Section 960

GUIDELINES FOR SUPERPAVE VOLUMETRIC MIX DESIGN AND VERIFICATION

960.01 Scope

This procedure provides guidelines to determine a Superpave Volumetric Mix Design for Hot/Warm-Mix Asphalt (HMA) for incorporation into Department projects. The Contractor will perform and submit the mix design according to specification; the Department will verify the mix design.

REFERENCES:

AASHTO STANDARDS:

- M 323 Superpave Volumetric Mix Design
- R 30 Standard Practice for Mixture Conditioning of Hot-Mix Asphalt (HMA)
- R 35 Standard Practice for Superpave Volumetric Design for Hot Mix Asphalt (HMA)
- T 30 Mechanical Analysis of Extracted Aggregate
- T 84 Specific Gravity and Absorption of Fine Aggregate
- T 85 Specific Gravity and Absorption of Coarse Aggregate
- T 166 Bulk Specific Gravity of Compacted Hot-Mix Asphalt Mixtures Using Saturated-Surface Dry Specimens
- T 209 Theoretical Maximum Specific Gravity and Density of Hot-Mix Paving Mixtures
- T 308 Determining the Asphalt Binder Content of Hot-Mix Asphalt (HMA) by the Ignition Method
- T 312 Standard Method for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
- T 319 Quantitative Extraction and Recovery of Asphalt Binder from Asphalt Mixtures
- T 324 Hamburg Wheel-Track Testing of Compacted Hot Mix Asphalt (HMA)

UDOT MATERIALS MANUAL OF INSTRUCTION (MOI) PART 8

UDOT MINIMUM SAMPLING AND TESTING REQUIREMENTS

UDOT STANDARD SPECIFICATIONS

UDOT PROJECT SPECIAL PROVISIONS

960.02 Significance and Use

The objective of HMA mix design is to determine the combination of asphalt binder and aggregates that will give long lasting performance as part of the pavement structure. Mix design involves laboratory procedures developed to establish the necessary proportion of materials for use in HMA. Well-designed asphalt mixtures can be expected to serve successfully for many years.

The mix design of HMA is just the starting point to assure that an asphalt concrete pavement will perform as required. Together with proper construction practice, mix design is an important step in achieving well-performing asphalt pavements. In many cases, the cause of poor performing pavements has been attributed to poor or inappropriate mix design or to the production of a mixture other than what was designed in the laboratory. To that end, it is critical that the materials and proportions used in the design are representative of the materials and proportions that will be used in the pavement structure.

The purpose of the Mix Design Verification Process is to provide an independent review of the Contractor's mix design. The verification process may consist of any, or all of the following:

- A review of the Contractor's design submittal documentation

- A review of the project history of a previously used HMA design
- A duplication of the Contractor's laboratory effort to verify individual mix components and/or total mix properties

960.03 Superpave Volumetric Mix Design Guidelines

The mix design shall comply with *AASHTO M 323: Standard Specification for Superpave Volumetric Mix Design* with the following modifications:

Asphalt binder, aggregate and mix properties are defined by project specification, including, but not limited to:

- Dust-to-binder ratio
- VMA
- VFA
- Design air void content (V_a) (% compaction @ N_{des})
- PG asphalt binder grade
- RAP asphalt binder recovered by AASHTO T 319
- Hamburg Wheel-Track Testing (HWTT) (MOI 8-990) - (replaces Tensile Strength Ratio (Lottman))
- Flakiness Index (MOI 8-933)-(replaces Flat and Elongated Particles)

The laboratory performing the mix design will be qualified in HMA by the Laboratory Qualification Program. Personnel must be qualified in Transportation Technician Qualification Program (TTQP) Asphalt (AsTT) and Superpave Mix Design (SMDTT)

The compactor will be approved as per MOI 8-961: Guidelines for Superpave Gyratory Compactor Protocol.

The HWTT lab will be approved by the Department, will be qualified by the Laboratory Qualification Program and will participate in all Department proficiency testing and inspections. AASHTO re:source accreditation in T-324 Hamburg Wheel-Track Testing of Hot Mix Asphalt (HMA) along with proficiency demonstration will be sufficient to obtain Department approval. Other means to approval will be considered on a case by case basis.

