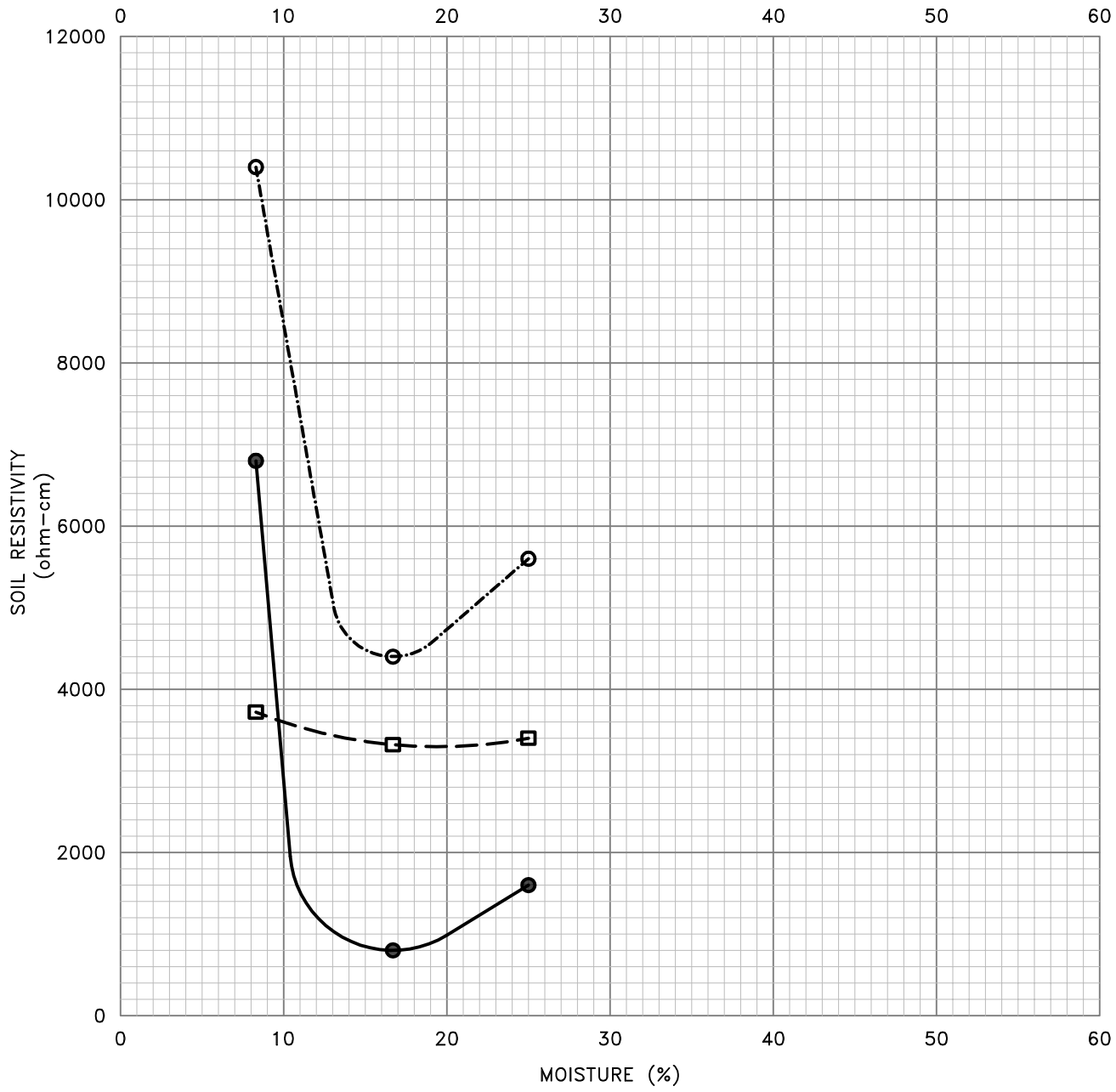
APPENDIX C

Resistivity Test Results



CURVE SYMBOL	SAMPLE IDENTIFICATION	SOIL OR BEDROCK TYPE	MINIMUM RESISTIVITY (ohm-cm)	RESISTIVITY AT IN SITU MOISTURE CONTENT (ohm-cm)
●	BORING S1A @ 2 FT.	Silty Sand (SM)	4,400	>12,000
○	BORING S2A @ 9 FT.	Claystone	424	1,725
□	BORING R5 @ 2 FT.	Fill: Clayey Sand (SC)	589	1,150

17-2-183A	Kumar & Associates	LABORATORY RESISTIVITY RESULTS	Fig. C1



CURVE SYMBOL	SAMPLE IDENTIFICATION	SOIL OR BEDROCK TYPE	MINIMUM RESISTIVITY (ohm-cm)	RESISTIVITY AT IN SITU MOISTURE CONTENT (ohm-cm)
●	BORING R14 @ 4 FT.	Clayey Sand (SC)	800	>12,000
○	BORING SW16 @ 14 FT.	Sandstone	4,400	>12,000
□	BORING F3 @ 4 FT.	Fill: Clayey Sand (SC)	3,320	3,400

17-2-183A	Kumar & Associates	LABORATORY RESISTIVITY RESULTS	Fig. C2

SCHEDULE K – MINIMUM INSURANCE REQUIREMENTS

The following listed minimum insurance requirements shall be carried by all contractors and consultants unless otherwise specified in the City's solicitation package, Special Provisions or Standard Specifications.

☒	Commercial General Liability for limits not less than $1,000,000 combined single limit with $2,000,000 aggregate for bodily injury and property damage for each occurrence. Coverage shall include blanket contractual, broad form property damage, products and completed operations
☒	Workers' Compensation and Employers Liability as required by statute. Employers Liability coverage is to be carried for a minimum limit of $100,000.
☒	Automobile Liability covering any auto (including owned, hired, and non-owned autos) with a minimum of $1,000,000 each accident combined single limit.
☒	Builders Risk or Installation Floater Insurance: Contractor shall purchase and maintain property insurance written on a builder's risk "all-risk" or equivalent policy form in the amount of the initial Contract Sum, plus value of subsequent Contract Modifications and cost of materials supplied or installed by others, comprising total value for the entire Project at the site on a replacement cost basis without optional deductibles. Such property insurance shall be maintained, unless otherwise provided in the Contract Documents or otherwise agreed in writing by all persons and entities who are beneficiaries of such insurance, until final payment has been made or until no person or entity other than the Owner has an insurable interest in the property.

Except for workers' compensation and employer's liability insurance, the **City of Colorado Springs must be named as an additional insured**. Certificates of Insurance must be submitted before commencing the work and provide 30 days' notice prior to any cancellation, non-renewal, or material changes to policies required under the contract.

All coverage furnished by contractor is primary, and any insurance held by the City of Colorado Springs is excess and non-contributory.

The undersigned certifies and agrees to carry and maintain the insurance requirements indicated above throughout the contract Period of Performance.

_____

(Name of Company)

_____

(Signature) *(Date)*

SCHEDULE L - EXHIBITS

Exhibit 1 Sample Contract
Exhibit 2 Qualification Statement
Exhibit 3 Bid Certification and Representations and Certifications
Exhibit 4 Bid Bond
Exhibit 5 CDOT Forms
Exhibit 6 Federal Forms

EXHIBIT 1 – SAMPLE CONTRACT

CONSTRUCTION CONTRACT

Contract Number:		Project Name/Title	Fairfax Full Spectrum Pond (CDOT)
Vendor/Contractor			
Contact Name:		Telephone:	
Email Address:			
Address:			
Federal Tax ID #		Please check one:	☐ Corporation ☐ Individual ☐ Partnership
City Contracting Specialist		City Dept Rep	
NOT TO EXCEED Contract Amount:		City Account #	
Contract Type:	Fixed Unit Price	Period of Performance:	

1. INTRODUCTION

THIS *Fixed Unit Price* CONTRACT ("Contract") is made and entered into this XXX day of XXX, 2023 by and between the City of Colorado Springs, a Colorado municipal corporation and home rule city, in the County of El Paso, State of Colorado, (the "City"), and _____ (the "Contractor").

THE CITY AND THE CONTRACTOR HEREBY AGREE AS FOLLOWS:

The City has heretofore prepared the necessary Contract Documents for the following Activity: Construct Full Spectrum Pond for Fairfax Basin Tributary.

The Contractor did on the XXX day of XXX, 2023 submit to the City the Contractor's written offer and proposal to do the work therein described under the terms and conditions therein set forth and furnish all materials, supplies, labor, services, transportation, tools, equipment, and parts for said work in strict conformity with the accompanying Contract Documents, which are attached hereto and incorporated herein by this reference, including the following:

1. This Contract
2. Schedule A – Bid Form
3. Schedule B – General Construction Terms and Conditions
4. Schedule C – Special Contract Terms and Conditions
5. Schedule D – Special Provisions
6. Schedule E – CDOT Revised Standard Special Provisions
7. Schedule F – Clauses for Contracts Subject to Federal Requirements
8. Schedule G – Construction Plan Set
9. Schedule H – Minimum Insurance Requirements

2. COMPENSATION/CONSIDERATION

THIS FIXED UNIT PRICE CONTRACT is established at the Not to Exceed amount of $xxxxxxxx.

Subject to the terms and conditions of the Contract Documents, Contractor agrees to furnish all materials and to perform all work as set forth in its proposal and as required by the Contract Documents.

All pricing is in accordance with the fixed unit prices found in Schedule A, as proposed by the Contractor. Payment made for actual quantities as set forth in Schedule B, General Construction Terms and Conditions. At no time shall the total obligation of the City exceed the not to exceed amount of this Contract.

