



ARKANSAS STATE CRIME LABORATORY FORENSIC DNA SECTION QUALITY MANUAL

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1 SCOPE

This document consists of definitions, policies and procedures intended to satisfy the quality assurance measures and specific requirements placed on the Forensic DNA Section of the Arkansas State Crime Laboratory (Forensic DNA) by the Arkansas State Crime Laboratory Quality Manual, the FBI Director's Quality Assurance Standards, and the ANSI-ASQ National Accreditation Board (ANAB), which is based on the ISO/IEC 17025:2017 standards and the 2017 ANAB ISO/IEC 17025:2017 —Forensic Science Testing and Calibration Laboratories Accreditation Requirements (AR 3125).

Forensic DNA Testing is to be understood to begin at sample extraction or direct amplification; therefore, at a minimum all actions taken by ASCL personnel concerning DNA Testing will be subject to the guidelines contained in this Forensic DNA Section Quality Manual (or the CODIS Section Quality Manual, as appropriate) until the completion of DNA testing activities and the documented transfer of associated evidence. Elements of the quality assurance program outlined in this manual may apply to steps which extend beyond the initiation or conclusion of DNA testing activities. Unless specifically noted, all DNA Casework activities will also be subject to the policies of the Arkansas State Crime Laboratory Quality Manual.

2 DEFINITIONS AND REFERENCES

It is the intention of the Forensic DNA Section to follow the standard definitions included in normative references listed as well as those found in the ASCL *QM*. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. Each document's location is referenced in brackets.

- A) ISO/IEC Guide 99, International vocabulary of metrology —Basic and general concepts and associated terms (VIM)[Qualtrax]
- B) ISO/IEC 17000, Conformity assessment —Vocabulary and general principles
- C) ISO/IEC 17025:2017, General requirements for the competence of testing and calibration laboratories
- D) ANAB ISO/IEC 17025:2017 –Forensic Science Testing and Calibration Laboratories Accreditation Requirements (AR 3125)
- E) Arkansas Code Annotated (A. C. A.) §§ 12-12-301 through 12-12-313 [Qualtrax]
- F) Quality Assurance Standards for Forensic DNA Testing Laboratories, 2020 [Qualtrax]
- G) Quality Assurance Standards for Forensic DNA Databasing Laboratories, 2020 [Qualtrax]

Additional common acronyms used in this manual are listed

Arkansas State Crime Laboratory (ASCL)

Arkansas State Crime Laboratory Quality Manual (ASCL QM)

Forensic DNA Section Quality Manual (DNA QM)

FBI Director's Quality Assurance Standards (QAS)

ANSI-ASQ National Accreditation Board (ANAB)

Quality Assurance Program (QA)

Quality Assurance Concern Workflow (QAC)

DNA Technical Leader (DNA TL)

JusticeTrax LIMS-plus (JTx)

Qualtrax Compliance Management System (QTx)

ForensicBiology Shared Drive (FB Drive)[\\Davinci\Sections\ForensicBiology]

3 QUALITY ASSURANCE PROGRAM

3.1 QUALITY MANUAL

The Forensic DNA QM has been approved by the DNA Casework Supervisor, CODIS Administrator, DNA Technical Leader, Laboratory Quality Assurance Manager, Assistant Director, and Director and is accepted as routine operating policy of the Forensic DNA Section within the *ASCL*.

- A) The FBI QAS serves as the basis for the ASCL Forensic DNA QA program with supplementary guidance from the ASCL-QM.
- B) This QM is one component of the Forensic DNA QA program; any elements not contained within this manual can be found in the QUALTRAX controlled document database.
- C) Any supplements and revisions to the FBI QAS guidelines will be reviewed for possible incorporation into the QA program.
- D) To discuss other possible revisions, meetings between the Casework Supervisor and the DNA Analysts will be held as needed.
- E) Any changes to this QA manual shall be approved by the same individuals as stated above, with affected manual pages and files updated. All Forensic DNA employees shall be notified of the changes and shall be given any necessary training.
- F) Previous versions of revised documents are maintained in a separate Historical Manual Archive.
- G) All Documents referenced within this manual shall be available or accessible on-site.

3.2 DOCUMENT RETENTION

The Forensic DNA section shall retain the following documents and records of processes in accordance with ASCL QM policies. These documents and records are maintained in a variety of secure methods, including JusticeTrax, Qualtrax, and the secure FB drive.

- 1. proficiency tests and proficiency test plans [all]
- 2. deviation requests and non-conformances [JTx and FB drive]
- 3. QA Concerns, Preventative Action, and Corrective Actions [QTx]
- 4. Audit Documents, ASCL Audit Responses, and NDIS Custodian Acceptance Letters [FB drive]
- 5. training records [all]
- 6. continuing education [QTx and FB drive]
- 7. case files [JTx and FB drive]
- 8. court testimony monitoring [QTx]
- 9. QA documentation [QTx and FB drive]

3.3 ANNUAL REVIEW OF THE QUALITY SYSTEM

The Forensic DNA section shall annually review the quality system under the direction of the DNA TL. This review shall be independent of any audit review with the purpose of ensuring that the quality system remains in compliance with applicable standards and guidelines. The quality system review shall be documented and approved in a Qualtrax workflow by the DNA TL.

3.4 ANNUAL REVIEW OF CASEWORK

The Forensic DNA section shall evaluate casework to ensure quality of product and adherence to the Forensic DNA QM SOP. This review will be based on a semi-random selection by the DNA TL of at least one casefile each month. The DNA TL shall endeavor to select cases from each analyst throughout each year, with preference given to more complex analyses and reports. This review will be documented separately from any technical review on the DNA QA Casework Review Form (DNA-FORM-44). Reviewers will be restricted to the DNA Supervisors, DNA TL, and DNA Quality Manager and may not be the author or analyst of record of the casefile in review. The DNA TL shall approve the results of the review and shall be consulted in determining any Nonconformance or Corrective Actions.

3.5 GOALS AND OBJECTIVES

IT IS THE MISSION OF THE FORENSIC DNA SECTION TO ANALYZE BIOLOGICAL EVIDENCE UTILIZING PCR TECHNOLOGY IN ORDER TO OBTAIN DNA PROFILES FOR COPMARISON TO KNOWN REFERENCE SAMPLES. THIS INFORMATION IS USED TO INCLUDE OR EXCLUDE INDIVIDUALS AS A CONTRIBUTORY SOURCE OF DNA FROM EVIDENTIARY ITEMS. ALL ELIGIBLE SAMPLES WILL BE ENTERED INTO THE CODIS DATABASE..

Goals: It is the goal of the ASCL DNA section to:

- a) Provide the users of laboratory services access to Forensic DNA analysis including DNA typing of selected biological materials associated with official investigations.
- b) Ensure the quality, integrity and accuracy of the DNA typing data and its presentation through the implementation of a detailed Quality Assurance/Quality Control program.
- c) Provide the criminal justice system with a functional DNA database (CODIS) to help law enforcement agencies solve criminal cases.

Objectives: It is the objective of the Quality Assurance program to:

- a) Monitor on a routine basis the analytical testing procedure for DNA typing by means of Quality Control (QC) standards, proficiency test and audits.

- b) Verify that the entire DNA typing procedure is operating within the established performance criteria, as stated in the Analytical section of the *DNA QM* and that the quality and validity of the analytical data are maintained.
- c) Ensure that problems are noted and that corrective action is taken and documented.
- d) Ensure the overall quality as outlined in the QAS and SWGDAM Guidelines.

4 ORGANIZATION & MANAGEMENT

4.1 MANAGEMENT

Under the guidance of the ASCL Administration, the operations of the Forensic DNA section are directly managed by the DNA Technical Leader, the DNA Supervisor, and the CODIS Administrator with the assistance of the section Quality Manager, Training Managers, and Safety officer.

4.1.1 ASCL ADMINISTRATION

The organization and authorizations of the ASCL Administrative positions can be located in the ASCL QM.

The ASCL Administration is responsible for ensuring facilities, funding, and policies for the efficient and quality standards-compliant operations of the Forensic DNA laboratory operations. The ASCL Administration is also responsible for providing the opportunity to comply with the requirement to stay abreast of developments within the field of DNA typing by making available current scientific or DNA applicable literature, and enabling attendance of seminars, courses or professional meetings through travel budget, membership dues and education expense reimbursement.

4.1.2 TECHNICAL LEADER

The DNA Technical Leader serves as Technical Leader of both the Forensic DNA and Databasing (CODIS) sections. The DNA Technical Leader is accountable for technical operations and quality assurance. The DNA Technical leader is a fully-qualified analyst and maintains proficiency in both Casework and Database DNA procedures.

4.1.3 CASEWORK CODIS ADMINISTRATOR

The Database section CODIS Administrator also serves as the Casework CODIS Administrator of the Forensic DNA section. The CODIS Administrator is accountable for all CODIS operations as well as serving as the personnel manager for the Database Section and the DNA Technical Leader. The CODIS Administrator is a fully-qualified analyst and maintains proficiency in both Casework and Database DNA procedures.

4.1.4 CASEWORK PERSONNEL

The DNA Supervisor serves as the personnel manager for the Forensic DNA section. At no time is there fewer than two full-time, qualified DNA Analysts employed by the ASCL.

4.1.5 ORGANIZATION

The organization and personnel authorizations of the Forensic DNA section are located in Qualtrax. The organizational chart can be found in Qualtrax as the *DNA Organizational Chart* (ASCL-DOC-70-DNA). Individual authorizations are documented in the Personnel tab of Qualtrax.

4.1.6 CONTINGENCIES

In the event the technical leader position is vacated, the following contingency plan will be submitted to the FBI within 14 days for approval. Any work that is in progress may be completed during the 14 day period, but new casework shall not be started until the plan is approved by the FBI.

With the approval from the Director or his /her designee, the ASCL will conduct interviews within the laboratory among any qualified individuals to be appointed by the Director to temporarily fill the technical leader position. If there are no interested or qualified individuals the ASCL will contact the surrounding states to ask for the assistance of their technical leader until the technical leader position can be posted, interviewed and filled.

A newly appointed technical leader shall be responsible for the documented review of the validation studies currently used by the laboratory and educational and training records of currently qualified analysts.

In the event that the number of qualified Forensic DNA analysts falls below two full-time employees, the following contingency plan will be submitted to the FBI within 14 days for approval. The CODIS Administrator, the alternate CODIS administrator, and/or DNA Technical Leader shall singly or collectively assume Forensic DNA analyst responsibilities and provide laboratory and analytical assistance to any remaining analyst in excess of a full-time qualified Forensic DNA analyst and work may be continued.

With the approval from the Director or his /her designee, the ASCL will conduct interviews within the laboratory among any other qualified individuals to be appointed by the Director to fill the DNA analyst position. If there are no qualified individuals the ASCL will begin hiring new trainees. No DNA sample processing will begin within the ASCL until two fully-qualified DNA analysts are employed.

4.2 APPLICABLE STANDARDS

The Forensic DNA section shall utilize the date of hire or appointment to a DNA position for determining applicable versions of standards for education, experience, and training requirements. Advancements subsequent to the initial employment of a DNA Analyst (e.g. DNA Analyst I to DNA Analyst II, or DNA Analyst II to DNA Supervisor) will not reset the date except those requirements that apply to the appointment of the Technical Leader.