960.04 Standard Practice for Superpave Volumetric Mix Design

Mix Designs will be performed in accordance with *AASHTO R 35: Standard Practice for Superpave Volumetric Design for Hot-Mix Asphalt* with the following modifications:

- Target air void content (V_a) is by project specification.

The mix design will be performed using materials intended for use on the project. Materials used in the mix design will meet the following criteria:

- **Asphalt binder** shall be obtained from a certified supplier meeting the requirements outlined in the UDOT *Quality Management Plan 509: Asphalt Binder Management System*. For mix design verifications, the Region Labs will obtain pre-qualified binder from the UDOT Binder Lab.
- **Chemical Warm Mix Asphalt** - These chemical admixtures tend to reduce the viscosity of the binder and reduce the film thickness and corresponding mix design asphalt content slightly. Mix designs are verified without the warm mix additive to meet the project requirements. The Hamburg Test is run on the final material with the warm mix additive.
- **Hydrated lime** shall be obtained from a certified supplier meeting the requirements outlined in *Quality Management Plan 510: Hydrated Lime Management System.* The hydrated lime will be accompanied by test results or will be pre-tested by the Central Materials Laboratory prior to use in the mix design verification

Requirements when using recycled asphalt pavement (RAP):

- Percentage of RAP/RAP Binder in the mix design will be expressed as a percentage of the final mix.
- For mix designs that incorporate more that 15 percent RAP, a test report will be provided for each stockpile of RAP that includes: gradation, aggregate properties, asphalt binder content and PG grade of extracted asphalt binder (AASHTO M 323).
- The final aggregate gradation is determined after the RAP and hydrated lime are added. (AASHTO T 30)

The HMA is mixed according to MOI 8-988. Mixed material will be short term aged for "Volumetric Mix Designs" as per AASHTO R 30.

After the mix design parameters are determined, prepare and compact four sets of two gyratory specimens. Compact three sets to N_{des} to verify the target air voids, as defined by UDOT Standard Specification 02741, $\pm$0.5% at optimum asphalt binder content. Compact one set to N_{max} to verify required relative density. AASHTO T 312

The laboratory performing the mix design or its subcontractor will perform Hamburg Wheel Track Testing of Compacted Bituminous Mixtures (MOI 8-990). Submit the complete test record in Standard Department format to the UDOT **.** Graph each wheel data showing the maximum rut depth and report the maximum impression for each wheel or test run. UDOT may verify the results by performing an additional test to be run on slabs or pucks at its discretion. Refer to 960.05 for material submittal.

960.05 Mix Design Verification Process

General:

The Department performs mix design verification; the verification process outlined in this document is intended to be complete. However, verification could include any or all tests identified in AASHTO M 323, project specifications, project special provisions, the current MOI, the current *Minimum Sampling and Testing Requirements* or other aggregate quality, volumetric, or mix performance tests that may be added in the future. All materials submitted for use in the verification process are required to be representative of those used in the mix design.

The Contractor will submit the volumetric mix design data and materials samples for verification at least 10 working days before beginning paving. Paving will not begin until verification is complete. "Working days" refer to Monday through Friday, excluding state holidays, and begin when all the following are submitted to the Region Laboratory:

- Mix Design Report
- *All* aggregate quality test results
- *All* pre-blended aggregate samples
- *A sufficient quantity* of the hydrat*ed lime*
- *A sufficient quantity* of the RAP used during the mix design process
- Test Report for RAP
- Test Report for hydrated lime
- Asphalt binder to Central Materials Lab
- Hamburg Wheel Tracker Test results

"Working days" end when the Region Materials Engineer (RME) provides a **Mix Design Review Report** to the Resident Engineer.

960.05.01 Contractor Submittals

Mix Design Report - The Contractor will submit the Mix Design Report to the RME. The Contractor will submit a Mix Design Report Summary and Transmittal Letter to the Resident Engineer (RE). The submittals should follow the outline and example in Appendix "A."

A verified mix design may be submitted for use on a project other than the project originally identified. The Contractor will submit the Verified Mix Design Report to the RME and a Mix Design Report Summary and Transmittal Letter to the RE for the new project. **Both reports must include documentation regarding field changes made after original verification.**

Pre-Blended Samples - The Contractor will prepare samples for use in the verification process. The pre-blended samples, RAP, and hydrated lime are submitted to the RME. The Contractor will provide additional samples upon request.