3. TERM OF CONTRACT

Contractor will start work promptly after the Notice to Proceed and continue to work diligently until completed. The Contractor shall complete all work on an as ordered basis throughout the Contract period which is **Notice to Proceed – December 31, 2023** ("Period of Performance") as per the specifications and drawings. The Contractor shall provide a two-year guarantee on all work performed under this Contract after the job has been completed and accepted.

4. INSURANCE

The Contractor shall provide and maintain acceptable Insurance Policy(s) consistent with the Minimum Insurance Requirements attached as Schedule H, which includes Property, Liability, and as otherwise listed in Schedule H. The City of Colorado Springs shall be reflected as an additional insured on the Property and Liability policy(s).

Further, Contractor understands and agrees that Contractor shall have no right of coverage under any existing or future City comprehensive, self, or personal injury policies. Contractor shall provide insurance coverage for and on behalf of Contract that will sufficiently protect Contractor, or Contractor's agents, employees, servants or other personnel, in connection with the services which are to be provided by Contractor pursuant to this Contract, including protection from claims for bodily injury, death, property damage, and lost income. Contractor shall provide worker's compensation insurance coverage for Contractor and all Contractor personnel. Contractor shall file applicable insurance certificates with the City and shall also provide additional insurance as indicated in this Contract. ***A CURRENT CERTIFICATE OF INSURANCE IS REQUIRED PRIOR TO COMMENCEMENT OF SERVICES LISTING THE CITY AS ADDITIONALLY INSURED.***

5. RESPONSIBILITY OF THE CONTRACTOR

A. The Contractor shall be responsible for the professional quality, technical accuracy, and the coordination of all Scope of Work services furnished by the Contractor under this Contract. The Contractor shall, without additional compensation, correct or revise any errors or deficiencies in services provided under this Contract to the satisfaction of the City.

B. The City's review, approval of, acceptance of, or payment for the services required under this Contract shall not be construed to operate as a waiver of any rights under this Contract or of any cause of action arising out of the performance of this Contract, and the Contractor shall be and remain liable to the City for any and all damages to the City caused by the Contractor's negligent performance of any of the services furnished under this Contract.

C. The rights and remedies of the City provided for under this Contract are in addition to any other rights and remedies provided by law.

D. If the Contractor is comprised of more than one legal entity, each such entity shall be jointly and severally liable hereunder.

6. WORK OVERSIGHT

A. The extent and character of the work to be done by the Contractor shall be subject to the general approval of the City's delegated Project Manager.

B. If any of the work or services being performed does not conform with Contract requirements, the City may require the Contractor to perform the work or services again in conformity with Contract requirements, at no increase in Contract amount. When defects in work or services cannot be corrected by re-performance, the City may (1) require the Contractor to take necessary action to ensure that future performance conforms to Contract requirements and (2) reduce the Contract price to reflect the reduced value of the work or services performed.

C. If the Contractor fails to promptly perform the defective work or services again or to take the necessary action to ensure future performance is in conformity with Contract requirements, the City may (1) by Contract or otherwise, perform the services and charge to the Contractor any cost incurred by the City that is directly related to the performance of such work or service or (2) terminate the Contract for breach of contract.

7. SUBCONTRACTORS, ASSOCIATES, AND OTHER CONTRACTORS

A. Any subcontractor, outside associates, or other contractors used by the Contractor in connection with Contractor's work under this Contract shall be limited to individuals or firms that are specifically identified by the Contractor in the Contractor's proposal and agreed to by the City. The Contractor shall obtain the City's Project Manager's written consent before making any substitution of these subcontractors, associates, or other contractors.

B. The Contractor shall include a flow down clause in all of its subcontracts, agreements with outside associates, and agreements with other contractors. The flow down clause shall cause all of the terms and conditions of this Contract, including all of the applicable parts of the Contract Documents, to be incorporated into all subcontracts, agreements with outside associates, and agreements with other contractors. The flow down clause shall provide clearly that there is no privity of contract between the City and the Contractor's subcontractors, outside associates, and other contractors.

8. KEY PERSONNEL

The key personnel listed in the proposal and/or below will be the individuals used in the performance of the work. If any of the listed key personnel leave employment or are otherwise not utilized in the performance of the work, approval to substitute must be obtained by the Contractor from the City's Project Manager. Any substitute shall have the same or a higher standard of qualifications that the key personnel possessed at the time of Contract award.

9. START AND CONTINUANCE OF WORK

It is further agreed that the Contractor will start work promptly and continue to work diligently until this Contract is completed.

10. APPROPRIATION OF FUNDS

This Contract is expressly made subject to the limitations of the Colorado Constitution and Section 7-60 of the Charter of the City of Colorado Springs. Nothing herein shall constitute, nor be deemed to constitute, the creation of a debt or multi-year fiscal obligation or an obligation of future appropriations by the City Council of Colorado Springs, contrary to Article X, § 20, Colo. Const., or any other constitutional, statutory, or charter debt limitation. Notwithstanding any other provision of this Contract, with respect to any financial obligation of the City which may arise under this Agreement in any fiscal year after the year of execution, in the event the budget or other means of appropriation for any such year fails to provide funds in sufficient amounts to discharge such obligation, such failure (i) shall act to terminate this Contract at such time as the then-existing and available appropriations are depleted, and (ii) neither such failure nor termination shall constitute a default or breach of this Contract, including any sub-agreement, attachment, schedule, or exhibit thereto, by the City. As used herein, the term “appropriation” shall mean and include the due adoption of an appropriation ordinance and budget and the approval of a Budget Detail Report (Resource Allocations) which contains an allocation of sufficient funds for the performance of fiscal obligations arising under this Contract.

11. CHANGES

The Contractor and the City agree and acknowledge as a part of this Contract that no change order or other form or order or directive may be issued by the City which requires additional compensable work to be performed, which work causes the aggregate amount payable under the Contract to exceed the amount appropriated for this Contract as listed above, unless the Contractor has been given a written assurance by the City that lawful appropriations to cover the costs of the additional work have been made or unless such work is covered under a remedy-granting provision of this Contract. The Contractor and the City further agree and acknowledge as a part of this Contract that no change order or other form or order or directive which requires additional compensable work to be performed under this Contract shall be issued by the City unless funds are available to pay such additional costs, and, regardless of any remedy-granting provision included within this Contract, the Contractor shall not be entitled to any additional compensation for any change which increases or decreases the Contract completion date, or for any additional compensable work performed under this Contract, and expressly waives any rights to additional compensation, whether by law or equity, unless, prior to commencing the additional work, the Contractor is given a written change order describing the change in Contract completion date or the additional compensable work to be performed, and setting forth the amount of compensation to be paid, and such change order is signed by the authorized City representative, as defined below. The amount of compensation to be paid, if any, shall be deemed to cover any and all additional, direct, indirect or other cost or expense or profit of the Contractor whatsoever. It is the Contractor's sole responsibility to know, determine, and ascertain the authority of the City representative signing any change order under this Contract.

No change, amendment, or modification to this Contract shall be valid unless duly approved and issued in writing by the City of Colorado Springs Procurement Services Division. The City shall not be liable for any costs incurred by the Contractor resulting from work performed for changes not issued in writing by the City of Colorado Springs Procurement Services Division.

The following personnel are authorized to sign changes, amendments, or modifications to this Contract.

The Project Manager: Changes up to $14,999.99
The City of Colorado Springs Chief of Staff: Changes up to $499,999.99
The Mayor of the City of Colorado Springs: Unlimited

12. ECONOMIC PRICE ADJUSTMENT

A. The Contractor shall notify the City of Colorado Springs Procurement Services Division if, at any time during contract performance, the rate of pay for labor or the unit prices for material shown in Schedule A experiences a significant increase. A change in price shall be considered significant when the unit price of an item increases by 10% from the execution date of this Contract. The Contractor shall furnish notice of this increase within 60 days after the increase, or within any additional period that the City Procurement Services Division may approve in writing, but not later than the date of final payment under this Contract. The notice shall include the Contractor's proposal for an adjustment in the Contract unit prices to be negotiated under paragraph (b) of this clause, and shall include, in the form required by the City Procurement Services Division, supporting data explaining the cause, effective date, and amount of the increase and the amount of the Contractor's adjustment proposal.

B. Promptly after the City Procurement Services Division receives the notice and data under paragraph (a) of this clause, the City Procurement Services Division and the Contractor shall negotiate a price adjustment in the contract unit prices and its effective date. However, the City Procurement Services Division may postpone the negotiations until an accumulation of increases in the labor rates (including fringe benefits) and unit prices of material shown in Schedule A results in an adjustment allowable under paragraph (c)(3) of this clause. The City Procurement Services Division shall modify this contract (1) to include the price adjustment and its effective date and (2) to revise the labor rates (including fringe benefits) or unit prices of material as shown in Schedule A to reflect the increases resulting from the adjustment. The Contractor shall continue performance at current rates pending agreement on, or determination of, any adjustment and its effective date.

C. Any price adjustment under this clause is subject to the following limitations:
   1. Any adjustment shall be limited to the effect on unit prices of the increases in the rates of pay for labor (including fringe benefits) or unit prices for material shown in Schedule A. There shall be no adjustment for:
      (i) Supplies or services for which the production cost is not affected by such changes;
      (ii) Changes in rates or unit prices other than those shown in Schedule A; or
      (iii) Changes in the quantities of labor or material used from those shown in Schedule A for each item.
   2. No upward adjustment shall apply to supplies or services that are required to be delivered or performed before the effective date of the adjustment, unless the Contractor's failure to deliver or perform according to the delivery schedule results from causes beyond the Contractor's control and without its fault or negligence, within the meaning of the Default clause.
   3. There shall be no adjustment for any change in rates of pay for labor (including fringe benefits) or unit prices for material which would not result in a net change of at least 3 percent of the then-current total contract price. This limitation shall not apply, however, if, after final delivery of all line items, either party requests an adjustment under paragraph (b) of this clause.