5 PERSONNEL

5.1 PERSONNEL QUALIFICATIONS AND JOB DESCRIPTIONS

The following establishes the job function, responsibility and qualifications for each position. This includes specification and description of lines of responsibility for developing, implementing, recording and updating the QA program. Job descriptions for personnel are established and located in each employee history binder. Each subordinate is accountable to one supervisor per function.

Records of qualifications, training, and experience will be maintained in training binders, as well as FB drive, JTx, and QTx as appropriate.

5.2 DNA TECHNICAL LEADER

5.2.1 EDUCATION

The DNA TL shall meet the following minimum educational requirements: a Master's degree in a biology-, chemistry- or forensic science- related area and have successfully completed 12 semester or equivalent credit hours from a combination of undergraduate and graduate coursework covering the following subject areas: biochemistry, genetics, molecular biology, and statistics or population genetics.

- 5.2.1.1 The 12 semester or equivalent credit hours shall include at least one graduate level course registering three (3) or more semester or equivalent credit hours.
 - 5.2.1.2 The specific subject areas listed above shall constitute an integral component of any course work used to demonstrate compliance with this standard.
 - 5.2.1.3 Individuals who have completed course work with titles other than those listed above shall demonstrate compliance with this standard through a combination of pertinent materials such as a transcript, syllabus, letter from the instructor, or other document that supports the course content.
 - 5.2.1.4 If the degree requirements listed above were waived by the American Society of Crime Laboratory Directors (ASCLD) in accordance with criteria approved by the director of the Federal Bureau of Investigation (FBI), such a documented waiver is permanent and portable.
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5.2.2 EXPERIENCE

Any DNA TL appointed prior to July 1, 2009, shall have three years of forensic DNA laboratory experience obtained at a laboratory where forensic DNA testing was conducted for the

identification and evaluation of biological evidence in criminal matters. Any DNA TL appointed on or after July 1, 2009, shall have a minimum of three years of human DNA (current or previous) experience as a qualified analyst on forensic samples.

5.2.3 NEW TL APPOINTMENTS

Any DNA TL appointed on or after July 1, 2020 shall be a currently or previously qualified analyst in each technology utilized in the laboratory, or have documented training in each technology utilized in the laboratory within one year of appointment.

Newly appointed technical leaders shall be responsible for the review of the following within one year of appointment:

- Validation studies and analytical procedures currently used by the laboratory; and
- Educational and training records of currently qualified analysts and technical reviewers.

5.2.4 AUDITOR TRAINING

The DNA TL shall have previously completed or will successfully complete the FBI's DNA auditor training course within one year of appointment.

5.2.5 RESPONSIBILITY

The TL is ultimately responsible for technical operations and the QA program of the DNA sections and thus the management of the DNA analysis program including technical troubleshooting, validation and systems management. Therefore the DNA TL shall have the following authority and responsibility as required by the FBI QAS:

- Oversee the technical operations of the DNA Laboratory.
- The TL has the authority to initiate, suspend, and resume the DNA analytical operations for the laboratory or an individual.
- Monitor, evaluate, and approve the development, validation, and implementation of the DNA QA program, new methods and new technologies.
- Review the academic transcripts and training records for newly qualified analysts and approve their qualifications prior to independent casework analysis and document such review.
- Approve the technical specifications for outsourcing agreements.
- Review internal and external DNA audit documents and, if applicable, approve corrective action(s), and document such review.
- Review, on an annual basis, the procedures of the laboratory and the quality system, then approve and document such review.
- Review and approve training, quality assurance, and proficiency testing programs in the laboratory.
- Review and approve contract employees for employed by multiple NDIS participating and/or vendor laboratories for potential conflict of interests.

Additional responsibilities of the DNA TL include:

- Review validation and methodologies currently used by the laboratory and educational qualifications and training records of currently qualified analysts.
- Ensure compliance with FBI QAS and ANAB requirements.
- Establish professional liaisons with colleagues engaged in DNA testing and research.
- Monitor training and the proficiency testing programs for DNA Casework Section personnel.
- Analyzing samples, providing expert testimony, and performing other routine duties of a Casework Analyst.
- Stay abreast of developments within the field of DNA typing by reading current scientific or DNA applicable literature, attending seminars, courses or professional meetings.
- Review casework to ensure quality of product and adherence to the Forensic DNA QM SOP as part of the Annual Casework Review [DNA QM 3.4]

5.2.6 ACCESSIBILITY

The technical leader shall be accessible to the laboratory to provide on-site, telephone, or electronic consultation as needed. Currently, the ASCL Forensic DNA testing is only available at the Main Laboratory location. In the event that additional locations are offered, the DNA TL shall conduct and document a site visit to each laboratory at least semi-annually.

5.2.7 AUTHORIZATIONS

See ASCL QM section 6.2.6 for categories of Authorizations.

- Can initiate, suspend, and resume DNA analytical operations for the laboratory or an individual.
- Reviews DNA quality manager's actions in implementing the quality assurance program for the Forensic DNA section.
- Oversees the technical operations of the Forensic DNA laboratory.
- Approves method development, modification, verification, and/or validation.

5.3 CODIS ADMINISTRATOR

The CODIS administrator is responsible for the administration of the laboratory's local CODIS network. The CODIS Administrator is also responsible for the technical operations and provisions of the resources needed to ensure the required quality of the laboratory operations. The CODIS Administrator has the responsibility and authority to receive and take action on CODIS employee concerns.

5.3.1 EDUCATION

The casework CODIS administrator shall meet the education requirements for an analyst as defined in DNA QM Section 5.5 (QAS Standard 5.4). A casework CODIS administrator appointed prior to July 1, 2020 shall be deemed to have satisfied the minimum educational requirements; satisfaction of

these minimum educational requirements shall be applicable to the specific laboratory by which the casework CODIS administrator is employed by prior July 1, 2020 and shall not be portable.

5.3.2 EXPERIENCE

A casework CODIS administrator shall be a current or previously qualified analyst as defined in DNA QM Section 5.5 (QAS Standard 5.4) with documented mixture interpretation training. A casework CODIS administrator appointed prior to July 1, 2009 who is not or has never been a qualified analyst (with documented training in mixture interpretation) shall be deemed to have satisfied the minimum experience requirements upon completion of FBI sponsored CODIS training; satisfaction of these minimum requirements shall be applicable to the specific laboratory the casework CODIS administrator is employed by prior to July 1, 2009 and shall not be portable.

5.3.3 CODIS TRAINING

The casework CODIS administrator shall successfully complete the FBI-sponsored training in CODIS software within six months of assuming CODIS casework administrator duties if the administrator had not previously completed such training. The casework CODIS administrator shall successfully complete the FBI's DNA auditor training course within one year of assuming his/her administrator duties if the administrator had not previously completed such training.

5.3.4 RESPONSIBILITY

The casework CODIS administrator shall have the following minimum responsibilities as required by the QAS:

- Administer the laboratory's local CODIS network.
- Schedule and document the CODIS computer training of casework analysts.
- Ensure that the security of data stored in CODIS is in accordance with state and/or federal law and NDIS operational procedures.
- Ensure that the quality of data stored in CODIS is in accordance with state and/or federal law and NDIS operational procedures.
- Ensure that matches are dispositioned in accordance with NDIS operational procedures.

Additional responsibilities of the casework CODIS Administrator include:

- Ensure compliance with FBI QAS and ANAB requirements.
- Maintain a list of all employees with access to the CODIS database.
- Stay abreast of developments within the field of DNA typing by reading current scientific or DNA applicable literature, attending seminars, courses or professional meetings.
- Notify the NDIS Custodian, within five business days, of the following:
 - 1) If a CODIS User, CODIS IT User or CODIS WAN User in its laboratory has been arrested for, or convicted or, a criminal offense;

- 2) If the laboratory loses its criminal justice agency status;
- 3) If the laboratory loses its accreditations, has its accreditation suspended or has its accreditation revoked;
- 4) if the laboratory loses the capability to perform DNA analysis at its facility;
- 5) If the laboratory has fewer than two full-time employees who are qualified DNA analyst;
- 6) If the laboratory has a vacancy in the laboratory's Technical Leader position when there is no one in the laboratory who meet the Quality Assurance Standards' qualifications and is available to serve in that positions; or
- 7) If the laboratory is not in compliance with the external QAS audit requirements.

5.3.5 PARTICIPATION IN CODIS

The casework CODIS administrator shall be authorized to terminate an analyst's or laboratory's participation in CODIS until the reliability and security of the computer data can be assured in the event an issue with the data is identified.

5.3.6 CONTINGENCY

In the event that the CODIS Administrator is unavailable such that they cannot administer the laboratory's CODIS network, the Alternate CODIS Administrator shall fulfill the role of Casework CODIS Administrator. In the event that the role of Casework CODIS Administrator is unoccupied, the ASCL shall not upload DNA profiles to NDIS.

5.4 DNA SUPERVISOR

The DNA Casework Supervisor is responsible for the daily operation, including the supervision and management of personnel and casework flow through the Forensic DNA Section. The DNA Casework Supervisor is also responsible for the technical operations and provisions of the resources needed to ensure the required quality of the laboratory operations. The DNA Casework Supervisor has the responsibility and authority to receive and take action on Casework employee concerns. If the Casework Supervisor is going to be absent for more than 2 days, a lab-wide email notification will be sent appointing another casework analyst for any managerial issues and/or emergencies

5.4.1 EDUCATION

The DNA Casework Supervisor shall meet the education requirements for an analyst as defined in DNA QM Section 5.5 (QAS Standard 5.4).

5.4.2 EXPERIENCE

A DNA Casework Supervisor shall be a current qualified analyst as defined in DNA QM Section 5.5 (QAS Standard 5.4) with documented mixture interpretation training. The DNA Casework

Supervisor of the laboratory is recommended to have a minimum of five (5) years of experience as a Forensic DNA analyst. The DNA Casework Supervisor is recommended to have successfully completed the FBI sponsored auditor training within one year of appointment.

5.4.3 RESPONSIBILITY

The Casework Supervisor is responsible for the daily operation of the Forensic DNA Section. The Casework Supervisor is also responsible for the technical operations and The Casework Supervisor has the responsibility and authority to receive and take action on Casework employee concerns. Specific responsibilities are as follows:

- Oversee day-to-day operation of the Forensic DNA Section, i.e., scheduling workload, supervising analysts, monitoring and reviewing results and case reports. These duties may be distributed among the DNA Analysts to facilitate case flow.
- Provide the resources needed to ensure the required quality of the laboratory operations.
- Monitor training, quality assurance, and proficiency testing programs in the laboratory.
- Review casework to ensure quality of product and adherence to the Forensic DNA QM SOP as part of the Annual Casework Review [DNA QM 3.4]
- Establishing professional liaisons with colleagues engaged in DNA testing and research.
- Conducting informational seminars for the principal users of the laboratory, i.e., judges, prosecutors, police administrators and investigators.
- Monitoring training programs for DNA unit personnel
- Enforcing safety procedures.
- Analyzing casework, providing expert testimony, and performing other routine duties of a DNA Analyst.
- Ensure compliance with FBI QAS and ANAB requirements.
- Stay abreast of developments within the field of DNA typing by reading current scientific or DNA applicable literature, attending seminars, courses or professional meetings.