Note: Asphalt binder for mix design verification will be supplied to the Region Materials Lab from Central Materials Lab.

A pre-blended sample is a blend of the final aggregate structure, without RAP, hydrated lime, and asphalt binder. Pre-blended samples are made at the required sample size by recombining the aggregate portion that has been sieved into individual sieve size fractions. Larger samples split to sample size are not acceptable.

The final gradation of the mix includes the RAP and hydrated lime, as per specification. Mix design verification may include a sieve analysis of the virgin materials and/or of the post-ignition final gradation.

The following tolerances from target gradation for each sieve will be allowed:

1/2 inch	2%
3/8 inch	2%
No. 4	2%
No. 8	1%
No. 16	1%
No. 30	1%
No. 50	1%
No. 100	1%
No. 200	0.8%

Initial pre-blended samples to be submitted:

11 Samples – Gyratory Compaction – AASHTO T 312

5 Samples – G_{mm} Determination – AASHTO T 209

2 Samples – Hamburg Wheel Track Testing – MOI 8-990

- Prepared as above (not mixed)
- Sufficient material for two 12”x12”x1.5” slabs

Samples to be submitted after the mix is verified:

4 Asphalt Binder Correction Samples per ignition oven, **AASHTO T 308**
Samples are submitted at mix design binder content and gradation: blend the final aggregate structure with hydrated lime, RAP, and asphalt binder according to MOI 8-988 prior to submitting. Follow Method A of T 308; in general do not use Note 6. The printed ticket from the oven should be used. However, it is recommended to check Method A with Method B often enough to make sure the oven is calibrated and working properly.

960.05.02 Verification Process

The Region materials laboratory will obtain appropriate asphalt binder for mix design verification from the Central Materials Laboratory. For tests performed on the HMA, the submitted material will be mixed according to MOI 8-988 and aged for “Volumetric Mix Designs” according to AASHTO R 30.

The following tests will be performed on submitted material during the verification procedure.

To verify the mix design volumetric properties, verify the volumetric properties at N_{des} determined by the Region material laboratory and the Contractor determined properties are within the "Precision and Bias" statement of the AASHTO procedure for acceptable multi-laboratory precision. See Appendix D.

G_{mb} – determined on 3 sets of 2 gyratory specimens compacted to N_{des} – AASHTO T 312 and T 166

%G_{mm} at N_{max} – determined on 1 set of 2 gyratory specimens compacted to N_{max} – AASHTO T 312 and T 166

G_{mm} – AASHTO T 209

Hamburg Wheel Track Testing – MOI 8-990

Final mix gradation – AASHTO T 30

- The gradation will be evaluated for compliance with the specifications.
- The stockpile gradations and blending percentages must be submitted and may be verified by the Region and compared to the submitted data.

The following tests may be performed on submitted material during the verification procedure.

G_{sb} – fine and coarse aggregate specific gravities – AASHTO T 84 and T 85

The following information may be evaluated on the submitted Mix Design:

Volumetric Calculations

Air Voids

Asphalt Binder Grade

Gyratory Compaction Effort (N_{values})

VMA

VFA

Aggregate Quality Tests

Hydrated Lime

Any or all of the quality verification tests may be revisited during production. If any of the aggregate quality tests do not meet the specified criteria, production shall be halted and the issue addressed.

960.05.03 Mix Design Performance Testing

Hamburg Wheel Track Testing of Compacted Bituminous Mixtures MOI 8-990 is a mix design requirement performed by the Mix Design Laboratory or its approved subcontractor. The Region Materials Laboratory may perform this test to verify the submitted results after a mix has been verified. The Region Lab will follow the procedure in MOI 8-990 for Slabs or Pucks at its discretion. The Region Lab will obtain appropriate asphalt binder from the Central Materials Laboratory.

960.05.04 Mix Design Re-Verification

The RME may choose to approve a previously verified mix design through a review of documentation of the original verification process. The documentation must include results of Hamburg testing. The RME may also require project performance data from use on previous projects.

- **The RME may elect to require re-verification of Hamburg Wheel Tracker performance.**

The RME will re-evaluate any mix design(s) at any indication of significant changes to the total mix properties and/or any individual component. A complete re-evaluation of HMA mix designs will occur at a minimum of every two years.