4. The aggregate of the increases in any contract unit price made under this clause shall not exceed 10 percent of the original unit price.

13. ASSIGNMENT

No assignment or transfer by the Contractor of this Contract or any part thereof or of the funds to be received thereunder by the Contractor will be recognized unless such assignment has had the prior written approval of the City and the surety has been given due notice of such assignment. Such written approval by the City shall not relieve the Contractor of the obligations under the terms of this Contract. In addition to the usual recitals in assignment contracts, the following language must be included in the assignment:

It is agreed that the funds to be paid to the assignee under this assignment are subject to a prior lien for services rendered or materials supplied for the performance of the work called for in said contract in favor of all persons, firms, or corporations rendering such services or supplying such materials.

14. CHOICE OF LAW

This Contract is subject to and shall be interpreted under the law of the State of Colorado, and the Charter, City Code, Ordinances, Rules and Regulations of the City of Colorado Springs, Colorado, a Colorado home rule city. Court venue and jurisdiction shall be exclusively in the Colorado District Court for El Paso County, Colorado. The Parties agree that the place of performance for this Contract is deemed to be in the City of Colorado Springs, El Paso County, State of Colorado. The Contractor shall ensure that the Contractor and the Contractor's employees, agents, officers and subcontractors are familiar with, and comply with, applicable Federal, State, and Local laws and regulations as now written or hereafter amended.

15. WORKERS' COMPENSATION INSURANCE

Contractor shall take out and maintain during the Period of Performance, Colorado Worker's Compensation Insurance for the Contractor and all employees of the Contractor. If any service is sublet by the Contractor, the Contractor shall require the subcontractor to provide the same coverage for the subcontractor and subcontractor's employees. Workers' Compensation Insurance shall include occupational disease provisions covering any obligations of the Contractor in accord with the provisions of the Workers' Compensation Act of Colorado.

16. INDEMNIFICATION

Contractor agrees that the Contractor shall indemnify, defend and hold harmless the City, its officers, employees and agents, from and against any and all loss, damage, injuries, claims, cause or causes of action, or any liability whatsoever resulting from, or arising out of, or in connection with the Contractor's obligations or actions under this Contract caused by any willful or negligent error, omission or act or a failure to observe any applicable standard of care by the Contractor or any person employed by it or anyone for whose acts the Contractor is legally liable. In consideration of the award of this Contract, to the extent damages are covered by insurance, the Contractor agrees to waive all rights of subrogation against the City, its subsidiary, parent, associated and/or affiliated entities, successors, or assigns, its elected officials, trustees, employees, agents, and volunteers for losses arising from the work performed by the Contractor for the City. The indemnification obligation shall survive the expiration or termination of this Contract

17. INDEPENDENT CONTRACTOR

In the performance of the Contractor's obligations under this Contract, it is understood, acknowledged and agreed between the parties that the Contractor is at all times acting and performing as an independent contractor, and the City shall neither have nor exercise any control or direction over the manner and means by which the Contractor performs the Contractor's obligations under this Contract, except as otherwise stated within the Contract terms. The City shall not provide any direction to the Contractor on the work necessary to complete the project. Contractor understands that it is an independent contractor responsible for knowing how to perform all work or tasks necessary to complete project. The Contractor understands and agrees that the Contractor and the Contractor's employees, agents, servants, or other personnel are not City employees. The Contractor shall be solely responsible for payment of salaries, wages, payroll taxes, unemployment benefits or any other form of compensation or benefit to the Contractor or any of the Contractor's employees, agents, servants or other personnel performing services or work under this Contract, whether it is of a direct or indirect nature. Further in that regard, it is expressly understood and agreed that for such purposes neither the Contractor nor the Contractor's employees, agents, servants or other personnel shall be entitled to any City payroll, insurance, unemployment, worker's compensation, retirement or any other benefits whatsoever.

18. APPLICABLE LAW AND LICENSES

In the conduct of the services or work contemplated in this Contract, the Contractor shall ensure that the Contractor and all subcontractors comply with all applicable state, federal and City and local law, rules and regulations, technical standards or specifications. The Contractor shall qualify for and obtain any required licenses prior to commencement of work.

19. PRIOR AGREEMENTS

This is a completely integrated Contract and contains the entire agreement between the parties. Any prior written or oral agreements or representations regarding this Contract shall be of no effect and shall not be binding on the City. This Contract may only be amended in writing, and executed by duly authorized representatives of the parties hereto.

20. INTELLECTUAL PROPERTY

The Parties hereby agree, and acknowledge, that all products, items writings, designs, models, examples, or other work product of the Contractor produced pursuant to this Contract are works made for hire, and that the City owns, has, and possesses any and all ownership rights and interests to any work products of the Contractor made under this Contract, including any and all copyright, trademark, or patent rights, and that compensation to the Contractor for Agreement and acknowledgment of this intellectual property right section of this Contract is included in any compensation or price whatsoever paid to the Contractor under this Contract. It is the intent of the parties that the City shall have full ownership and control of the Contractor's work products produced pursuant to this Contract, and the Contractor specifically waives and assigns to the City all rights which Contractor may have under the 1990 Visual Artists Rights Act, federal, and state law, as now written or later amended or provided. In the event any products, items writings, designs, models, examples, or other work product produced pursuant to this Contract is deemed by a court of competent jurisdiction not to be a work for hire under federal copyright laws, this intellectual property rights provision shall act as an irrevocable assignment to the City by the Contractor of any and all copyrights, trademark rights, or patent rights in the Contractor's products,

items writings, designs, models, examples, or other work product produced pursuant to this Contract, including all rights in perpetuity. Under this irrevocable assignment, the Contractor hereby assigns to the City the sole and exclusive right, title, and interest in and to the Contractor's products, items writings, designs, models, examples, or other work product produced pursuant to this Contract, without further consideration, and agrees to assist the City in registering and from time to time enforcing all copyrights and other rights and protections relating to the Contractor's products, items writings, designs, models, examples, or other work product in any and all countries. It is the Contractor's specific intent to assign all right, title, and interest whatsoever in any and all copyright rights in the Contractor's products, items writings, designs, models, examples, or other work product produced pursuant to this Contract, in any media and for any purpose, including all rights of renewal and extension, to the City. To that end, the Contractor agrees to execute and deliver all necessary documents requested by the City in connection therewith and appoints the City as Contractor's agent and attorney-in-fact to act for and in Contractor's behalf and stead to execute, register, and file any such applications, and to do all other lawfully permitted acts to further the registration, prosecution, issuance, renewals, and extensions of copyrights or other protections with the same legal force and effect as if executed by the Contractor; further, the parties expressly agree that the provisions of this intellectual property rights section shall be binding upon the parties and their heirs, legal representatives, successors, and assigns.

21. WAIVERS

No waiver of default by the City of any of the terms, covenants, and conditions hereof to be performed, kept, and observed by the Contractor shall be construed, or shall operate, as a waiver of any subsequent default of any of the terms, covenants, or conditions herein contained to be performed, kept, and observed by the Contractor.

22. THIRD PARTIES

It is expressly understood and agreed that enforcement of the terms and conditions of this Contract, and all rights of action relating to such enforcement, shall be strictly reserved to the Parties hereto, and nothing contained in this Contract shall give or allow any such claim or right of action by any other or third person or entity on such Contract. It is the express intention of the Parties hereto that any person or entity, other than the Parties to this Contract, receiving services or benefits under this Contract shall be deemed to be incidental beneficiaries only.

23. TERMINATION

A. Termination for Convenience.

By signing this Contract, Contractor represents that it is a sophisticated business and enters into the Contract voluntarily, has calculated all business risks associated with this Contract, and understands and assumes all risks of being terminated for convenience, whether such risks are known or not known. Contractor agrees that the City may terminate this Contract at any time for convenience of the City, upon written notice to the Contractor. Contractor expressly agrees to and assumes the risk that the City shall not be liable for any costs or fees of whatsoever kind and nature if termination for convenience occurs before Contractor begins any work or portion of the work. Contractor further expressly agrees and assumes the risks that the City shall not be liable for any unperformed work, anticipated profits, overhead, mobilizations costs, set-up, demobilization costs, relocation costs of employees, layoffs or severance costs, administrative costs, productivity costs, losses on disposal of equipment or materials, cost associated with the

termination of subcontractors, costs associated with purchase orders or purchases, or any other costs or fees of any kind and nature, if Contractor has started or performed portions of the Contract prior to receiving notice from the City. The City shall be liable only for the portions of work Contractor actually satisfactorily completed up to the point of the issuance of the Notice of Termination for convenience. Upon receipt of this notice the Contractor shall immediately: discontinue all services affected (unless the notice directs otherwise), and deliver to the City all data, drawings, specifications, reports, estimates, summaries, and other information and materials accumulated in performing this Contract, whether completed or in process.