5.4.4 CONTINGENCY

If the Casework Supervisor is going to be absent for more than 2 days, a lab-wide email notification will be sent appointing another casework analyst for any in-person managerial issues and/or emergencies.

5.4.5 AUTHORIZATIONS

See [ASCL QM](#) section 6 for categories of Authorizations

- Can reject materials or suspend testing in the same manner as the DNA Quality Manager, following the same unit notification and problem documentation specifications.
- Approves DNA quality manager's actions in implementing the quality assurance program for the DNA section.

5.5 FORENSIC DNA ANALYST

The Forensic DNA analyst is an employee or contract employee of the laboratory responsible for performing DNA analysis and specifically delegated QA responsibilities from the Casework Supervisor. The analyst shall meet the following qualifications:

5.5.1 EDUCATION

The analyst shall have at a minimum a bachelor's (or its equivalent) or an advanced degree in a biology-, chemistry-, or forensic science-related area and shall have successfully completed coursework (graduate or undergraduate level) covering the following subject areas: biochemistry, genetics, and molecular biology.

- Any analyst hired/appointed/promoted prior to July 1, 2020, shall have coursework and/or training in statistics and/or population genetics as it applies to forensic DNA analysis.
- Any analyst hired/appointed/promoted on or after July 1, 2020, shall have successfully completed coursework covering statistics and/or population genetics.

5.5.1.1 COURSEWORK

The specific subject areas listed in Section 5.5.1 shall be an integral component of any coursework for compliance with this standard. If coursework consists of the title listed (biochemistry, genetics, molecular biology, and statistics or population genetics), the coursework shall be considered to meet the integral component requirement. Coursework is generally assessed as the set number of credits on a transcript. Each course topic must be satisfied by a course in that subject or a course that is considered to meet the integral component requirement. Absent a course titled as listed, coursework used to fulfill the requirement should include the following components:

Biochemistry:

- Structure, function, and interaction of biological macromolecules such as proteins, carbohydrates, lipids and nucleic acids
- Enzymes and chemistry of enzyme-catalyzed reactions
- DNA, RNA, and protein synthesis
- Signal transduction
- Metabolism
- Cell membrane transport

Genetics:

- Laws and patterns of inheritance
- Basic structure and function of genes and chromosomes
- Mutation
- Mitosis/Meiosis

- Recombination
- Gene expression

Molecular Biology:

- Prokaryotic and eukaryotic genome structure and function
- Interrelationship of DNA, RNA, and protein synthesis
- Transcription, translation, replication
- Gene expression and regulation
- Recombinant DNA techniques
- PCR
- DNA sequencing

Population Genetics:

- Estimation and testing of measures of allelic association within and between loci (Hardy-Weinberg principle)
- Description and estimation of measures of relatedness at the individual and population level (population structure)
- Genetic drift, mutation, migration and selection
- Absent a course titled “Statistics,” coursework used to fulfill the statistics requirement should include the following integral components:
 - Descriptive statistics
 - Sampling uncertainty and sampling distributions
 - Confidence limits and intervals
 - Discrete and continuous variables
 - Estimation and hypothesis testing, including the use of likelihoods
 - Laws of probability and independence
 - Bayes' Theorem

5.5.1.2 APPOINTMENTS POST-JULY 1, 2009

Analysts appointed or hired on or after July 1, 2009 shall have a minimum of nine cumulative semester hours or equivalent that cover the required subject areas of biochemistry, genetics, and molecular biology.

5.5.1.3 ALTERNATE COMPLIANCE

Analysts who have completed coursework with titles other than those listed in DNA QM 5.5.1 above shall demonstrate compliance with this standard through a combination of pertinent materials, such as a syllabus, letter from the instructor, or other document that supports the course content. The technical leader shall approve compliance with this standard.

5.5.2 EXPERIENCE

The analyst shall have no less than six months of forensic human DNA laboratory experience. If prior forensic human DNA laboratory experience is accepted by a laboratory, the prior experience shall be documented and augmented by additional training, as needed. The technical leader shall approve the extent of the prior experience.

Analyst training entails the analysis of a range of samples routinely encountered in forensic casework prior to independent work using DNA technology. Additionally, the analyst shall successfully complete a competency test and proficiency test before beginning independent DNA analysis. A complete list of training requirements can be located in the Casework and CODIS Sections Analyst Training Manual. The analyst shall successfully complete the required training.

5.5.3 RESPONSIBILITY

The Forensic DNA Analyst is responsible for any assigned tasks in the operations of the Forensic DNA Section.

- Implementing the QA program.
- Handling reagents.
- Establishing liaisons with colleagues in the field.
- Analyzing, interpreting and reporting casework.
- Providing expert testimony.
- Interacting with investigative personnel.
- Executing all duties of QA Manager, if so designated.
- Assisting in training new employees.
- Stay abreast of developments within the field of DNA typing by reading current scientific or DNA applicable literature, attending seminars, courses or professional meetings.
- All other duties as assigned.

5.5.4 AUTHORIZATIONS

See **ASCL QM** section 6.2.6 for categories of Authorizations

- May recommend rejection of chemicals, reagents, supplies or materials that are found to be inadequate.
- May recommend termination of DNA testing if a technical problem is found.
- May Analyze and Report Results, Technically Review and Authorize Reports.

5.6 TECHNICAL REVIEWER

The technical reviewer shall be an employee or contract employee of the laboratory. The technical reviewer shall meet the education and experience requirements in DNA QM section 5.5 (QAS Standard 5.4) and shall meet the following:

- A current or previously qualified analyst.
- Successful completion of documented training.

5.7 FORENSIC DNA PROCESSOR

The Forensic DNA Processor is a DNA Technician or an Analyst not fully-qualified as a Forensic DNA Analyst responsible for processing DNA samples for analysis and specifically delegated QA responsibilities from the Casework Supervisor. The DNA Processor will be authorized to perform individual sample processing tasks specified on Letters of Qualification from the DNA Technical Leader and Casework Supervisor following the satisfactory completion of training and testing. For purposes of brevity, the term Processor may be used in the standard operating procedures to refer to any personnel authorized for a task being discussed.

5.7.1 EDUCATION

The DNA processor shall have at a minimum, a high school diploma or equivalent.

5.7.2 EXPERIENCE

The DNA processor shall complete the DNA training program established by the ASCL DNA Technical Leader and DNA Casework Supervisor. This training entails the processing of a range of samples encountered in the assigned forensic casework prior to independent work using DNA technology. Additionally the analyst shall successfully complete a competency test and proficiency test before beginning independent DNA sample processing. A complete list of training requirements can be located in the DNA Casework Section Technician Training Manual.

5.7.3 RESPONSIBILITY

The Forensic DNA Processor is responsible for any assigned tasks in the operations of the Forensic DNA Section.

- Implementing the QA program.
- Handling reagents.
- Establishing liaisons with colleagues in the field.
- Processing casework samples for analysis.
- Providing expert testimony.
- Interacting with investigative personnel.
- Assisting in training new employees.
- The DNA processor must stay abreast of developments within the field of DNA typing by reading current scientific or DNA applicable literature, attending seminars, courses or professional meetings.
- All other duties as assigned.

5.7.4 AUTHORIZATIONS

See **ASCL QM** section 6.2.6 for categories of Authorizations

- May recommend rejection of chemicals, reagents, supplies or materials that are found to be inadequate.
- May recommend termination of DNA testing if a technical problem is found.

5.8 DNA QUALITY MANAGER

The DNA quality manager is responsible for implementing the quality assurance program for the Forensic DNA section.

5.8.1 RESPONSIBILITY

- Ensure proper maintenance is being performed according to the quality assurance manual.
- Ensure that the quality manual procedures are being followed.
- Maintain all logs documenting the quality check of new chemicals.
- Review casework to ensure quality of product and adherence to the Forensic DNA QM SOP as part of the Annual Casework Review [DNA QM 3.4]

5.8.2 AUTHORIZATIONS

See **ASCL QM** section 6.2.6 for categories of Authorizations

- Can reject any chemical, reagent, supply or material which fails to meet the specifications set forth in the DNA *QM*. The rejection of any such item must be documented in the Reagent Preparation Manual.
- Can terminate DNA testing if a technical problem is identified and is not resolved by the Technical Leader. The CODIS Administrator and the rest of the DNA Section must be notified and the specific problem(s) must be documented in the QA manual where the Casework Supervisor, CODIS Administrator and/or Technical Leader will initial to signify approval.

5.9 DNA SAFETY OFFICER

The DNA safety officer is responsible for all aspects of the safety program for the Forensic DNA section.

5.9.1 RESPONSIBILITY

- Test safety equipment and complete required documentation.

- Maintain chemical inventory within the section as well as maintain MSDS binder.
- Responsible for the disposal of any chemical/biological waste.
- Complete safety survey on a semi-annual basis.
- Insures incident reports are completed and returned when an accident occurs.
- Maintain first aid kit.
- Provide safety orientation for new employees and manage the overall safety of the section.

6 TRAINING

6.1 TRAINING PROGRAM

Training will be guided by the appropriate DNA Training Manual, either Analyst or Processor. The six-month minimum training period for a forensic analyst will be dependent upon previous training and experience. Additionally, the analyst training period may consist of continuous training or it may consist of periods of training with time spent as an authorized processor in actual casework.

The Training Program shall:

- include all standard DNA procedures used in the laboratory. Training and authorization of advanced, or alternate, laboratory methodologies (e.g. bone/tooth extraction) will be addressed individually as with any new technology or methodology.
- include practical training exercises to include all routine casework processes.
- include instruction and supervised practical experience to learn the technical skills and knowledge required to perform DNA analysis as well as technical reviews.
- require successful completion of a moot court before performing independent casework.

See the Training Manuals for the complete training programs.

6.2 TRAINING MODIFICATIONS

The DNA Technical Leader, with the CODIS Administrator and Casework Supervisor, shall approve and document any modifications to or deviations from the training program including those based on prior experience.

6.3 COMPETENCY TESTING

At the completion of the training program, all employees will be required to successfully complete a competency test. For analysts, the test shall include: a practical test (such as an expired external proficiency test), a written qualifying test, and an oral discussion of the written test. Processors will be required to successfully complete a practical competency test, at a minimum.

Competency testing for the following activities will be conducted and documented prior to these actions being performed on evidence:

- Laboratory activities (testing and/or sampling)
- Analysis of results
- Review of results
- Authorization of results
- Verification of results
- Technical review
- Expressing an opinion or interpretation

6.4 NEW OR ADVANCED TESTING METHODOLOGY

As new methodologies are added to the DNA Section or as an employee is to be qualified in an advanced method, each previously qualified analyst or processor shall receive training in the methodology and pass a competency in the method if they are to be qualified in the procedure. This competency test shall include a practical component at a minimum. A proficiency test in the technology must be completed within six (6) months of the qualifying exam.

6.5 NEW OR ALTERNATE ANALYSIS TECHNOLOGY

As new analytical technologies are added to the DNA Section or as an analyst is to be qualified in an alternate technology, each previously qualified analyst shall receive training in the methodology and pass a competency in the technology if they are to be qualified in the procedure. This competency test shall include a practical component in addition to a knowledge assessment. A proficiency test in the technology must be completed within six (6) months of the qualifying exam.