960.05.05 Field Mix Design Verification

The RME may allow a field verification option of the mix design. The Region or Satellite Lab performs the tests for field verification on material placed on an independent test strip outside of the project limits. The verification laboratory is required to perform an ignition oven calibration prior to field mix design verification in order to determine an accurate field asphalt binder content for volumetric calculations. Warm Mix designs using Asphalt Foaming will follow this procedure.

To verify the mix design, determine that the volumetric properties at N_{des} meet project specifications. The following tests are performed on samples obtained in accordance with MOI 8-984, and reduced in accordance with MOI 8-985.

G_{mb} – determined on a minimum of 3 sets of 2 gyratory specimens compacted to N_{des} – AASHTO T 312 and T 166

$\%G_{mm}$ at N_{max} – determined on a minimum of 1 set of 2 gyratory specimens compacted to N_{max} – AASHTO T 312 and T 166

G_{mm} – AASHTO T 209

% Asphalt Binder Content – AASHTO T 308 Follow Method A of T 308; in general do not use Note 6. The printed ticket from the oven should be used. However, it is recommended to check Method A with Method B often enough to make sure the oven is calibrated and working properly.

Gradation of residual aggregate – AASHTO T 30 – performed on the remaining T-308 sample

Hamburg Wheel Track Testing of Compacted Bituminous Mixtures –
MOI 8-990

Should the test results not meet specification the supplier may make adjustments and the process repeated. The mix design is “Not Verified” if test results fail to meet specification after the second attempt.

960.06 Mix Design Review Report

After the verification process is complete, the RME will place a written summary report in the materials database as notification of the results. The Mix Design Review Report will indicate whether the mix design has been:

- **Verified as Submitted**
- **Verified with Conditions**
- **Not Verified**

Results of **“Verified with Conditions”** and **“Not Verified”** will include an explanation of conditions and/or deficiencies.

The Mix Design Review Report will also contain a summary of the region laboratory test results and necessary construction information. The materials database contains the necessary report form.

APPENDIX "A"
INFORMATION OUTLINE FOR CONSULTANT / CONTRACTOR
MIX DESIGN REPORT

First Two/Three Pages of Design Submitted Shall Include the Following Mix Design Information:

X Date:
X Laboratory Name:
    Accreditation / Credentials (AASHTO RE:SOURCE/UDOT approved)
X Laboratory Technicians :
    Credentials (UDOT certified)
X UDOT Project Name & Number:
X Nominal Gradation Size:
X Number of Gyrations:
    N_{ini}, N_{des}, N_{max}
    Corresponding ESAL Loading Range
X Gyratory Compactor:
    Brand / Model
X Asphalt Binder:
    PG Grade
    Asphalt binder Source
    Asphalt binder Specific Gravity
X Warm Mix if used:
    Type:
        Asphalt Foaming
        Asphalt Modifying agent
        Other
X Recycled Asphalt Pavement (RAP) if used:
    Gradation
    PG Grade
    % Asphalt Binder Content
    % Virgin Asphalt Binder used to achieve final asphalt binder content
    % RAP used in mix
X Measured Physical Properties
    Design Mixing Temperature
    Design Compaction Temperature
    % Asphalt Binder Content @ N_{des}
    % Absorbed Asphalt Binder @ N_{des}
    % Effective Asphalt Binder @ N_{des}
    % VMA @ N_{des} (Percent by Weight of Total Mix)
    % VFA @ N_{des}
    % Compaction @ N_{ini}
    % Compaction @ N_{des}
    % Compaction @ N_{max}
    Dust to Asphalt Binder Ratio @ N_{des}
    Maximum Specific Gravity @ N_{des}
    % Hydrated lime Required
    Bulk Specific Gravity G_{sb}
    Maximum Specific Gravity G_{mm}
    Target Gradation
X Proof Testing
    Hamburg Wheel Tracker
        Data output in Department standard format
        Plot of maximum rut depth data set for each wheel or single wheel test
        Report of maximum rut depth
X Aggregate
    One Fracture Face Count

Two Fracture Face Count
Fine Aggregate Angularity
Flakiness
L.A. Wear
Sand Equivalency (Pre-wet Method)
Natural Fines %

X Additional Aggregate Source Information
Sodium Soundness
Unit Weight
Clay Lumps & Friable Particles
Plasticity Index