B. Termination for Cause: The occurrence of any one or more of the following events ("Event of Default") will justify termination for cause:

1. Contractor's failure to perform the work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the progress schedule as adjusted from time to time.
2. Contractor's disregard of the laws or regulations of any public body having jurisdiction.
3. Contractor's disregard of the authority of Project Manager.
4. Contractor's violation in any material provision of the Contract Documents.
5. Contractor's failure to make prompt payments to its subcontractors, and suppliers of any tier, or laborers or any person working on the work by, through, or under the Contractor or any of them, any all of their employees, officers, servants, members, and agents.
6. Contractor files a petition commencing a voluntary case under the U.S. Bankruptcy Code, or for liquidation, reorganization, or an arrangement pursuant to any other U.S. or state bankruptcy Laws, or shall be adjudicated a debtor or be declared bankrupt or insolvent under the U.S. Bankruptcy Code, or any other federal or state laws relating to bankruptcy, insolvency, winding-up, or adjustment of debts, or makes a general assignment for the benefit of creditors, or admits in writing its inability to pay its debts generally as they become due, or if a petition commencing an involuntary case under the U.S. Bankruptcy Code or an answer proposing the adjudication of Contractor as a debtor or bankrupt or proposing its liquidation or reorganization pursuant to the Bankruptcy Code or any other U.S. federal or state bankruptcy laws is filed in any court and Contractor consents to or acquiesces in the filing of that pleading or the petition or answer is not discharged or denied within sixty (60) Calendar Days after it is filed.
7. A custodian, receiver, trustee or liquidator of Contractor, all or substantially all of the assets or business of Contractor, or of Contractor's interest in the Work or the Contract, is appointed in any proceeding brought against Contractor and not discharged within sixty (60) Calendar Days after that appointment, or if Contractor shall consent to or acquiesces in that appointment.
8. Contractor fails to commence correction of defective work or fails to correct defective work within a reasonable period of time after written notice.

If one or more of the events identified in Paragraphs 1-8 above occur, City may give Contractor written notice of the event and direct the event be cured. Any such Notice to Cure will provide Contractor a minimum of ten (10) calendar days to prepare and submit to the Project Manager a plan to correct the Event of Default. If such plan to correct the Event of Default is not submitted to the Project Manager within ten (10) days after the date of the written notice or such plan is unacceptable to the City, the City may, give Contractor (and the Surety, if any) written notice that Contractor's services are being terminated for cause. Upon delivery of the termination notice, City may terminate the services of Contractor in whole or in part, exclude Contractor from the site, and take possession of the work and of all Contractor's tools, appliances, construction equipment, and machinery at the project site, and use the same to

the full extent they could be used by Contractor (without liability to Contractor for trespass or conversion), incorporate in the work all materials and equipment stored at the site or for which City has paid Contractor but which are stored elsewhere, and finish the work as City may deem expedient. In such case, Contractor shall not be entitled to receive any further payment until Certificate of Completion of the work. In the event City terminates this Contract for Cause and the cost of completing the work exceeds the unpaid balance of the Contract price, Contractor shall pay City for any costs of completion which exceed the Contract price when combined with all amounts previously paid to Contractor. When exercising any rights or remedies under this paragraph City shall not be required to obtain the lowest price for the work performed. Should the cost of such completion, including all proper charges, be less than the original Contract price, the amount so saved shall accrue to the City. Neither the City nor any officer, agent or employee of the City shall be in any way liable or accountable to the Contractor or the Surety for the method by which the completion of the said work, or any portion thereof, may be accomplished or for the price paid.

Where Contractor's services have been so terminated by City, the termination will not affect any rights or remedies of City against Contractor or Surety then existing or which may thereafter accrue. Any retention or payment of moneys due Contractor by City will not release Contractor from liability.

C. Termination Notice. Upon receipt of a termination notice, whether for convenience or cause, the Contractor shall immediately: discontinue all services affected (unless the notice directs otherwise), and deliver to the City all data, drawings, specifications, reports, estimates, summaries, and other information and materials accumulated in performing this Contract, whether completed or in process.

D. Removal of Equipment. Except as provided above, in the case of termination of this Contract before completion from any cause whatever, the Contractor, if notified to do so by the City, shall promptly remove any part or all of Contractor's equipment and supplies from the property of the City, failing which the City shall have the right to remove such equipment and supplies at the expense of the Contractor.

24. BOOKS OF ACCOUNT AND AUDITING

The Contractor shall make available to the City if requested, true and complete records, which support billing statements, reports, performance indices, and all other related documentation. The City's authorized representatives shall have access during reasonable hours to all records, which are deemed appropriate to auditing billing statements, reports, performance indices, and all other related documentation. The Contractor agrees that it will keep and preserve for at least seven years all documents related to the Contract which are routinely prepared, collected or compiled by the Contractor during the performance of this Contract.

The City's Auditor and the Auditor's authorized representatives shall have the right at any time to audit all of the related documentation. The Contractor shall make all documentation available for examination at the Auditor's request at either the Auditor's or Contractor's offices, and without expense to the City.

25. COMPLIANCE WITH IMMIGRATION REFORM AND CONTROL ACT OF 1986

Contractor certifies that Contractor has complied with the United States Immigration Reform and Control Act of 1986. All persons employed by Contractor for performance of this Contract have completed and signed Form I-9 verifying their identities and authorization for employment.

26. LABOR

The Contractor shall employ only competent and skilled workmen and foremen in the conduct of work on this Contract. The Contractor shall at all times enforce strict discipline and good order among Contractor's employees. The Project Manager shall have the authority to order the removal from the work of any person, including Contractor's or any subcontractor's employees, who refuses or neglects to observe any of the provisions of these Plans or Specifications, or who is incompetent, abusive, threatening, or disorderly in conduct and any such person shall not again be employed on the Project.

In accord with the Keep Jobs in Colorado Act, codified at sections 8-17-101, et seq., C.R.S., Colorado labor shall be employed to perform the work to the extent of not less than eighty percent (80%) of each type or class of labor in the several classifications of skilled and common labor employed on this Project et seq.=; provided however, that this paragraph shall not apply if the Project receives federal funding.

In no event shall the City be responsible for overtime pay.

27. GRATUITIES

A. This Contract may be terminated if the Mayor, the Mayor's designee, and/or the Procurement Services Manager determine, in their sole discretion, that the Contractor or any officer, employee, agent, or other representative whatsoever, of the Contractor offered or gave a gift or hospitality to a City officer, employee, agent or Contractor for the purpose of influencing any decision to grant a City contract or to obtain favorable treatment under any City contract.

B. The terms "hospitality" and "gift" include, but are not limited to, any payment, subscription, advance, forbearance, acceptance, rendering or deposit of money, services, or anything of value given or offered, including but not limited to food, lodging, transportation, recreation or entertainment, token or award.

C. Contract termination under this provision shall constitute a breach of contract by the Contractor, and the Contractor shall be liable to the City for all costs of reletting the contract or completion of the project. Further, if the Contractor is terminated under this provision, or violates this provision but is not terminated, the Contractor shall be subject to debarment under the City's Procurement Regulations. The rights and remedies of the City provided in this clause shall not be exclusive and are in addition to any other rights and remedies provided by law or under this Contract.

28. NON-DISCRIMINATION

A. In accord with section 24-34-402, C.R.S., Title VII of the Civil Rights Act of 1964, Americans with Disabilities Act of 1990 as amended, all applicable federal and state laws, the Contractor will not discriminate against any employee or applicant for employment because of disability, race, creed, color, sex, sexual orientation, gender identity, gender expression, religion, age, national origin, or ancestry.

B. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.

C. The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to disability, race, creed, color, sex, sexual orientation, gender identity, gender expression, religion, age, national origin, or ancestry.

29. ORDER OF PRECEDENCE

Any inconsistency in this Contract shall be resolved by giving precedence in the following order:

A. This Contract document with its terms and conditions
B. Specific Construction Terms and Conditions
C. General Construction Terms and Conditions
D. The Statement of Work
E. Specific Specifications
F. General Specifications
G. Other Appendices, Attachments, Exhibits, or Schedules

30. HEADINGS

The section headings contained in this Contract are for reference purposes only and shall not affect the meaning or interpretation of this Contract.

31. DISPUTES

A. All administrative and contractual disputes arising from or related to this Contract other than those arising under Unanticipated Circumstances provisions (in section107.27 of Schedule B General Construction Terms and Conditions) shall be addressed in the following manner:
    1. If either Party disputes or disagrees with a Contract term or the other Party's interpretation of a Contract term or has any other administrative or contractual dispute not addressed in the Unanticipated Circumstances provisions, such Party shall promptly give the other Party written notice of said dispute.
    2. The Parties shall hold a meeting as soon as reasonably possible, but in no event later than thirty (30) calendar days from the initial written notice of the dispute, attended by persons with decision-making authority regarding the dispute, to attempt in good faith to negotiate a resolution of the dispute; provided, however, that no such meeting shall be deemed to vitiate or reduce the obligations and liabilities of the Parties or be deemed a waiver by a Party of any remedies to which such Party would otherwise be entitled unless otherwise agreed to by the Parties in writing.
    3. If, within thirty (30) calendar days after such meeting, the Parties have not succeeded in negotiating a resolution of the dispute, they agree to submit the dispute to non-binding mediation and to bear equally the costs of the mediation.
    4. The Parties will jointly appoint a mutually acceptable mediator. If they fail to do so within twenty (20) calendar days from the conclusion of the negotiation period, they shall each select a mediator. The two mediators will then appoint a third mediator who shall conduct mediation for the Parties as the sole mediator.
    5. The Parties agree to participate in good faith in the mediation and negotiations for a period of thirty (30) calendar days. The substantive and procedural law of the State of Colorado

shall apply to the proceedings. If the Parties are not successful in resolving the dispute through mediation, then the Parties shall be free to pursue any other remedy afforded by the laws of the State of Colorado.

6. Until final resolution of any dispute hereunder, the Contractor shall diligently proceed with the performance of this Contract as directed by the City. For purposes of this Contract, termination for convenience shall not be deemed a dispute. The City of Colorado Springs and the Contractor agree to notify each other in a timely manner of any claim, dispute, or cause of action arising from or related to this Contract, and to negotiate in good faith to resolve any such claim, dispute, or cause of action. To the extent that such negotiations fail, the City of Colorado Springs and the Contractor agree that any lawsuit or cause of action that arises from or is related to this Contract shall be filed with and litigated only by the Colorado District Court for El Paso County, CO.