6.6 TECHNICAL REVIEWS FOR NEW METHODS OR TECHNOLOGIES

All technical reviewers of new methods and technologies shall be fully qualified in the method or technology prior to the review.

6.7 LEGACY DATA FOR NEW ANALYSTS

New analysts are not qualified for previously retired methods and technologies without specific additional training. For an analyst to be qualified in reinterpretation of legacy data for which they were not previously qualified within the laboratory, the analyst shall receive training in the methods and technology required to interpret data, reach conclusions, and generate reports in the legacy technology, typing test kit, and/or platform.

6.7.1 LEGACY DATA COMPETENCY TESTING

The analyst shall successfully complete a competency test in the legacy technology, typing test kit, and/or platform to the extent of his/her participation in casework analyses. The competency testing shall include practical components of reinterpretation.

6.8 LEGACY DATA FOR PREVIOUSLY QUALIFIED ANALYSTS

An analyst previously qualified in a legacy method or technology may continue to reanalyze or perform technical review on the legacy data for one year from the date of completion of their last proficiency in the technology. Reanalysis of existing legacy data is permitted by an analyst within two years of completion of the last proficiency in that data with expressed authorization by the Technical Leader.

For legacy data using analytical methods last proficiency tested more than two years prior, the analyst and DNA TL will review applicable historical documentation including the appropriate QM, SOP, and validation(s) for that technology, together.

6.8.1 LEGACY DATA REAUTHORIZATION

The DNA TL shall evaluate the analyst's technical skills and knowledge of the technology and shall authorize the analyst to reinterpret the legacy data for a period of no more than two years.

6.9 TRAINING REVIEW

The technical leader, with the Casework Supervisor and CODIS Administrator, shall review the training records for the analyst, technician, and/or technical reviewer and approve his/her qualifications prior to independent casework responsibilities.

6.10 AUTHORIZATIONS

The analyst, technician, and/or technical reviewer shall be authorized to independently perform assigned job responsibilities and this authorization will be documented through QUALTRAX.

6.11 LABORATORY SUPPORT PERSONNEL

Laboratory support personnel shall receive training specific to their job functions. This training will be documented and approved by their supervisor and reviewed by the DNA TL.

6.12 RETRAINING

In the event that an analyst or processor is unable to maintain their proficiency testing cycle or is deemed by the DNA TL to have lost competency in a method or technology, the individual shall cease casework or reviews that involve the method or technology. The individual shall receive any necessary retraining as determined by the DNA TL and the DNA TL shall be responsible for assessing the effect of the retraining.

6.12.1 RETRAINING COMPETENCY TEST

The individual shall successfully complete competency testing prior to his/her return to participation in casework analyses. This competency testing shall include a practical component.

6.13 TRAINING RECORDS

The laboratory shall maintain records on the training, including successful completion of competency testing, of the laboratory personnel through the use of Training Binders, JTx, QTx, and the FB drive.

7 FACILITIES

Note: The organization of this section does not strictly adhere to the numbering of the subsections of FBI QAS Standard 7.

7.1 OVERALL LABORATORY SECURITY

The ASCL system has security monitors that cover the external perimeter of the buildings and parking lots. Security cameras are also located on the first floor of the Main Crime Laboratory. Only authorized personnel are allowed access to the 2nd and 3rd floor unless accompanied by authorized personnel. Security fobs and keys are issued to authorized personnel in order to access the certain areas of the laboratory and must be approved by the Executive Director. The ASCL has a security fob access system controlled by a computer placed in the Administrative Section (access reports can be generated from the security fob access system software). Refer to the *ASCL QM* for comprehensive details regarding laboratory wide security.

The ASCL currently performs DNA laboratory activities at only one location:

- Main Laboratory: 3 Natural Resources Drive, Little Rock AR 72205

The Physical Evidence, CODIS and DNA Casework areas of the laboratory are limited in access to other laboratory personnel through the electronic security system. Each analyst is assigned a unique programmed fob that enables entry into the laboratory. If an area is not monitored by the electronic security system, then access to the area is controlled by physical lock-and-key, with only authorized personnel being issued the key to the area.

7.2 FORENSIC DNA CASEWORK LABORATORY

The Forensic DNA Laboratory spaces are designed to minimize contamination during the processing of evidence. The sensitivity of PCR-based analysis, involving the amplification of minute quantities of DNA, makes it necessary to take certain precautions to avoid sample contamination. See *DNA QM Section 18.2* for a full discussion of contamination prevention guidelines. Records of critical environmental conditions will be stored in the *DNA QC Images* folder of the FB drive.

7.2.1 DNA PRE-PCR LABORATORY

The Forensic DNA Pre-PCR areas consist of evidence handling, DNA extraction and isolation, and preparation of samples for quantitation and amplification. The CODIS section may also share this space for the processing, extraction, and amplification setup of database samples.

SPECIAL PRECAUTIONS:

- 1) Use disposable gloves at all times.

- 2) Sterilize the bench top before and after each use with diluted bleach solution. Use disposable bench paper to prevent the accumulation of human DNA on permanent work surfaces. Bleach shall be used to decontaminate exposed work surfaces after each use.
- 3) Evidence handling, extractions, and PCR setup shall be performed in separate spaces or separate times, always with a full decontamination of the bench before, after, and between.
- 4) Sterilize solutions and lab ware that can be heated in an autoclave without affecting their performance. Steam sterilization under bacterial decontamination conditions degrades DNA to a very low molecular weight, rendering it un-amplifiable.
- 5) Always change pipette tips between handling each sample even when dispensing reagents.
- 6) Store reagents as small aliquots to minimize the number of times a given tube of reagent is opened. Record the lot numbers of reagents used in each set of samples so that if contamination occurs, it can be traced more readily. It is recommended that the small aliquots are retained until typing of the set of samples for which the aliquots were used is completed.
- 7) Centrifuge tubes before opening.
- 8) Include reagent blank controls with each set of DNA extractions to check for the presence of contaminating DNA in the reagents.
- 9) Wear a dedicated lab coat for pre-amplification sample handling when working in the pre-PCR DNA extraction work area. Lab coats will be washed on a monthly basis.
- 10) Facemasks and/or face shields must be worn when working with evidence and setting up amplifications.
- 11) General housekeeping will be performed as needed (e.g., sweeping, mopping, dusting).
- 12) Doors will remain closed except for passage.

7.2.2 DNA POST-PCR LABORATORY

The DNA Casework Post-PCR area consists of quantitation, amplification and PCR product typing. It is important that there is a one-way flow from the Pre-PCR lab to the Post-PCR lab. This is to prevent possible contamination between areas. Amplified DNA must be handled carefully. Steps will be taken to avoid dispersing it around the room to reduce the potential for transfer of amplified DNA to other work areas.

SPECIAL PRECAUTIONS:

- 1) Always remove gloves and lab coat when leaving the Amplified DNA Work Area to avoid the transfer of amplified DNA into other work areas.
- 2) Sterilize the bench top before and after each use with diluted bleach solution.
- 3) Reduce the unnecessary dispersal of DNA around the work area by changing gloves whenever they may have become contaminated with amplified DNA.
- 4) Use disposable bench paper to cover the work area used to perform the typing steps to prevent the accumulation of amplified DNA on permanent work surfaces.
- 5) Plates of amplified DNA will be kept in the work area until all reviews are completed, and then will be properly disposed of.
- 6) The doors are to remain closed except for passage.

7.3 EVIDENCE CONTROL

**See ASCL QM for lab-wide policy regarding Evidence Control and Case Management.*

**NOTE: Arrestee samples are handled differently than casework evidence; see CODIS QM for sample processing. When referencing the sample in Casework reports the ASCL CODIS section number (YYYY-1-XXXXX) or (YYYY-XXXXXX) will be used.*

7.3.1 EVIDENCE HANDLING PROCEDURES

Evidence is submitted to the ASCL from investigating agencies only. Evidence submitted to the Evidence Receiving section of the laboratory is assigned a unique identifying case number. These case files are then distributed to the proper sections of the Crime Laboratory.

Evidence that is screened for DNA evidence is processed through the Physical Evidence Section of the lab. Evidence is then packaged, submitted, and a request for DNA examination is made.

Evidence is collected, received, handled, sampled and stored so as to preserve the identity, integrity, condition and security of the item.

Before analysis begins, a second review is conducted by the Casework Supervisor and/or the DNA analyst to determine if there is anything more specific about the request and to determine if the laboratory has the capability and resources to perform the services requested (i.e., adequate standards, controls and approved test methods). Documentation is only noted if significant changes are observed. By starting analysis the analyst agrees to the request. If the request needs to be amended after work has begun, all affected personnel shall be notified.

7.3.2 CHAIN OF CUSTODY

See the *ASCL QM* for Chain of Custody guidelines. Extracts from Forensic DNA testing may be returned to the same packaging as the original item for long-term storage without sub-itemization. If the original item is to be returned, the extracts will be sub-itemized for long-term storage. Sub-items collected for Forensic DNA testing may be retained by the ASCL indefinitely.

7.3.3 PRIORITIZING

All cases may be prioritized based on a system that allows for a timely response. Priority may be made for the following reasons:

- at Investigating Officer request,
- at Court Official request (including court date and court orders),
- Threat to public safety (homicides, rapes, and violent crimes),

Other cases or types of cases may be prioritized at the request of the DNA Supervisor, Assistant Director, or the Executive Director. All priority requests will be documented in the LIM systems under the "Request Tab" with a brief description of the prioritization request.

7.3.4 PACKAGING

At times, evidence submitted for DNA testing is not adequately packaged. The analyst may document and correct the deficiency. If there is any concern that the packaging deficiency has affected the integrity or identity of the test item, the analyst's Section Chief and the customer agency shall be advised and consulted with for further instructions. If the analyst discovers an inconsistency between the stated and actual contents of a package, or if there is doubt about the suitability of an evidence item for testing, then the analyst shall attempt to contact the customer before proceeding. All contacts will be documented in the case record (e.g., using an *Agency Contact Form* ([ASCL-FORM-06](#)), by email). For minor inconsistencies, the analyst shall use their judgment on whether to contact the customer, but must make a note of the discrepancy in the case file. After analysis, the DNA Analyst re-packages the evidence in a manner that will preserve the evidence while in storage and awaiting trial.

7.3.5 SEALS

During the evidence processing procedure, the DNA Analyst will, if possible, avoid damaging seals on the evidence made by others. For example, a box or a bag will be cut open in an area not sealed with evidence tape. After processing, the DNA Analyst completely seals all openings made in the packaging with tape. The tape is marked with the analyst's initials, and the package is checked to ensure that the State Crime lab number as well as a number to identify the item of evidence is present.

7.3.6 RELEASE OF EVIDENCE

No evidence will be released from the laboratory, unless to the submitting agency, a police property custodian, or to a person with a court order or search warrant. (See *ASCL QM*)

7.3.7 RELEASE OF INFORMATION

See the *ASCL QM* for the policy on the release of information. See [Statute 12-12-312](#) *Records confidential and privilege*.

7.3.8 DISPOSITION

All appropriate DNA evidence will be retained by the Forensic DNA Section.