X Gradation
Stockpile Percentages
Stockpile Specific Gravities & Absorptions
Hydrated lime Specific Gravity & Percentage & Supplier
Target Gradation
Plotted Gradation (0.45 power curve, control points, caution zone)

X Gyratory Design
Calibrated Gyratory Angle
Calibrated Gyratory Pressure
Specimen Heights

Reported Elsewhere in the Submittal:

X Trial Blend
Plotted on 0.45 Power Curve (Control Points, Caution Zone)
Stockpile Percentages
Stockpile Bulk Specific Gravities
Target Gradations
%AC, $\%G_{mm}$ @ N_{ini}, $\%G_{mm}$ @ N_{des}, $\%G_{mm}$ @ N_{max} (Sum.Table)
%AC, % Air Voids, %VMA, %VFA, Dust/Asphalt Binder , $\%G_{mm}$ @ N_{ini}, $\%G_{mm}$ @ N_{des}, $\%G_{mm}$ @ N_{max} (Summary Table @ N_{des})
Trial Blends
AC Percentage
Compaction Results
N_{ini} - N_{des} - N_{max}
Maximum Specific Gravity G_{mm}
Gyratory Equipment Printouts for all Blends
Specimen Heights
Pressure Applied
Gyration Tables for Each Design AC Content
Number of Gyrations
Specimen Height
Estimated Bulk Density
Corrected Bulk Density
% of Maximum Specific Gravity

Appendix B to MOI 960
Equations

Calculate the amount of Lime

$$Grams\ of\ Lime\ = (Dry\ Weight\ of\ Virgin\ Aggregate)\left(\frac{Percent\ of\ Lime}{100}\right)$$

Calculation of RAP Binder

$$Total\ RAP\ Binder = (Percent\ Binder\ in\ RAP)\left(\frac{Percent\ of\ RAP}{100}\right)$$

Calculation of Total Virgin Binder

$$Total\ Virgin\ Binder = (Target\ Binder - RAP\ Binder)$$

Divisor for Calculating Total Sample Weight

$$Divisor = \left(\frac{100 - Virgin\ Binder}{100}\right)$$

$$Total\ Sample\ Weight = \left(\frac{Aggregate\ With\ Lime\ \&\ RAP}{Divisor}\right)$$

Example

Target AC = 5.0%
% RAP = 20%
% Binder in RAP = 4.5%
% Lime = 1%
Dry Weight of Virgin Aggregate = 1503.0g
Grams of RAP = 400.0g

$$Grams\ of\ Lime\ = (1503.0g)\left(\frac{1}{100}\right) = 15.0\text{g}$$

or Total Agg W/ Lime = 1518.0g

$$Total\ RAP\ Binder = (4.5\%)\left(\frac{20\%}{100}\right) = 0.900\%$$

$$Total\ Virgin\ Binder = (5.0\% - 0.900\%) = 4.10\%$$

$$Divisor = \left(\frac{100-4.10\%}{100}\right) = 0.9590$$

$$Total\ Sample\ Weight = \left(\frac{(1518.0+400.0)}{0.9590}\right) = 2000.0\text{g}$$

Appendix C to MOI 960
SMA Equations

The dry weight of virgin aggregate may or may not include the mineral filler. If the mineral filler does not go through the Pugmill, it is then not considered part of the dry weight of virgin aggregate.

Calculate the amount of Lime

$$Grams\ of\ Lime\ = (Dry\ Weight\ of\ Virgin\ Aggregate)\left(\frac{Percent\ of\ Lime}{100}\right)$$

Calculation of Mineral Filler

$$Total\ Mineral\ Filler = (Percent\ Mineral\ Filler)(Dry\ Weight\ of\ Virgin\ Agg\ With\ Lime)$$

Calculation of Fiber – (Fiber is based off of total mix. An estimated total mix can be calculated or the contractor can supply this value. i.e. 2000g for Rice, 4800 g Gyratories, etc.)

$$Binder\ Divisor = \left(\frac{100 - Virgin\ Binder}{100}\right)$$

$$Estimated\ Total\ Sample\ Weight = \left(\frac{Aggregate\ With\ Lime, Mineral\ Filler}{Binder\ Divisor}\right)$$

$$Total\ weight\ of\ Fiber = \left(\frac{Estimated\ Total\ Sample\ Weight}{Fiber\ Divisor}\right)$$