32. DELIVERY

The City may cancel this Contract or any portion thereof if delivery is not made when and as specified, time being of the essence in this Contract. Contractor shall pay the City for any loss or damage sustained by the City because of failure to perform in accordance with this Contract.

33. PAYMENTS

All invoices shall be sent to the Project Manager identified in this Contract.

The City will pay the Contractor, upon submission of proper invoices, the prices stipulated in the Contract for services rendered and accepted, less any deductions provided in this Contract within 30 days (Net 30). The City will not pay late fees or interest. Any discount payment terms offered on the invoice may be taken by the City.

All payments for Construction will be made in accordance with the Payment provisions found in Schedule B – General Construction Terms and Conditions.

Each invoice must contain at least the following information:

Contract number, issued purchase order number, invoice number, invoice date, timeframe covered by invoice, type and amount of labor and materials used for that time period, dollar amount in unit price, extended price, and total value of invoice.

34. INSPECTION OF SERVICES

The Contractor is responsible for performing or having performed all inspections and tests necessary to substantiate that the services furnished under this Contract conform to Contract requirements, including any applicable technical requirements for specified manufacturers' parts. This clause takes precedence over any City inspection and testing required in the Contract's specifications, except for specialized inspections or tests specified to be performed solely by the City.

A. Definition of "services", as used in this clause, includes services performed, workmanship, and material furnished or utilized in the performance of services.

B. The Contractor shall provide and maintain an inspection system acceptable to the City covering the services under this Contract. Complete records of all inspection work performed

by the Contractor shall be maintained and made available to the City during Contract performance and for as long afterwards as the Contract requires.

C. The City has the right to inspect and test all services called for by the Contract, to the extent practicable at all times and places during the term of the Contract. The City will perform inspections and tests in a manner that will not unduly delay the work.

D. If the City performs inspections or test on the premises of the Contractor or a subcontractor, the Contractor shall furnish, and shall require subcontractors to furnish, at no increase in Contract price, all reasonable facilities and assistance for the safe and convenient performance of these duties.

35. SECURITY

The City maintains security requirements regarding access to City buildings and other City workplaces and worksites on City property. All Contractor personnel accessing City buildings, workplaces, or worksites, may be required to produce a valid, Government issued picture identification. Contractor personnel lacking such identification may not be allowed access to such sites. No costs incurred by the Contractor due to City security requirements shall be allowable or payable under this Contract.

36. TIME IS OF THE ESSENCE

In as much as the Contract concerns a needed or required service, the terms, conditions, and provisions of the Contract relating to the time of performance and completion of work are of the essence of this Contract. The Contractor shall begin work on the day specified and shall prosecute the work diligently so as to assure completion of the work within the number of calendar days or date specified, or the date to which the time for completion may have been extended.

37. EMPLOYMENT OF LABOR

The Contractor shall comply with, and defend and hold the City harmless from any violation of all laws and lawful rules and regulations, both of the State of Colorado and of the United States, relating to Workmen's Compensation, unemployment compensation, Social Security, payment for overtime, and all other expenses and conditions of employment under this Contract.

38. SALES TAX

The Contractor must have a tax-exemption certificate from the Colorado Department of Revenue for this project. The certificate does not apply to City of Colorado Springs Sales and Use Tax which shall be applicable. The tax exempt project number and the exemption certificate only applies to County, PPRTA (Pikes Peak Rural Transportation Authority), and State taxes when purchasing construction and building materials **to be incorporated into this project**.

Furthermore, the exemption **does not** include or apply to the purchase or rental of equipment, supplies or materials that **do not become a part of the completed project or structure**. Such purchases and rentals are subject to full applicable taxation.

All contracts with subcontractors must include the City of Colorado Springs Sales and Use Tax on the work covered by the Contract, and other taxes as applicable.

Note: For all equipment, materials and supplies incorporated into the work purchased from vendors or suppliers not licensed to collect City Sales Tax (i.e. out of state suppliers, etc.), City Use Tax is due and payable to the City. The Contractor shall execute and deliver, and shall cause the Contractor's subcontractors to execute and deliver to the City Sales Tax Office, ST 16 forms listing all said equipment, materials and supplies and the corresponding use tax due, along with payment for said taxes. Any outstanding taxes due may be withheld from the final payment due the Contractor and may result in suspension of Contractor from bidding on City projects.

Forms and instructions can be downloaded at https://coloradosprings.gov/cat/government/tax-information/sales-tax. Questions can be directed to the City Sales Tax Division at (719) 385-5903.

Our Registration Numbers are as follows:
City of Colorado Springs
Federal I.D.: 84-6000573
Federal Excise: A-138557
State Sales Tax: 98-03479

The Contractor's payment or exemption of State of Colorado, El Paso County and City Sales and Use Taxes shall be as specified herein.

39. SEVERABILITY

If any terms, conditions, or provisions of this Contract shall be held unconstitutional, illegal, or void, such finding shall not affect any other terms, conditions, or provisions of this Contract.

40. LIABILITY OF CITY EMPLOYEES

All authorized representatives of the City are acting solely as agents and representatives of the City when carrying out and exercising the power or authority granted to them under the Contract. There shall not be any liability on them either personally or as employees of the City.

41. USE OF CITY NAME OR LOGO

Except as otherwise provided in this Contract, the Contractor shall not refer to this Contract or the City of Colorado Springs in any advertising or promotions in such a manner as to state or imply that the product or service provided is endorsed or preferred by the City of Colorado Springs, its employees, or its Departments, or is considered by these entities to be superior to other products or services. Any use of the name or logo of the City of Colorado Springs in advertising or promotions must be approved in writing by the City of Colorado Springs Contracts Specialist assigned to the Contract prior to such use.

42. TRAVEL

If travel expenses are included as a line item in this Contract, all travel expenses incurred and billable by the Contractor are subject to City approval. Air travel shall be limited to the round trip "economy coach" fare. Travel from the Colorado Springs Airport is encouraged. Unless there are extenuating circumstances, the Contract should take advantage of lower airfares by purchasing tickets more than 14 days in advance of travel. In-state travel by air must be more economical than travel by private vehicle. Use of a private vehicle may be reimbursed per mile at the current rate published by the IRS annually. Short-term parking, long-term parking or cab fare associated

with airport departure and arrival may be allowable expenses. Valet parking will not be allowed unless it is the least expensive or only option. Car rental rates may be reimbursed for car rentals no greater than the intermediate or standard classification. The City will not reimburse any other travel methods or expenses. The City will pay for lodging, meals, and miscellaneous expenses on a per diem basis only, in accordance with the current per diem rates published by the IRS annually. The City will not pay for Contractor expenses exceeding the per diem rates. Receipts for all reimbursable expenses must be provided with the Contractor's invoice.

43. ELECTRONIC SIGNATURE

This Agreement and all other documents contemplated hereunder may be executed using electronic signature with delivery via facsimile transmission, by scanning and transmission of electronic files in Portable Document Format (PDF) or other readily available file format, or by copy transmitted via email, or by other electronic means and in one or more counterparts, each of which shall be (i) an original, and all of which taken together shall constitute one and the same agreement, (ii) a valid and binding agreement and fully admissible under state and federal rules of evidence, and (iii) enforceable in accordance with its terms

44. APPENDICES

The following Appendices are made a part of this Agreement:

1. Schedule A – Bid Form
2. Schedule B – General Construction Terms and Conditions
3. Schedule C – Special Contract Terms and Conditions
4. Schedule D – Special Provisions
5. Schedule E – CDOT Revised Standard Special Provisions
6. Schedule F – Clauses for Contracts Subject to Federal Requirements
7. Schedule G – Construction Plan Set
8. Schedule H – Minimum Insurance Requirements

CONTRACT SIGNATURE PAGE

IN WITNESS WHEREOF, the parties have caused these presents to be executed on the day and the year first above written.

This Contract is executed in one (1) original copy.

THE CITY OF COLORADO SPRINGS, COLORADO:

SECOND PARTY: SAMPLE CONTRACT – DO NOT SIGN	
Corporate Name	
Signature	Date
Title	

EXHIBIT 2 – QUALIFICATION STATEMENT

This statement will provide information which will enable the City to evaluate the qualifications of your firm and staff with regard to the requirements of this Invitation for Bid. Please complete this form in its entirety and submit it (in the number of copies requested) along with the other required proposal documents. If a request in the Qualification Statement is contained in the Bid, indicate the section in the Bid where that information can be found.

(PRINT)
FIRM NAME: _____
ADDRESS: _____
CITY STATE ZIP: _____
AUTHORIZED REPRESENTATIVE: _____
TITLE: _____
AUTHORIZED SIGNATURE: _____
PHONE: _____ FAX: _____
E-MAIL ADDRESS: _____
1. TYPE OF BUSINESS _____
2. TYPE OF LICENSE AND LOCATION _____
CORPORATION ☐ INDIVIDUAL ☐
PARTNERSHIP ☐ JOINT VENTURE ☐
OTHER: _____

3. TYPE OF SERVICE TO BE PROVIDED FOR IFB: _____

4. NUMBER OF YEARS IN BUSINESS: _____

5. ON A SEPARATE SHEET PROVIDE A BRIEF HISTORY OF YOUR FIRM, STAFF SIZE AND EXPERIENCE. SUBMIT A RESUME FOR THE PROJECT MANAGER AND EACH KEY PERSONNEL ASSIGNED TO THIS PROJECT.