7.3.9 PURGING OF PAPER CASEFILES

The ASCL is currently using the JusticeTrax LIMS-plus software program. All case documentation will be stored electronically. Once reviewed, this electronic version is considered the official case record.

Since 2008, the case file is stored electronically within JusticeTrax. For any case submitted prior to 2008 not already stored electronically in JusticeTrax, the paper case files are stored in a secure location. These files are stored either on site or in the ASCL annex.

7.3.10 DISTRUCTION OF EVIDENCE

The Forensic DNA Section destroys no evidence, except in the case of fetal tissue samples as described in 7.3.11.9. Any packaging not retained will be documented in the appropriate casefile.

7.3.11 SAMPLE HANDLING AND STORAGE

The following written policy ensures that evidence samples will be handled, processed and preserved so as to protect against loss, contamination or deleterious change. Testing of evidence and evidence samples is conducted to provide the maximum information with the least consumption of the sample. Whenever possible, a portion of the original sample is retained by the Forensic DNA Section. However, the Forensic DNA section reserves the right to consume the entire sample to maximize the information from a sample.

See the *ASCL QM* to find Test Item Packaging and Sealing requirements. Key points are listed below:

- DNA evidence will be sealed so that the contents cannot escape and that opening the container results in obvious damage or alteration.
- A proper seal includes the initial of the person sealing the evidence across the seal. As soon as is practicable once the examination is complete at least one layer of packaging will be properly sealed.
- DNA evidence will be protected from loss, cross-transfer, contamination, and deleterious change.
- If evidence must be stored or conditioned under special environmental conditions (e.g., refrigerated, frozen), then these conditions shall be maintained, monitored, and recorded.
- Whenever practical, the original seal will be left intact when opening a container.
- If the original packaging cannot be kept, complete documentation and a picture of original packaging must be retained in the case record.

7.3.11.1 ACCEPTANCE FOR DNA

Any felony, criminal case that has biological fluids identified will be a candidate for DNA testing. Misdemeanor or drug cases may be excluded from being processed by the DNA Section with the approval of the Casework Supervisor.

7.3.11.2 IDENTIFICATION OF EVIDENCE & WORK PRODUCT

DNA extracts, excluding known samples, are considered as evidence and will be dried, sealed, and stored in DNA storage after the completion of the testing. Work products are all other materials produced during the DNA analysis procedure and can be discarded after the product has been used.

7.3.11.3 ADDITIONAL SAMPLES

In cases where the source of the DNA has been identified through evidence that has already been processed, the Casework Supervisor should approve any requests for additional testing.

7.3.11.4 EVIDENCE MARKING

The Evidence Receiving Section of the ASCL generates a unique case file number. This number is designated by the year and numerical order of cases submitted to the laboratory (ex: YYYY-000000). Each item of evidence will receive a specific identifier. Agency evidence numbers will be used whenever practical. Other identifiers may be assigned by the Forensic Serologists, and in such case, the DNA Analyst will use that same identifier. Other identifiers may be utilized if appropriate for the specific case. All evidence tubes are labeled with case number, analyst initials, and item number.

7.3.11.5 EVIDENCE COLLECTION & EXAMINATION

Requests for DNA examination are designated on an *ASCL Submission Sheet*. Evidence may be submitted and checked out for examination through the Evidence Receiving Section or received from another laboratory analyst via secure laboratory storage. Detailed procedures required for obtaining evidence can be found in the Evidence Receiving Section Quality Manual.

Evidence is brought directly to the section where it is properly secured in a drawer, cabinet, refrigerator or freezer.

PREPARATION FOR THE EXAMINATION:

- 1) Review all the information provided to determine what questions an investigator needs to have answered. A discussion with a supervisor or other colleague may be helpful.
- 2) Items which are submitted and are transferred directly for DNA testing will, with some reasonable exceptions, be assigned the same identifier in which it was submitted under, so not to assign redundant item numbers.
- 3) Prepare the work area. The bench space must be clean and free of clutter. The work area will be covered with white paper to prevent loss of small evidence and to prevent the cross transfer of trace evidence from one item to another. The necessary tools and reagents for examination should be conveniently placed. Adequate lighting should be provided to allow close visual inspection of evidence. Lab work sheets should be at hand to note observations.
- 4) All PPE must be worn to protect evidence from contamination and personnel from contagion.

EXAMINATION:

- 1) Examine one item at a time, making sure the work area and tools are cleaned between examinations.
- 2) Mark evidence for future identification with analyst initials. The package will be checked to ensure that the lab case number and item number is present.

- 3) If items are known to be disease contaminated, handle cautiously yet expeditiously. It is always good laboratory practice to handle all evidence with universal precautions as though the evidence was disease contaminated. Clean hood or work area and instruments with bleach solution.

7.3.11.6 EVIDENCE CONTROL SYSTEM

The DNA Casework section will utilize a Filemaker Database and an excel spreadsheet (DNA-FORM-1) and the labeling of tubes to ensure the integrity of each sample throughout processing. The software will generate labels for each tube. The label will contain at least the case number, unique sample ID, and analyst's initials. The DNA-FORM-1 will serve to document the location of each sample during the quantitation, amplification, and electrophoretic processes. If evidence is to leave the secure DNA Cleanroom, a COC transfer will be recorded in the JTx casefile.

7.3.11.7 LONG TERM STORAGE

See the *ASCL QM* section 7.4.1.1 to find Test Item Storage requirements. For evidence storage purposes, DNA mag-locked areas meet the definition of "secure, limited-access area" and key-locked pre-amplification cleanroom areas meet the definition of "short-term storage location". Upon completion of the testing, the DNA Analyst has the ultimate responsibility for long-term storage of the following case samples. Items are placed in coin envelopes and placed in storage envelopes to be stored at room temperature when appropriate. Samples requiring sub-zero temperatures may be stored appropriately. All retained samples, including reference samples must be sealed and stored with contents identified. Outer containers must contain at a minimum, the laboratory case number, item number, and initials of analyst. Additional Storage Information:

- 1) Upon completion of the case, all question sample extracts are placed in a spin-vac and dried. The dried extracts are placed into the appropriate storage container with the original samples/cuttings when possible.
- 2) All liquid blood samples must be dried down for long term storage.
- 3) It is not required to retain extracts from reference blood samples or oral samples unless the entire reference sample was consumed during extraction. In that situation, the reference sample extract will be dried down and retained in the appropriate container.
- 4) Any unused reference samples collected with Q-tip swabs are retained.
- 5) Blood sample(s) collected by the Medical Examiner's Office, spotted on FTA paper, can be stored at room temperature in long term evidence storage.

7.3.11.8 RECONSTITUTION OF DRIED SAMPLES

When a dried sample needs to be used for further testing it may be reconstituted with amplification-grade water. Prior to reconstitution, the expected final volume of the sample extract and all associated reagent blanks (RB) will be calculated to estimate the amount of amplification-grade water to be added to each. Sample may be placed on the heat blocks to assist the

reconstitution. The sample RB must be reconstituted alongside the sample unless the RB has been previously run with the technology requested. If the volume of the water is less for the RB or if the RB has already been run then a reconstitution RB must be run consisting of the same water aliquot used for reconstitution or the analyst is required to ensure that the same water aliquot will be used in the amplification negative control.

As with regular reconstitution of dried samples, any sample extracts stored for more than one month in refrigerated conditions or more than three months in frozen conditions after quantitation will need to calculate the expected remaining volume prior to opening any extract tubes. This will be documented within the casefile, including that of any associated reagent blank (RB). The sample extracts, including any associated RB, will have the actual remaining volume checked against the calculated volume via pipette prior to use in any analytical procedure.

If the actual volume is found to deviate from the expected volume, the analyst will determine the cause prior to use. If evaporation is the cause, the analyst will add amplification-grade water to bring the volume of the extract to the appropriate amount. A reconstitution RB of that water aliquot will be created to concurrently accompany the samples through all remaining analytical procedures or the analyst is required to ensure that the same water aliquot will be used in the amplification negative control.

7.3.11.9 RETENTION/DESTRUCTION POLICY FOR FETAL TISSUE SAMPLES

Fetal Tissue Samples fall under specific legislation in Arkansas. Act 725 (2013) amended AR Code 12-18-108 to include language which directs the ASCL to test and dispose of tissue samples from aborted products of conception from juvenile patients. The fetal sample will be examined, documented and processed in order to obtain a DNA profile, per laboratory policy. This profile will be entered into the "QC" category of CODIS.

The sample extract will be dried down and retained as per normal laboratory policy. Once the report has been released to the investigating agency, the agency will be contacted to request a letter or email stating that the remaining fetal tissue may be destroyed. The letter or email will be scanned into the case file and the remaining fetal tissue will then be destroyed.

8 VALIDATIONS

8.1 REQUIREMENT OF VALIDATION

The laboratory shall only use validated methodologies for DNA analyses. These include any new methods and procedures for sampling, handling, transport, storage and preparation of items to be tested. There are two types of validation: developmental and internal. See the *ASCL QM* discussion for Validation procedures.

8.2 DEVELOPMENTAL VALIDATION

Developmental validation is required on any novel methodology for forensic DNA analysis. When method development is performed, a plan is approved by the DNA Technical leader and assigned to personnel approved to perform method validation. Adequate resources are made available and the underlying scientific principle(s) of the method must be published for peer-review.

During the method development, the process is reviewed to ensure that the original goals are still being fulfilled. If a modification to the plan is required, it will be approved and authorized by a revision of the plan document in Qualtrax.

The developmental validation shall include the following studies, where applicable:

- 1) Characterization of genetic markers.
- 2) Species specificity.
- 3) Sensitivity.
- 4) Stability.
- 5) Case-type samples.
- 6) Population.
- 7) Mixture.
- 8) Precision.
- 9) Accuracy.
- 10) PCR-based studies.
 - a) Reaction conditions.
 - b) Assessment of differential amplification.
 - c) Assessment of preferential amplification.
 - d) Effects of multiplexing.
 - e) Assessment of appropriate controls.
 - f) Product detection.

8.3 INTERNAL VALIDATION

Internal validation is required on any methodologies that are utilized for forensic DNA analysis in the laboratory. A developmentally validated methodology cannot be utilized in the laboratory until it has been internally validated, reviewed and approved by the technical leader. The internal validation procedure will be tested using known and non-probative evidence samples or database-type samples of a sufficient number and type to demonstrate the reliability and limits of the method. The validation shall contain the following studies where applicable:

- 1) Accuracy
- 2) Precision
- 3) Reproducibility
- 4) Sensitivity & Stability
- 5) Mixture.
- 6) Contamination assessment

Internal validation shall define quality assurance parameters and interpretation guidelines, including, as applicable, guidelines for mixture interpretation and the application of appropriate statistical calculations.

Mixture interpretation validation studies shall include samples with a range of the number of contributors, template amounts, and mixture ratios expected to be interpreted in casework.

Internal validation studies shall be conducted prior to implementing a change in platform instrument model or typing test kit.

Internal validation studies shall be documented and summarized. Internal validation shall be reviewed and approved by the DNA TL prior to implementing a procedure for forensic applications.

Before a processor can begin using an internally validated procedure for DNA casework, the processor must successfully complete training and a qualifying test. A proficiency test must be completed within (6) months of qualification of the new technology or methodology. See the *ASCL QM* for specific requirements of validation.