Calculating Total Sample Weight

$$Actual\ Total\ Sample\ Weight = \left(\frac{Aggregate\ With\ Lime, Mineral\ Filler, \&\ Fiber}{Binder\ Divisor}\right)$$

Example

Target AC = 6.5%
% Mineral Filler (MF) = 6%
% Fiber = 0.5%
% Lime = 1%
Dry Weight of Virgin Aggregate = 1800.0g

$$Grams\ of\ Lime\ = (1800.0g)\left(\frac{1\%}{100}\right) = 18.0\text{g}$$

or Total Agg W/ Lime = 1818.0g

$$Total\ Mineral\ Filler = (1818.0g)\left(\frac{6\%}{100}\right) = 109.1\text{g}$$

Or Total Aggregate, Lime, and MF = 1818.0 + 109.1 = 1927.1g

$$Divisor = \left(\frac{100-6.5\%}{100}\right) = 0.935$$

$$Total\ Estimated\ Sample\ Weight = \left(\frac{1927.1}{0.935}\right) = 2061.1\text{g}$$

$$Total\ Fiber = (2061.1)\left(\frac{0.5\%}{100}\right) = 10.3\text{g}$$

$$Actual\ Total\ Sample\ Weight = \left(\frac{(1927.1+10.3)}{0.935}\right) = 2072.1\text{g}$$

Appendix D to MOI 960
Mix Design Precision Limits Gmb and Gmm

# of Samples	Multiplier of Standard Deviation or Coefficient of Variation per ASTM C670 15, Table 1	Multiplier of Standard Deviation or Coefficient of Variation (Rounded)	Gmb T 166		Gmm T 209 (Rice)	
	Condition of Test		Single lab	Multi lab	Single lab	Multi lab
	Standard Deviation (s)		0.002	0.006	0.0051	0.0084
1						
2	2.771808	2.8	0.006	0.017	0.014	0.023
3	3.314493	3.3	0.007	0.020	0.017	0.028
4	3.633160	3.6	0.007	0.022	0.019	0.031
5	3.857656	3.9	0.008	0.023	0.020	0.032
6	4.030092	4.0	0.008	0.024	0.021	0.034
7	4.169554	4.2	0.008	0.025	0.021	0.035
8	4.286309	4.3	0.009	0.026	0.022	0.036
9	4.386509	4.4	0.009	0.026	0.022	0.037
10	4.474124	4.5	0.009	0.027	0.023	0.038
11	4.551864	4.6	0.009	0.027	0.023	0.038
12	4.621655	4.6	0.009	0.028	0.024	0.039
13	4.684920	4.7	0.009	0.028	0.024	0.039
14	4.742732	4.7	0.009	0.028	0.024	0.040
15	4.795924	4.8	0.010	0.029	0.024	0.040
16	4.845154	4.8	0.010	0.029	0.025	0.041
17	4.890951	4.9	0.010	0.029	0.025	0.041
18	4.933745	4.9	0.010	0.030	0.025	0.041
19	4.973892	5.0	0.010	0.030	0.025	0.042
20	5.011689	5.0	0.010	0.030	0.026	0.042
22	5.081193	5.1	0.010	0.030	0.026	0.043
24	5.143852	5.1	0.010	0.031	0.026	0.043
26	5.200850	5.2	0.010	0.031	0.027	0.044
28	5.253094	5.3	0.011	0.032	0.027	0.044
30	5.301290	5.3	0.011	0.032	0.027	0.045
32	5.346000	5.3	0.011	0.032	0.027	0.045
34	5.387678	5.4	0.011	0.032	0.027	0.045
36	5.426697	5.4	0.011	0.033	0.028	0.046
38	5.463363	5.5	0.011	0.033	0.028	0.046
40	5.497935	5.5	0.011	0.033	0.028	0.046
50	5.646026	5.6	0.011	0.034	0.029	0.047
60	5.764388	5.8	0.012	0.035	0.029	0.048
70	5.862730	5.9	0.012	0.035	0.030	0.049
80	5.946701	5.9	0.012	0.036	0.030	0.050
90	6.019871	6.0	0.012	0.036	0.031	0.051
100	6.084638	6.1	0.012	0.037	0.031	0.051