6. WHAT OTHER NAME(S) HAS YOUR COMPANY OPERATED UNDER:

7. HAVE YOU OR YOUR FIRM EVER FAILED TO COMPLETE ANY WORK AWARDED TO YOU? YES ☐ NO ☐ IF "YES", EXPLAIN:

8. HAS ANY OFFICER OR PARTNER OF YOUR ORGANIZATION EVER BEEN AN OFFICER OR PARTNER OF ANOTHER ORGANIZATION THAT FAILED TO COMPLETE A CONTRACT WITHIN THE LAST FIVE (5) YEARS? YES ☐ NO ☐
IF "YES", EXPLAIN:

9. HAS YOUR FIRM OR ANY PARTNERS OR OFFICERS EVER BEEN INVOLVED IN ANY BANKRUPTCY ACTION? YES ☐ NO ☐ IF "YES", EXPLAIN:

_____

_____

_____

_____

10. ARE YOU PRESENTLY INVOLVED IN ANY LITIGATION WITH ANY GOVERNMENT AGENCY? YES ☐ NO ☐ IF "YES", EXPLAIN TYPE, KIND, PLAINTIFF, DEFENDANT, ETC., AND STATE THE CURRENT STATUS:

_____

_____

_____

_____

11. BANK REFERENCE: _____

ADDRESS: _____

CONTACT: PHONE:

12. LIST THREE (3) SIMILAR PROJECTS (LOCAL OR STATE-WIDE) **FROM LAST FIVE (5) YEARS**-INCLUDE LOCATION OF PROJECT, SIZE OF PROJECT (CONTRACT AMOUNT), CONTACT NAME, ADDRESS, TELEPHONE NUMBERS

NOTE: DETAILED INFORMATION ON THESE PROJECTS MAY ALSO BE REQUESTED IN THE IFB PACKAGE.

1. Location of Project:
Size of Project:
Contract Amount:
Contact Name and Title:
Contract Address:
Contact telephone and FAX Numbers:

2. Location of Project:
Size of Project:
Contract Amount:
Contact Name:
Contact Address:
Contact telephone and FAX Numbers:

3. Location of Project:
Size of Project:
Contract Amount:
Contact Name:
Contact Address:
Contact telephone and FAX Numbers:

13. LIST **CURRENT** SIMILAR PROJECTS (LOCAL OR STATE-WIDE) UNDER CONTRACT-INCLUDE LOCATION OF PROJECT, SIZE OF PROJECT (CONTRACT AMOUNT) CONTACT NAME, ADDRESS, TELEPHONE NUMBERS.

NOTE: DETAILED INFORMATION ON THESE PROJECTS MAY ALSO BE REQUESTED IN THE IFB PACKAGE.

1. Location of Project:
Size of Project:
Contract Amount:
Contact Name and Title:
Contact Address:
Contact telephone and FAX Numbers:

2. Location of Project:
Size of Project:
Contract Amount:
Contact Name and Title:
Contact Address:
Contact telephone and FAX Numbers:

3. Location of Project:
Size of Project:
Contract Amount:
Contact Name and Title:
Contact Address:
Contact telephone and FAX Numbers:

14. LIST OF SUB-CONTRACTORS TO BE USED FOR THIS PROJECT:
(INCLUDE NAME, ADDRESS, TELEPHONE NUMBER, TYPE OF WORK)

1. Name:
Address:
Telephone Number:
Type of Work:

2. Name:
Address:
Telephone Number:
Type of Work:

3. Name:
Address:
Telephone Number:
Type of Work:

IF ADDITIONAL INFORMATION IS PROVIDED ON A SEPARATE SHEET FOR ANY OF THE ITEMS, CLEARLY SPECIFY WHERE IT CAN BE LOCATED IN YOUR BID PACKAGE.

EXHIBIT 3 – BID CERTIFICATION AND REPRESENTATIONS AND CERTIFICATIONS

Check or Mark the space after each number to indicate compliance.

1. _____ Address of Offeror's Principal Place of Business:

   _____

   _____

Does Offeror have an established office or facility in Colorado Springs?

Yes _____ No _____

If yes, indicate address below if different than Principal Place of Business.

Colorado Springs Facility - Year established _____

Address of Colorado Springs Facility:

   _____

   _____

Percent of Work to be Performed from Principal Place of Business? _____

Percent of Work to be Performed from Colorado Springs Facility? _____

2. _____ Indicate your ability to provide a certificate of insurance evidencing the required coverage types and limits specified in Minimum Insurance Requirements Exhibit. (The certificate of insurance must reflect the City of Colorado Springs as an Additional Insured, as applicable.)

Indicate your ability to comply with the following requirements:

The City shall be added as an Additional Insured to all liability policies:

Yes _____ No _____

Your property and liability insurance company is licensed to do business in Colorado:

Yes _____ No _____

Provide the name of your property and liability insurance company here:

Name: _____

Your property and liability insurance company has an AM best rating of not less than B+ and/or VII:

Yes _____ No _____

Worker's Compensation Insurance is carried for all employees and covers work done in Colorado:

Yes _____ No _____

3. _____ Provide one (1) copy of current financial statements (if required). Enclose financial information in a separate envelope; do not bind with the other proposal copies. If review of the information is to be restricted to the City's financial officer, it must be marked accordingly.

4. _____ Provide the completed and signed bid. (Bids must be identified as specified in this IFB document). All required Exhibits are attached.

By signing below, the Offeror certifies that no person or firm other than the Offeror or as otherwise indicated has any interest whatsoever in this offer or any Contract that may be entered into as a result of this offer and that in all respects the offer is legal and firm, submitted in good faith without collusion or fraud. The undersigned additionally declares that it has carefully examined the Bid information and the complete Solicitation prior to submitting a Bid. The Bidder's signature will be considered the Bidder's acknowledgement of understanding and ability to comply with all items in the solicitation.

Offeror has appointed _____ as the Offeror's representative and contact for all questions or clarifications in regard to this Offeror.

Telephone: (___) _____

Email: _____

The undersigned acknowledges and understands the terms, conditions, Specifications and all Requirements contained and/or referenced and are legally authorized by the Offeror to make the above statements or representations.

_____ _____
(Name of Company) (Signature)

_____ _____
(Address) Date

_____ _____
(City, State and Zip) (Telephone Number)

_____ _____
(Name typed/Printed) (Title)

_____
(E-Mail Address)

FEDERAL TAX ID #_____

This Company Is: Corporation___ Individual____ Partnership____ LLC____

Offeror hereby acknowledges receipt of the following amendments, if applicable. Offeror agrees that it is bound by all Amendments identified herein.

AMENDMENT #1_____ DATED:_____

AMENDMENT #2_____ DATED:_____

AMENDMENT #3_____ DATED:_____

Please Note: the following Representations and Certifications must be initialed by Offeror in the spaces provided and returned with this certification.

1. INSURANCE REQUIREMENTS

Offeror shall comply with all insurance requirements and will submit the Insurance Certificates prior to performance start date. If limits are different from the stated amounts, Offeror shall explain variance. Certain endorsements and "additionally insured" statements may require further clarification and specific statements on a project specific basis and should have been described in the Offeror's Bid.

_____
Initials for 1

2. ETHICS VIOLATIONS

A. The Offeror shall have in place and follow reasonable procedures designed to prevent and detect possible violations described in this clause in its own operations and direct business relationships.
B. Offeror certifies the Offeror has not violated or caused any person to violate, and shall not violate or cause any person to violate, the City's Code of Ethics contained in Article 3, of Chapter 1 of the City Code and in the City's Procurement Rules and Regulations
C. When the Offeror has reasonable grounds to believe that a violation described in this clause may have occurred, the Offeror shall promptly report the possible violation to the City Contracts Specialist in writing.
D. The Offeror must disclose with the signing of this Bid, the name of any officer, director, or agent who is also an employee of the City and any City employee who owns, directly or indirectly, an interest of ten percent (10%) or more in the Offeror's firm or any of its branches.
E. In addition, the Offeror must report any conflict or apparent conflict, current or discovered during the performance of the Contract, to the City Contracts Specialist.
F. The Offeror shall not engage in providing gifts, meals or other amenities to City employees. The right of the Offeror to proceed may be terminated by written notice issued by City Contracts Specialist if Offeror offered or gave a gratuity to an officer, official, or employee of the City and intended by the gratuity to obtain a contract or favorable treatment under a contract.
G. The Offeror shall cooperate fully with the City or any agency investigating a possible violation on behalf of the City. If any violation is determined, the Offeror will properly compensate the City.
H. The Offeror agrees to incorporate the substance of this clause (after substituting "Contractor" for "Offeror") in all subcontracts under this offer.

_____
Initials for 2

3. COOPERATION WITH OTHER CONTRACTORS

Other City activities/contracts may be in progress or start during the performance of this contract. The Offeror shall coordinate the work harmoniously with the other contractors or City personnel, if applicable.

_____
Initials for 3

4. INTERNET USE

Should the Offeror require access to City Internet resources in the performance of this requirement, a "Contractor's Internet Use Agreement" form must be separately signed by each individual having access to the City Network. The completed Contractor's Internet Use Agreement will be maintained with this agreement. Inappropriate use of the City Network will be grounds for immediate termination of any awarded contact.

_____

Initials for 4

5. LITIGATION

If awarded a contract, Offeror shall notify the City within five (5) calendar days after being served with a summons, complaint, or other pleading in any matter which has been filed in any federal or state court or administrative agency. The Offeror shall deliver copies of such document(s) to the City's Procurement Services Manager. The term "litigation" includes an assignment for the benefit of creditors, and filings of bankruptcy, reorganization and/or foreclosure.