8.4 CERTIFIED REFERENCE MATERIAL

Newly validated DNA methods (from amplification through characterization), typing test kit, or platform instrument model shall be checked against an appropriate and available certified reference material (or sample made traceable to the certified reference material) prior to the implementation of the method for forensic analysis.

8.5 MATERIAL MODIFICATIONS

Material modifications made to validated procedures shall be evaluated and approved for use if the modifications are covered by the initial validation conditions by the DNA Technical Leader. An additional validation of the modification will be needed if determined by the technical leader.

The performance of a modified procedure shall be evaluated by comparison to the original procedure using similar DNA samples and the evaluation documented. The evaluation shall be reviewed and approved by the technical leader prior to the implementation of the modified procedure into casework applications.

8.6 MODIFIED RAPID VALIDATION

The ASCL does not perform Modified Rapid testing.

8.7 RAPID PERFORMANCE CHECK

The ASCL does not perform Rapid testing.

8.8 NEW SOFTWARE

New software or new modules of existing software and modifications to software shall be evaluated to assess the suitability of the software for its intended use in the laboratory and to determine the necessity of validation studies or software testing. This evaluation by the DNA TL shall include the determination of which studies will and will not be conducted and shall be documented.

8.8.1 DEVELOPMENTAL VALIDATION OF SOFTWARE

New software or new modules of existing software that are used as a component of instrumentation, for the analysis and/or interpretation of DNA data, or for statistical calculations, shall be subject to developmental validation prior to implementation in forensic DNA analysis.

- 8.8.1.1 With the exception of legally protected information, the underlying scientific principle(s) utilized by software with an impact on the analytical process, interpretation, or statistical calculations shall be publicly available for review or published in a peer-reviewed scientific journal.
 - 8.8.1.2 Developmental software validation studies for new software or new modules of existing software used as a component of instrumentation shall include at a minimum, functional testing and reliability testing.
 - 8.8.1.3 Developmental software validation studies for new software or new modules of existing software for the analysis and/or interpretation of DNA data shall include at a minimum, functional testing, reliability testing, and as applicable, accuracy, precision, sensitivity, and specificity studies.
 - 8.8.1.4 Developmental software validation studies for new software or new modules of existing software for statistical calculations shall include at a minimum, functional testing, reliability testing, and as applicable, accuracy, and precision studies.
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8.8.2 INTERNAL VALIDATION OF SOFTWARE

New software or new modules of existing software that are used as a component of instrumentation, for the analysis and/or interpretation of DNA data, or for statistical calculations shall be subject to internal validation specific to the laboratory's intended use prior to implementation in forensic DNA analysis.

- 8.8.2.1 Internal software validation studies for new software or new modules of existing software used as a component of instrumentation shall include functional testing and reliability testing.
 - 8.8.2.2 Internal software validation studies for new software or new modules of existing software for the analysis and/or interpretation of DNA data shall include functional testing, reliability testing, and, as applicable, precision and accuracy studies, sensitivity, and specificity studies.
 - 8.8.2.3 Internal software validation studies for new software or new modules of existing software for statistical calculations shall include functional testing, reliability testing, and, as applicable, precision and accuracy studies.
 - 8.8.2.4 Software that does not impact the analytical process, interpretation, or statistical calculations shall require at a minimum, a functional test.
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8.8.3 MODIFICATION TO SOFTWARE

Modifications to software as described in Standards 8.8.1 and 8.8.2 shall be evaluated to determine if the modifications result in major or minor revisions to the software.

- 8.8.3.1 A major revision to software used as a component of instrumentation shall require validation prior to implementation. Software validation studies shall include functional testing, reliability testing, and regression testing.
 - 8.8.3.2 A major revision to software used for the analysis and/or interpretation of DNA data shall require validation prior to implementation. Software validation studies shall include functional testing, reliability testing, regression testing, and, as applicable, precision and accuracy studies, sensitivity, and specificity studies.
 - 8.8.3.3 A major revision to software used for statistical calculations shall require validation prior to implementation. Software validation studies shall include functional testing, reliability testing, regression testing, and, as applicable, precision and accuracy studies.
 - 8.8.3.4 A minor revision to software that does not impact the analytical process, interpretation, or statistical calculations shall require at a minimum, a functional test.
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8.8.4 ASCL DOES NOT PROCESS DNA AT MULTIPLE LOCATIONS

8.8.5 RETENTION OF RECORDS

Software validation and testing shall be documented. Software validation and testing shall be reviewed and approved by the DNA TL prior to implementation.

8.9 RETENTION FOR REVIEW

Developmental validation studies, internal validation studies, modified procedure evaluations, and software testing, including the approval of the DNA TL, shall be retained and available for review.

9 ANALYTICAL PROCEDURES (TEST METHODS)

9.1 APPROVED PROCEDURES

Following a review of submitted evidence by an Evidence Receiving technician or other approved ASCL personnel, a DNA request will be created in LIMS if appropriate. Requests for non-routine work must be reviewed by the Forensic DNA Supervisor or her designee. If approved, the Supervisor (or designee) must initial and date the *ASCL Evidence Submission Form* or LIMS-generated Submission sheet next to the request. Deviations from normal analytical procedures not covered under the ASCL Quality Manual (ASCL-DOC-01) standard 5.5.3 will be documented on the *Deviations/Non-Conformance Form (CODIS-FORM-17)* to ensure technical justification and authorization.

The laboratory shall only use validated methodologies for DNA analyses (see Appendix A). Approved procedures are listed with instructions, appropriate controls and interpretation guidelines.

9.2 REAGENTS

9.2.1 COMMERCIAL REAGENTS

The following is a list of critical reagents used in the Forensic DNA Section:

Commercial Kits:

DNA Investigator Kits	Qiagen
Quantiplex Pro	Qiagen
PowerPlex Fusion 6C	Promega
YfilerPlus	ThermoFisher

Miscellaneous Items:

2800M	Promega
Buffer G2	Qiagen
Buffer MTL	Qiagen
3M Sodium Acetate, pH 5.2	ThermoFisher
0.5M EDTA, pH 8.0	ThermoFisher
GeneScan 600 Liz	ThermoFisher

9.2.1.1 SOURCES OF MATERIALS, REAGENTS, CHEMICALS, & SUPPLIES

A listing of commercial sources for all materials, reagents, chemicals, and supplies will be maintained in the Reagent Log. All commercial reagents will be labeled with the identity of the reagent, open date and the expiration date if applicable. All information relevant to material or services that must meet certain specifications for testing will be provided in the External Supply Request to the purchasing department. Only suitable externally-provided products will be used.

9.2.1.2 SUPPLY & MATERIALS INVENTORY

Upon receipt of all materials, reagents, chemicals and supplies, the packing slip will be checked for agreement with the items received when available. The analysts are responsible for initialing and dating chemical and reagent containers with an "Open Date". Reagents and supplies, which have passed their expiration date, will not be used in casework unless a performance check has been conducted and the technical leader has approved and documented the deviation to extend the expiration date.

9.2.1.3 SAFETY DATA SHEETS (SDS, PREVIOUSLY MSDS)

The SDS received from the manufacturer for each chemical used in the laboratory can be found in the designated SDS book or electronically. These data sheets are readily available to all laboratory personnel. Master copies of all SDS sheets for the laboratory are kept by the Laboratory Health and Safety Manager. All chemicals must be stored, used, and disposed of in a manner conforming to established safety requirements

9.2.2 LABORATORY PREPARED REAGENTS & SOLUTIONS

A log will be maintained for each laboratory prepared reagent and solution except dilutions of laboratory concentrates. Each reagent/solution prepared will have the following recorded in the DNA Reagent Log or stored electronically on the FB drive:

- Identity
- Date of preparation
- Date of expiration
- Instructions on preparation of reagent
- Lot numbers of solvents and/or chemicals used in preparation of reagent
- A method to verify the reagent's reliability (if applicable)
- Initials of the person preparing reagent
- Initials of the person verifying reagent (if applicable)

9.2.2.1 LABELING REQUIREMENTS

All laboratory prepared reagents and solutions including dilutions and aliquots will be clearly labeled. Labels will include at a minimum: identity of reagent; date of preparation or expiration; and identity of individual preparing reagent. Lot number and storage requirements (as appropriate) may also be included. Labels may be placed on the individual reagent aliquots or on the specific container of the aliquots. A barcode may represent the lot number. Labels or records will also include identity of preparing analyst, components used, and expiration date. All chemicals must be stored, used, and disposed of in a manner conforming to established safety requirements.

9.3 CRITICAL REAGENTS & SUPPLIES

Critical consumables, supplies, and services which affect the quality of testing will be obtained from reliable suppliers. All critical reagents and supplies must be quality control tested for accurate, reliable performance prior to use in the Forensic DNA Section. Quality control test results will be recorded in the Quality Control of Critical Reagents Log.

9.3.1.1.1 DNA INVESTIGATOR KITS & COMPONENTS

DNA investigator kits will be marked with the receive date and initials of the individual who receives the kit. A known blood sample will be processed through the extraction kit to check the quality of the reagents. The DNA extract will be amplified with a QC checked PowerPlex Fusion 6C kit, and analyzed to ensure the correct profile was produced. Once the lot has been verified the QC date will be placed on all received kits. If the kit does not produce the expected profile, the known blood samples will be re-extracted and re-analyzed. If the kit fails the QC a second time the Technical Leader, or designee will be informed. The Technical Leader, or designee, will examine the problem and contact the manufacturer if necessary.

9.3.1.1.2 QUANTITATION KITS

The quantitation kits will be marked with the receive date and initials of the individual who receives the kit. A dilution of standards, as described in the SOP for each of the quantitation kits, will be run and analyzed to ensure the quality of the newly received kits. Using the guidelines in the appropriate SOP, a R^2 of ≥ 0.98 will be considered passing. Once the lot has been verified the QC date will be placed on all received kits. If the standard curve does not have a R^2 of ≥ 0.98 , the standard will be re-run and re-analyzed. If the standard fails the QC a second time the Technical Leader, or designee will be informed. The Technical Leader, or designee, will examine the problem and contact the manufacturer if necessary.

9.3.1.1.3 AMPLIFICATION KITS & COMPONENTS

The genetic typing kits will be marked with the receive date and initials of the individual who receives the kit. The appropriate positive control as described in the corresponding SOP will be amplified in duplicate along with an AMP- sample. The samples will then be analyzed to ensure the

appropriate DNA profile is obtained. Once the lot has been verified the QC date will be placed on all received kits. If the kit does not produce the expected profile, the samples will be re-injected or re-amplified. If the positive or negative controls still do not produce the expected result, the Technical Leader, or designee, will be informed. The Technical Leader, or designee, will examine the problem and contact the manufacturer if necessary. Critical Reagents purchased as a component of a kit may only be used with a kit lot for which it has passed a Quality Check. Critical Reagents not purchased as a component of a kit are not restricted to use with only the lot used to perform the Quality Check.

9.3.1.1.4 BONE & TOOTH EXTRACTION REAGENTS

The reagents will be marked with the receive date and initials of the individual who receives the kit. An appropriate positive control will be extracted along with a reagent blank. The positive control will then be analyzed to ensure the appropriate DNA profile is obtained. Once the lot has been verified the QC date will be placed on all received reagents. If the reagent does not produce the expected profile, the samples will be re-injected or re-amplified. If the positive or negative controls still do not produce the expected result, the Technical Leader, or designee, will be informed. The Technical Leader, or designee, will examine the problem and contact the manufacturer if necessary. Critical Reagents not purchased as a component of a kit are not restricted to use with only the lot used to perform the Quality Check.

9.4 QUANTIFICATION

The DNA content of Forensic samples shall be quantitated prior to DNA amplification. Based on a validated protocol, the analyst may determine that a Forensic sample does not contain sufficient DNA for amplification, or is unsuitable based on the female to male ratio. A quantitation standard curve made from DNA of known quantity will be maintained for use.

9.5 CONTROLS AND STANDARDS

It is essential that proper control samples are included when samples are extracted, amplified and typed. The typing results obtained from these controls are important for the interpretation of the profiles obtained. All employees and supervisory personnel must be vigilant for any indication of nonconforming tests and work.

9.5.1 REAGENT BLANK (RB)

The reagent blank consists of all reagents used in the test process minus any sample and is extracted concurrently through all steps alongside the question or known samples on the same extraction instrument. A reagent blank must be included with each extraction set (up to 7 forensic evidence samples and up to 13 forensic known samples). The reagent blank will be amplified the same as the samples at full strength and typed under the same conditions as the samples

The reagent blank is used to test for possible contamination of the sample preparation, reagents, and/or supplies by an external DNA source. If the reagent blank exhibits any typing results above the analytical threshold the reagent blank can be re-amplified. If the typing results remain above threshold after re-amplification, then all DNA samples that were associated with reagent blank will be considered inconclusive for analysis and re-extracted. If the DNA sample has been consumed and re-extraction is not possible, then the DNA Technical Leader, Casework Supervisor and/or Laboratory Director will be consulted to analyze the samples and reagent blank. If after analysis the source of the contaminating DNA does not appear to be in the samples, then the sample may be reported and the contamination of the reagent blank will be noted in the report. If the extraneous DNA is present in both the reagent blank and associated sample the sample will be reported as inconclusive.

9.5.2 QUANTIFICATION STANDARDS

The quantification standards (or standard curve), including a No Template Control (NTC), will be amplified and analyzed with each sample set. The standards quantify the instrument measurements to known amounts of DNA. Performance of the standard curve and NTC will be assessed to ensure appropriate set-up and functioning.

A usable standard curve must consist of at least one replicate in 4 of the 5 dilutions.

9.5.3 AMPLIFICATION CONTROLS

9.5.3.1 POSITIVE CONTROL

The positive control contains DNA from a known source with a known DNA profile. The positive control will be amplified and analyzed with each sample set.

The positive control tests to insure the proper performance of the amplification and typing procedure. 2800M is the positive control for Fusion 6C and Y23. 007 is the positive control for Yfiler Plus. If the positive control does not exhibit the appropriate results, then samples associated with that positive control are considered inconclusive for analysis and must be re-amplified. Positive controls may be setup in duplicate to compensate for poor injections, spikes, or other artifacts. Only one of the positive controls is required to produce the expected results. If a positive control is lacking expected allele(s) at a locus, then the control can be used, but that locus will be marked as inconclusive in all samples associated with the positive control. If there are more than two loci that lack the expected allele(s) then all samples associated with the positive control must be re-injected or re-amplified.

9.5.3.2 NEGATIVE CONTROL (AMP-)

The negative control (amplification blank) contains all the reagents for the amplification mix but no DNA. The negative control will be amplified and analyzed concurrently in the same instrument with the same samples and same PCR kit.

The negative control tests for contamination of samples during the setup of the amplification reactions. If the negative control exhibits unexplainable peaks above the analytical threshold that are not eliminated after re-injection, then all samples associated with the negative control are considered inconclusive for analysis and must be re-amplified.

9.5.4 SEQUENCING CONTROLS

The ASCL does not perform DNA sequencing.

9.5.5 INTERNAL SIZE MARKER & ALLELIC LADDER

Internal size marker is added to each sample and ladder prior to electrophoresis. The internal size marker allows the genetic analysis software to determine the size (in base pairs) of the peaks in the samples and ladders.

The allelic ladder is supplied with each of the amplification kits and is run with each set of samples. The allelic ladder allows GeneMapper ID-X to assign an allele call to any peaks observed based on their size.

9.5.6 OTHER STANDARDS AND CONTROLS

9.5.6.1 NIST STANDARD

DNA-typing procedures will be checked annually using the NIST PCR-based DNA Profiling Standard (SRM 2391 for autosomal STRs and Y-STRs or an internal NIST traceable sample). NIST SRM will remain suitable for use on annual retesting beyond manufacturer expiration provided that the materials continue to produce complete and correct profiles of comparable quality when compared to the original use of the material on the platform and with the technology and methodology. New or modifications to existing methodologies, new technologies or new platforms require NIST SRM within manufacturer expiration limits.

9.5.6.1.1 INTERNAL NIST STANDARDS

Internal NIST Traceable Standards are created by running NIST Standard Reference Material alongside the internal standard. The internal standard will be viable until a new lot is taken or until an internal expiration date (if applicable). If expired, remaining stock of the internal standard expiration date may be renewed by rerunning along with a NIST SRM. All internal NIST traceable standards will be labeled with a lot designator and will be maintained as labeled.

9.5.6.1.2 NIST STANDARDS HANDLING, STORAGE, & PREVENTION OF DETERIORATION

NIST SRM samples will be maintained as the manufacturer recommends. All NIST samples will be transported, handled, and used as all casework samples to prevent contamination and deterioration and to protect the integrity of the sample.

9.5.6.1.3 NIST QUANTITATION STANDARDS

NIST Human DNA Quantitation Standard (SRM 2372) samples will be maintained as the manufacturer recommends. The NIST quantitation standard may be used to adjust analysis settings for the sequence detection software v.1.2.3 and the expected IPC and Y-intercept value ranges in use for casework quantitation. An annual check of DNA quantitation procedures is not required.

9.6 INTERPRETATION GUIDELINES

Note: The organization of this section does not strictly adhere to the numbering of the subsections of FBI QAS Standard 9.6.

9.6.1 QUANTITATION INTERPRETATION

Upon collection of any quantitation data, the standards and controls shall be interpreted first to ensure suitability of the sample results for interpretation.

The QIAGEN Investigator Quantiplex Pro (QuantPro) system is used for the quantification of amplifiable total human and human male DNA in a sample. The DNA quantitation assay combines a target-specific human DNA assay, target-specific human male DNA assay, and an internal PCR control (IPC) assay. QuantPro also includes a human DNA degradation assay.

9.6.1.1 QUANT STANDARD CURVE PREP RESULTS

After data analysis on the instrument software, the data shall be exported for review in the *QuantPro QC Check* file from the FB drive. Instructions can be found on the Instructions sheet if needed. After importing the data, the results are reviewed to ensure Ct values are within the accepted range from the validation results by green "Pass" boxes for standards A-E.

9.6.1.2 STANDARDS QUANTITATION RESULTS

After data analysis on the instrument software, the data can be exported for review in the excel Sample Management Project. Examine each standard curve to ensure $R^2 \geq 0.98$. If not, outlying standard results can be eliminated to a minimum of one replicate of 4 of 5 standard measurements. The resulting slope and Y-intercept values should be reviewed to ensure they remain in the expected ranges. If a reduced standard curve does not have a $R^2 \geq 0.98$, then the DNA TL shall be

contacted to assess the reaction quality indicators and results will only be used with caution following DNA TL approval.

Quality indicators include:

Internal PCR Control (IPC): indicates the presence of inhibitors or less than optimal reaction conditions – expected to be consistent across all reactions.

Non-template Control (NTC): negative amplification control – expected to yield baseline results (except IPC).

Reaction slope – indications of amplification efficiency – expected to remain close to -3.3

Y-intercept – indication of expected Ct for 1 ng/uL sample

Distribution of Ct values: the distribution of Ct values – expected to be consistent if DNA template dilution is consistent.

9.6.1.3 SAMPLE QUANTITATION RESULTS

If samples results are negative or 'not detected', the analyst shall amplify using the maximum volume of extract allowed for the amplification kit.

Samples at risk of exceeding maximum limits (>10ng/μL) can be diluted appropriately and amplified.

Stopping further analysis based on quantitation results:

- If total DNA quantitation result is .0025 ng/μL or below then the sample does not need to be further processed for STR analysis. (See report sections for report wording)
- If a sexual assault sample contains 5% or less of male contributor (Quant Pro: Male quantitation result / Total quantitation result * 100) then the sample does not need to be further processed for STR analysis. (See report sections for report wording)
- If male DNA quantitation results is 0.00044 ng/μL or less then the sample does not need to be further processed for Y-STR analysis (See report sections for report wording)
- If the semen fraction of a sexual assault case is processed for STR analysis then the corresponding epithelial fraction will be processed regardless of the percent male contribution in the epithelial fraction.
- If all question (Q) items are stopped because of quantitation then victim knowns do not need to be processed for STR analysis. Suspect knowns will be processed for STR analysis.

Case specific factors may dictate that some samples not be processed for Y-STR analysis. These include:

- In cases with multiple samples, low male samples may be reserved pending Y-STR results from samples with good male quantitation results,

- Number of suspected male perpetrators,
- Number of male contributors to the autosomal mixture exceeds two.

9.6.2 DNA TYPING INTERPRETATIONS

Upon collection of any DNA Typing data, the standards and controls shall be interpreted first to ensure suitability of the sample results for interpretation.

9.6.2.1 GENERAL TYPING CONTROLS

SIZING STANDARDS

The Data Collection software for the 3500xl Analyzers has a quality-check function which automatically detects marginal or failing sizing quality. In this event, an analyst, or processor in consultation with an analyst, may immediately reinject the injection set and analyze only the new data. A note about the reinjection will be included in the casefile(s) associated and the raw data of the failed injection will be securely retained.

If the raw data is analyzed in a GeneMapper ID-X project, the analyst shall:

- examine the sizing quality flag (SQ) for each control in the Project Window
- open the Raw Data View for any flagged controls to confirm the injection did not fail
- verify that the analysis range is between 60bp and 600bp and the correct Analysis Method and Sizing Standard are selected
- In the Size Match Editor Size Matches window, confirm the peaks are correctly labeled on the failing controls. Include a passing sample to allow simple comparison.

Analysts do not routinely correct incorrect sizing labels. In the event a high quality injection experiences an issue such as a Spike which disrupts the size-calling, the DNA TL may be asked to examine, and if deemed appropriate, correct the peak designation. Any controls with passing flags may be examined in the Samples Plot view. Failing controls shall be reinjected if a second like control is not passing.

ALLELIC LADDERS

After confirming the Sizing quality, the analyst shall examine the Allelic Ladders to confirm that the injections are satisfactory. Occasionally, an injection will result in a rising baseline which appears in the analyzed data as shortening and broadening of the larger fragment peaks. The analyst shall confirm that the peaks are correctly called and if necessary, shall re-designate the ladder as a “Sample” and reanalyze the project. A minimum of one passing ladder per project is necessary.