_____

Initials for 5

6. CONTRACTOR'S REGISTRATION INFORMATION

Offeror's firm verifies and states that they are (check all that apply):

_____ Large Business (i.e. do not qualify as a small business or non-profit)

_____ Nonprofit

_____ Small Business

_____ Minority Owned Business/Small Disadvantaged Business

_____ Woman Owned Business

_____ Veteran Owned Business

_____ Service-Disabled Veteran Owned Business

_____ HUBZone Business

Note: The City accepts self-certification for these categories in accordance with Small Business Administration (SBA) standards. The SBA size standards are found on the SBA website https://www.sba.gov/content/am-i-small-business-concern.

_____
Initials for 6

7. CONTRACTOR PERSONNEL

A. The Offeror shall appoint one of its key personnel as the "Authorized Representative" who shall have the power and authority to interface with the City and represent the Offeror in all administrative matters concerning this Bid and any awarded contract, including without limitation such administrative matters as correction of problems modifications, and reduction of costs.
B. The Authorized Representative shall be the person identified in the Offeror's Bid, unless the Offeror provides written notice to the City naming another person to serve as its Authorized Representative. Communications received by the City Contracts Specialist from the Authorized Representative shall be deemed to have been received from the Offeror.

The individual, _____ (Name)
with position, _____ (Title)
Can be reached at
Work telephone number: _____

Home telephone number: _____
Cellular telephone number: _____
E-mail address: _____

_____
Initials for 7

8. OFFEROR's CERTIFICATION

The undersigned hereby affirms that:

A. He/She is a duly authorized agent of the Offeror;
B. He/She has read and agrees to the City's standard terms and conditions attached.
C. The offer is presented in full compliance with the collusive prohibitions of the City of Colorado Springs. The Offeror certifies that no employee of its firm has discussed, or compared the offer with any other offeror or City employee and has not colluded with any other offeror or City employee.
D. The Offeror certifies that it has checked all of its figures, and understands that the City will not be responsible for any errors or omissions on the part of the Offeror in preparing its Bid.
E. By submitting an offer the Offeror certifies that it has complied and will comply with all requirements of local, state, and federal laws, and that no legal requirements have been or will be violated in making or accepting this solicitation.
F. If awarded the contract, the Offeror agrees to execute and enter into a contract with the City, and furnish the necessary security within ten (10) days of receipt of the "Notice of Award:, and to begin the work within ten (10) day from the date of the receipt of the "Notice to Proceed", and to complete the Work with the above specifications.
G. I hereby certify that I am submitting the Bid based on my company's capabilities to provide quality products and/or services on time.

_____
Initials for 8

9. OFFEROR CERTIFICATION REGARDING DEBARMENT, SUSPENSION, PROPOSED DEBARMENT, AND OTHER RESPONSIBILITY MATTERS:

A. The Offeror certifies to the best of its knowledge and belief, that (i) the Offeror and/or any of its Principals
    1. Are ( ), Are not ( ) presently debarred, suspended, proposed for debarment, or declared ineligible for the award of contracts by any Federal agency;
    2. Have ( ), Have not ( ), within a three year period preceding this offer, been convicted of or had a civil judgment rendered against them for: commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (federal, state, local) contract or subcontract; violation of Federal or state antitrust statutes relation to the submission of offers; or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statement, tax evasion, or receiving stolen property; and
    3. Are ( ), Are not ( ) presently indicated for, or otherwise criminally or civilly charged by a governmental entity with, commission of any of the offenses enumerated in any paragraphs above.
B. The Offeror shall provide immediate written notice to the City Contracts Specialist if, at any time prior to contract award, the Offeror learns that its certification was erroneous when submitted or has become erroneous by reasons of changed circumstances.
C. The certification in paragraph 1. above, is a material representation of fact upon which reliance was placed when making award. If it is later determined that the Offeror knowingly rendered an erroneous certification, in addition to other remedies available to the City, the City Contracts Specialist may terminate the contract resulting from this solicitation for default. Termination for default may result in additional charges being levied for the costs incurred by the City to initiate activities to replace the awarded Contractor.

_____
Initials for 9

10. ACCEPTANCE OF CITY CONTRACTS SPECIALIST'S SOLE AUTHORITY FOR CHANGES

Unless otherwise specified in the Contract, the Offeror hereby agrees that any changes to the scope of work, subsequent to the original contract signing, shall be generated in writing and an approval signature shall be obtained from the City Contracts Specialist prior to additional work performance.

_____
Initials for 10

11. CITY CONTRACTOR SAFETY PROGRAM

The Offeror hereby agrees to adhere to a worker safety program for contractor employees on a City job site or location. By initialing below, the Offeror has reviewed the information and will abide by the City Policy which is available for review:

https://coloradosprings.gov/finance/page/procurement-regulations-and-documents

_____
Initials for 11

12. ACCEPTANCE OF CITY ENVIRONMENTALLY PREFERRED PURCHASING (EPP) POLICY

The City of Colorado Springs is committed to buying more environmentally preferable goods and services, as long as they meet performance needs, are available within a reasonable time and at a reasonable cost. The Offeror hereby acknowledges review of this policy by initialing below.

https://coloradosprings.gov/finance/page/procurement-regulations-and-documents

_____
Initials for 12

13. FRAUD, WASTE, AND ABUSE

Everyone has a duty to report any suspected unlawful act impacting the City of Colorado Springs operations and its enterprises. Anyone who becomes aware of the existence or apparent existence of fraud, waste, and abuse in City of Colorado Springs is encouraged to report such matters to the City Auditor's Office in writing or on the telephone hotline 385-2387 (ADTR). Written correspondence can be mailed to:

City Auditor
P.O. Box 2241
Colorado Springs CO 80901

Or via email FraudHotline@coloradosprings.gov. Any of these mechanisms allow for anonymous reporting. For more information, please go to the website https://coloradosprings.gov/cityfraud.

_____
Initials for 13

Name of Company: _____

Federal Tax ID Number: _____

DUNS Number: _____

Principal Place of Business: _____

_____
Signature of Authorized Representative

Printed Name:_____

Title:_____

Date:_____

EXHIBIT 4 – CITY OF COLORADO SPRINGS BID BOND

1. KNOW ALL MEN BY THESE PRESENTS, THAT:

_____
(Name)

_____ As Principal, hereinafter called Principal, and
(Address)

_____
(SURETY Name)

a corporation organized and existing under the laws of the State of:

_____
(SURETY Address)

and AUTHORIZED TO DO BUSINESS IN THE STATE OF COLORADO, as Surety, hereinafter called Surety, are held firmly bound to the CITY OF COLORADO SPRINGS, COLORADO, as Obligee, hereinafter called the Obligee, in the sum of: (Insert Bid Amount in Words)

($ DOLLARS),

lawful money of the United States of America, for payment of which sum well and truly to be made, the Principal and the Surety bind themselves, their heirs, executors, successors and assigns, jointly and severally, firmly by these presents.

2. WHEREAS, the Principal has submitted to the Obligee,

a contract bid dated the _____ day of _____ For the following contract:

_____

3. NOW THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH THAT, If Principals bid is accepted by Obligee and Principal is awarded the contract in whole or in part, and the Principal shall enter into the contract with the Obligee in accordance with the terms of such bid, and give such Payment, Performance, and Maintenance bond or bonds as may be specified in the bidding or contract documents with good and sufficient surety for the faithful performance of such Contract and for the prompt payment of labor and material furnished in the prosecution thereof, or in the event of the failure of the Principal to enter such contract and give such bond or bonds, if the Principal shall promptly pay to the Obligee the amount of this bond as set forth herein above, then this obligation shall be null and void, otherwise this obligation to remain in full force and effect.

Signed and sealed on the dates set forth below:

_____ FOR: _____
(Witness) (Principals Name)

BY: _____

ITS: _____

(Seal)

This _____ day of _____

_____ FOR: _____
(Witness) (Surety's Name)

BY: _____

ITS: _____

(Seal)

This _____ Day of _____

Bond # _____ This Bond __(is) __ (is not) a SBA Guaranteed Bond.

EXHIBIT 5 – CDOT FORMS

Starts On Next Page

COLORADO DEPARTMENT OF TRANSPORTATION

ANTI-COLLUSION AFFIDAVIT

PROJECT NO.
LOCATION

I hereby attest that I am the person responsible within my firm for the final decision as to the price(s) and amount of this bid or, if not, that I have written authorization, enclosed herewith, from that person to make the statements set out below on his or her behalf and on behalf of my firm.

I further attest that:

1. The price(s) and amount of this bid have been arrived at independently, without consultation, communication or agreement for the purpose or with the effect of restricting competition with any other firm or person who is a bidder or potential prime bidder.

2A. Neither the price(s) nor the amount of this bid have been disclosed to any other firm or person who is a bidder or potential prime bidder on this project, and will not be so disclosed prior to bid opening.

2B. Neither the prices nor the amount of the bid of any other firm or person who is a bidder or potential prime bidder on this project have been disclosed to me or my firm.

3A. No attempt has been made to solicit, cause or induce any firm or person who is a bidder or potential prime bidder to refrain from bidding on this project, or to submit a bid higher than the bid of this firm, or any intentionally high or non-competitive bid or other form of complementary bid.

3B. No agreement has been promised or solicited for any other firm or person who is a bidder or potential prime bidder on this project to submit an intentionally high, noncompetitive or other form of complementary bid on this project.

4. The bid of my firm is made in good faith and not pursuant to any consultation, communication, agreement or discussion with, or inducement or solicitation by or from any firm or person to submit any intentionally high, noncompetitive or other form of complementary bid.

5. My firm has not offered or entered into a subcontract or agreement regarding the purchase or sale of materials or services from any firm or person, or offered, promised or paid cash or anything of value to any firm or person, whether in connection with this or any other project, in consideration for an agreement or promise by any firm or person to refrain from bidding or to submit any intentionally high, noncompetitive or other form of complementary bid or agreeing or promising to do so on this project.

6. My firm has not accepted or been promised any subcontract or agreement regarding the sale of materials or services to any firm or person, and has not been promised or paid cash or anything of value by any firm or person, whether in connection with this or any other project, in consideration for my firm's submitting any intentionally high, noncompetitive or other form of complementary bid, or agreeing or promising to do so, on this project.

7. I have made a diligent inquiry of all members, officers, employees, and agents of my firm with responsibilities relating to the preparation, approval or submission of my firm's bid on this project and have been advised by each of them that he or she has not participated in any communication, consultation, discussion, agreement, collusion, or other conduct inconsistent with any of the statements and representations made in this affidavit.

8. I understand and my firm understands that any misstatement in this affidavit is and shall be treated as a fraudulent concealment from the Colorado Department of Transportation, of the true facts relating to submission of bids for this contract.

I DECLARE UNDER PENALTY OF PERJURY IN THE SECOND DEGREE, AND ANY OTHER APPLICABLE STATE OR FEDERAL LAWS, THAT THE STATEMENTS MADE ON THIS DOCUMENT ARE TRUE AND COMPLETE TO THE BEST OF MY KNOWLEDGE.

Contractor's firm or company name	By	Date
	Title	
2nd contractor's firm or company name. (If joint venture.)	By	Date
	Title	

Sworn to before me this day of, 20

Notary Public	
My commission expires	

NOTE: This document must be signed in ink.

COLORADO DEPARTMENT OF TRANSPORTATION

BIDDERS LIST

Project Name/Description	Project Number	Project Code/ SubAccount	Proposal Date
Contractor			Region

Subcontractors/Suppliers/Vendors: The bidder must list all firms seeking to participate on the contract. This information is used by the Colorado Department of Transportation (CDOT) to determine overall goals for the Disadvantaged Business Enterprise Program. Failure to submit this form may result in the proposal being rejected.

Firm Name	Email	Work Proposed (Select all that apply)	DBE (Y/N)	Selected (Y/N)

I certify that the information provided herein is true and correct to the best of my knowledge.

Name	Signature/Initials	Title	Date

Work Proposed Categories:

1. *Materials and Supplies*
2. *Flagging and Traffic Control*
3. *Trucking and Hauling*
4. *Precast Concrete, Foundations, and Footings*
5. *Concrete Paving, Flatwork and Repair*
6. *Lighting and Electrical*
7. *Signs, Signal Installation, and Guardrail*
8. *Fencing*
9. *Buildings and Vertical Structures*
10. *Utility, Water and Sewer Lines*
11. *Structural Steel and Steel Reinforcement*
12. *Riprap and Anchored Retaining Walls*
13. *Landscape and Erosion Control*
14. *Bridge and Bridge Deck Construction*
15. *Asphalt Paving*
16. *Road and Parking Lot Marking*
17. *Chip Seal, Crack Seal, Joint Seal and Crack Fill*
18. *Bridge Painting and Coating*
19. *Stairway and Ornamental Metal*
20. *Parking Lots and Commercial Sidewalks*
21. *Clearing, Demolition, Excavation and Earthwork*
22. *Engineering and Surveying Services*
23. *Public Relations and Involvement*
24. *Piles and Deep Foundations*
25. *Waste Management and Recycling*
26. *Site Clean Up*
27. *Mechanical and HVAC*
28. *Tunnel Construction*
29. *Profiling and Grinding*
30. *Environmental Health and Safety*

This form must be submitted by the proposal deadline. For CDOT projects, submit to cdot_hq_dbeforms@state.co.us.

COLORADO DEPARTMENT OF TRANSPORTATION

ANTICIPATED DBE PARTICIPATION PLAN

Bidder:		Project Name:	
Bidder Contact:		Subaccount #:	
Bidder Phone:		Bid Submission Date:	
Bidder Email:		DBE Contract Goal:	
Preferred Contact Method:		Region:	

DBE Commitments

DBE Firm Name	Work to Be Performed	Commitment Amount	Eligible Participation
		Total Eligible Participation	$0.00
		Total Bid Amount	
		Total Eligible Participation Percentage	#DIV/0!

Bidder Signature

COMMITMENTS LISTED ON THIS FORM SHALL BE BINDING ON THE BIDDER UPON CONTRACT AWARD. IF THE DBE GOAL IS ZERO, DBE COMMITMENTS ARE OPTIONAL AND THE BIDDER IS NOT REQUIRED TO LIST ANY DBE COMMITMENTS ON THIS FORM. This section must be signed by an individual with the authority to bind the Bidder. By signing this form, as an authorized representative of the Bidder, you declare under penalty of perjury in the second degree and any other applicable state or federal laws that the statements made in this document are true and complete to the best your knowledge. Further, you attest that you understand the following:

CDOT shall not award a contract (or provide its concurrence to award a Local Agency Project) until it has been determined that commitments are sufficient to meet the DBE contract goal or else good faith efforts have been made to meet the goal despite falling short. Once your bid has been submitted, commitments may not be modified or terminated without the approval of CDOT. If selected as the lowest apparent bidder, you shall submit a Form 1415 for each commitment listed above. If you have not met the contract goal, you will also be required to submit documentation of all good faith efforts to meet the contract goal. It is your responsibility to ensure that the selected DBEs are certified for the work to be performed and that their eligible participation has been properly counted. Please review your project's DBE requirements for additional information and instructions on calculating eligible participation.

Name	Title	Signature	Date

EXHIBIT 6 – FEDERAL FORMS

CERTIFICATION REGARDING DEBARMENT, SUSPENSION AND OTHER RESPONSIBILITY MATTERS

The undersigned duly authorized official of the proposer certifies to the best of its knowledge and belief, that it and its principals:

A. Are not presently debarred, suspended, proposed for debarment, and declared ineligible or voluntarily excluded from covered transactions by any Federal department or agency.

B. Have not within a three-year period preceding this proposal been convicted of or had a civil judgement rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain or performing a public (federal, state or local) transaction or contract under a public transaction; violation of federal or state antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification, or destruction of records, making false statements or receiving stolen property.

C. Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (federal, state or local) with commission of any of the offenses enumerated in paragraph (B) of this certification; and

D. Have not within a three-year period preceding this application/proposal had one or more public transaction (federal, state or local) terminated for cause or default.

E. Are not on the Comptroller General's List of Ineligible Bidders or any similar list maintained by any other governmental entity.

Where the proposer is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

(Check One)

I DO CERTIFY (_____) **I DO NOT CERTIFY (_____)**

Date: _____

Signature: _____

Title: _____

RESTRICTIONS ON LOBBYING CERTIFICATION

Pursuant to United States Public Law 101-121, Section 319, the undersigned duly authorized official of the proposer hereby certifies, to the best of her/his knowledge and belief, that:

1. No Federal appropriated funds have paid or will be paid, by or on behalf of the undersigned, to any person for the purpose of influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress, in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

2. If any funds other than Federal appropriated funds have been paid or will be paid to any person or agency for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress, in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit a Standard Form-LLL, "Disclosure Form to Report Lobbying", in accordance with its instructions.

3. The undersigned duly authorized official shall require and ensure that the language of this certification be included in any award documents for subcontracts, grants, loans, and cooperative agreements, and that all subcontractors shall so certify and disclose accordingly.

This Certification is a material representation of fact, upon which reliance was placed when this transaction was made or entered into. The submission of this Certification is a prerequisite for making or entering into this transaction, imposed by Title 31 USC Section 1352. Any proposer (person) who fails to file the required certification shall be subject to civil penalty of not less than ten thousand dollars ($10,000) and not more than one hundred thousand dollars ($100,000) for each such failure to file.

Proposer: _____

Signature: _____

Title: _____

Date: _____

NON-COLLUSION AFFIDAVIT

The undersigned duly authorized official of the proposer hereby certifies, to the best of her/his knowledge and belief, that:

1. That I am an officer or employee of the _____(proposing entity) having the authority to sign on behalf of the corporation, and,

2. That the prices in the attached proposal were arrived at independently by _____ _____(proposing entity) without collusion, consultation, communication, or any agreement, for the purpose of restricting competition as to any matter relating to such prices with any other proposer or with any other competitor regarding an understanding, or planned common course of action with any other vendor of materials, supplies, equipment, or service described in the RFP/IFB designed to limit independent proposals or competition; and

3. That unless otherwise required by law, the contents and prices contained in the proposal have not been communicated by _____ (proposing entity) or its employees or agents to any person not an employee or agent of _____(proposing entity), or its surety on any bond furnished with the proposal, and will not be communicated to any such person prior to the official opening of the proposal; and,

4. That I have fully informed myself regarding the accuracy of the statements made in this affidavit.

Proposer: _____

Signature:_____

Title:_____

Date:_____

EQUAL EMPLOYMENT STATUS REPORT

Contractor's Name

_____

Street Address

_____

City _____State _____ Zip _____

This firm is:

_____Independently owned and operated

_____ An Affiliate Parent Company

_____

or

_____ A Subsidiary of Address

_____

or

_____ A Division City and State

_____

Zip _____

1. Contractor ____ HAS ____ HAS NOT

Developed and has on file an affirmative action program in conformance with 41 CFR 60-2.

2. Contractor ____ HAS ____ HAS NOT

Participated in any previous contract or subcontract subject to the equal opportunity clause either with the City or any Federal agency.

3. Contractor ____ HAS ____ HAS NOT

Filed with the City, or where applicable, joint Reporting Committee, or other Federal Agency, all reports due under the applicable contract(s) or subcontract(s).

Contractor's Equal Employment Opportunity Program ____ HAS ____ HAS NOT been subject to a Federal Equal Opportunity Compliance Review. If so, then state date of Review below.

_____

Signature _____ Date _____

Title _____