ANALYTICAL CONTROLS

After confirming the Sizing quality, the analyst shall examine the Analytical Controls to confirm that the injections are satisfactory. The analyst shall confirm that the peaks are correctly called for the positive control(s) and that the locus specific quality flags are passing or the issue is addressed. A

minimum of one passing positive control is required per project (also see 9.5.3.1). The negative control and reagent blanks shall be examined for any peaks above analytical threshold, or any patterns of below threshold peaks which indicate possible allelic origin (also see 9.5.3.2). Failing controls can be reinjected, and failing reagent blanks may be reamplified to attempt passing results, but failing amplification controls will require the entire project to be reamplified. See also section 9.5.

9.6.2.2 AUTOSOMAL STR INTERPRETATION GUIDELINES

The interpretation of results in casework is a matter of professional judgment and expertise. Not every situation can or should be covered by a pre-set rule. However, it is important that the laboratory develops and adheres to minimum criteria for interpretation of analytical results. These criteria are based on validation studies, literature references, and casework. It is to be expected that these interpretation guidelines will continue to evolve as the technology and collective experience of the laboratory grows.

The purpose of these guidelines is to establish a general framework and outline minimum standards to ensure that:

- Conclusions in casework reports are scientifically supported by the analytical data, including that obtained from appropriate standards and controls;
- Interpretations are made as objectively as possible, consistently from analyst to analyst, and within established limits;
 - The evaluation of question items includes identifying artifacts and variant alleles, determining the number of contributors, and examining any other quality indicators to assess the suitability of the profile for comparison and (if applicable) for statistical rarity calculations, prior to comparison to one or more known reference items.
 - Known reference items, with few exceptions, are expected to consist of DNA from only one individual but as with question items, must also be evaluated for suitability prior to comparison. Additionally, known reference items must be assessed for the probative value of a comparison to an item of evidence prior to the comparison. Comparisons which cannot provide probative information may be evaluated to allow further deconvolution by assuming a contribution or be omitted entirely, as appropriate.

The goal of the evaluation and interpretation of amplified STR data is to determine the DNA profile(s) of the donor(s) of the questioned samples for comparison to reference sample profiles.

- A peak is defined as a distinct, triangular section of an electropherogram.
- Genotypes are determined from the diagnostic peaks of the appropriate color and size range for a particular locus.

9.6.2.2.1 ANALYTICAL THRESHOLD

The minimum peak height threshold will be set at 175 (Relative Fluorescent Unit) RFU for PowerPlex 16 HS and Fusion 6C for software recognition of a peak. The analytical threshold is the value that denotes a signal is above the background noise and is considered a true peak and it is set at 175 RFU for PowerPlex 16 HS and Fusion 6C. Optimal peak height values range between 1000-4000 RFU, although acceptable and typeable signals may occur outside of this range.

9.6.2.2.2 STOCHASTIC THRESHOLD

The stochastic threshold is the value that denotes both peaks for a heterozygous locus will be detected and it is set at 600 RFU for PowerPlex Fusion 6C. For PowerPlex 16HS reanalysis, the stochastic threshold is set at 500 RFU.

9.6.2.2.3 PEAK HEIGHT RATIO

Peak height ratios of heterozygote alleles are defined as the ratio of the lower peak's height to the higher peak's height, expressed as a percentage. Peak height ratios were examined in the validation data and thresholds were. Peak height of the higher sister allele dictates which ratio to use below.

PowerPlex 16HS (reanalysis)

Peak Height	Ratio
>2500 RFU	60%
1500-2500 RFU	50%
<1500 RFU	30%

Fusion 6C

Peak Height	Ratio
>1500 RFU	60%
<1500 RFU	30%

Homozygote allele peak heights are approximately twice that of heterozygotes as a result of a doubling of the signal from two alleles of the same size.

9.6.2.2.4 OFF LADDER VARIANTS

Off ladder (OL) calls are first converted to size in base pairs (bp), then compared to the size of the appropriate ladder alleles and the allelic designation is determined. If the OL is not a "perfect" repeat, but rather varies by 1, 2 or 3 bp from a ladder allele, then it will be designated as an integer of that variation. For example, if a green OL peak is observed for the first time with a size of 273.44 bp, and the 22 allele of the **D2S1338** ladder is 271.45 bp, then the peak will be designated a **D2S1338 22.2 OL**. If an allele falls above the largest or below the smallest

peak of the sizing ladder, the allele will be designated as either greater than (>) or less than (<) the respective ladder allele.

The analyst will re-amplify or re-inject, then type any sample containing a peak not properly interpreted as an allele by the software, especially if it is not appropriately balanced with an associated allele or at a height expected for a homozygote.

Following the confirmation as a true Off Ladder allele, the allele will be added to the appropriate Ladder(s) as a virtual allele with the OL designation. Any second observation of the same allele will also be reconfirmed.

An off ladder variant which has been seen and confirmed at least two times in the population sampled at the ASCL is no longer considered a rare variant. These peaks can be confidently and accurately called without confirmation.

9.6.2.2.5 TRI-ALLELE

A tri-allelic system is one which contains three distinct alleles, rather than the normal one or two. In order to insure that the sample is a true tri-allelic specimen, the sample will be re-amplified and run a second time. If observed in overlapping systems or in multiple samples from the case, tri-allelic loci may be considered confirmed. If there is not enough extract left for re-amplification, the sample may be re-loaded. However, if the tri-allelic sample cannot be confirmed, the locus may be reported as inconclusive or a technical note may be recorded in the case file (the Casework Supervisor or Technical Leader needs to be notified). Confirmed triallelic loci will not be used for statistical calculations.

9.6.2.2.6 ARTIFACTS

Artifacts can occur and need to be recognized. These may include, but are not limited to, the following: spikes, pull-up, stutter, and non-template nucleotide addition.

9.6.2.2.6.1 SPIKES

Spikes are artifactual peaks usually observed in at least two colors. Spikes can be caused by urea crystals in the capillary, power surges, or other instrument related issues. A spike will not exhibit the same morphology as a peak, but will be sharper or “spike” shaped. Spikes are unique to fragments analyzed using capillary electrophoresis. Spikes will have fragment sizes which vary only slightly in the 3500xl data. Above threshold spikes will be noted and may be re-injected.

9.6.2.2.6.2 STUTTER

In addition to an allele’s primary peak, artifact peaks can occur at 2-, 3-, 4-, or 5-base intervals. The most common stutter peaks observed in all loci are 1 repeat smaller than the primary

peak (“n-4”). It is also possible to see additional peaks 1 repeat larger (“n+4”), especially when excessive DNA template is amplified.

Stutter peaks are evaluated by examining the ratio of the stutter peak height to the height of the appropriate adjacent allele, expressed as a percentage. The height of stutter peaks can vary by locus, and longer alleles within a locus generally have a higher percentage of stutter. The maximum expected percentage of stutter is less than 25% for any locus. Peaks in the stutter positions greater than this value may indicate the presence of a mixture. In addition to a mixed sample, stutter peaks may be elevated above established thresholds by the following:

Analyzed peak heights above the optimal range may be “off-scale” in the raw data, meaning that the CCD camera may be saturated. While the GeneMapper ID-X software will alert the analyst to any off-scale raw data peaks, the analyzed peak may be assigned a lower value due to smoothing and base-lining functions. Therefore, the observed percent stutter will be inaccurately high. If the stutter peak is greater than the maximum allowed and the primary peak is above 20,000 RFU and/or has been labeled off-scale, the analyst will interpret the results with caution. The sample may be re-amplified with less input DNA or re-injected.

Approved STR Stutter Ratios can be seen in table form in Appendix E.

9.6.2.2.6.3 NON-TEMPLATE NUCLEOTIDE ADDITION (-A)

Amplification conditions have been set to maximize the non-template addition of a 3' terminal nucleotide by DNA polymerase. Failure to attain complete terminal nucleotide addition results in “band splitting”, visualized as two peaks one base apart. This is most often seen when an excessive amount of DNA is amplified or amplification is performed under sub-optimal PCR conditions.

9.6.2.2.6.4 PULL-UP

Small artifactual peaks can appear in other colors under true peaks. This phenomenon is termed “pull-up”. Pull-up is a result of spectral overlap between the dyes, which is normally corrected for by the spectral calibration. If a pull-up peak is above the minimum peak height detection threshold, it will be sized at approximately the same size as the true peak. Pull-up can occur as a result of the following:

- Application of a sub-optimal spectral can cause pull-up. If necessary, spectral standards can be injected on the same capillary after the analytical run and a new spectral can be made and applied.
- Amplification using excess input DNA can lead to off-scale peaks. The matrix may not perform properly with off-scale data.

9.6.2.2.6.5 OTHER

In addition to amplification artifacts described above the following anomalies can arise during electrophoresis and analysis:

Significant room temperature fluctuation may result in size variation between injections such that allelic ladder peaks differ by more than 0.5 bp from allelic peaks in other injections. This will disrupt sample analysis using the GeneMapper ID-X program. Analyzing samples with an injection of allelic ladder nearest the questioned samples may alleviate this problem. If desired, the sample(s) and an allelic ladder may be re-injected to confirm the typing.

Artifactual peaks of a single color will not display the typical spectral overlap characteristic of the five fluorescent dyes in the raw data. Peak width may not be similar to the peaks resulting from dye-labeled DNA. These peaks can be shown to be artifactual by re-injection of the sample.

9.6.2.2.7 DETECTION OF SINGLE SOURCE SAMPLES

A sample is consistent with being from a single source if each locus typed has only one or two alleles. For an apparent single-source questioned sample, compare the results obtained from the questioned sample with the results from the known samples in the case. The determination of inclusions or exclusions is the responsibility of the analyst working the case. This determination is based on all tests and observations made for that sample.

9.6.2.2.8 DETECTION OF MIXTURES

Samples may contain DNA from more than one individual. A sample may be consistent with being a mixture if it exhibits one or more of the following characteristics at more than one locus:

- More than two alleles are present a locus after stutter and other artifact considerations have been evaluated and dismissed as possible causes.
- A peak is present at a stutter location and its height is greater than the pre-determine stutter ratios of the height of the appropriate adjacent allele.
- Severely unbalanced peak height ratios exist for sister alleles of heterozygous genotypes within the profile. With the possible exception of low template amplifications, ratios less than 60% are rare in normal unmixed samples.

9.6.2.2.9 INTERPRETATION OF MIXED SAMPLES

The interpretation applied to a mixed sample by the analyst in each particular case will be based upon all relevant information. Appendix B is a Generalized Guideline for Mixture Interpretation Workflow. The workflow and the guidelines below allow for the interpretation of the majority of samples in the DNA section of the ASCL. Any significant deviation from the

workflow or guidelines below needs to be discussed and approved by the DNA Technical Leader.

- **Note – For PowerPlex 16 HS** All mixture samples will have been injected for 24 seconds on the 3500xl. The two exceptions to this rule in PowerPlex 16 HS are if the minor is already too complex in the 12 second injection data, and if the minor profile is the victim that will be applied to the mixture.
- Determination of the number of contributors is performed by examining all loci for the number of alleles present. (Caution should be taken when the potential contributors are related due to the sharing potential of sharing alleles)
- If any locus has greater than 6 alleles the sample has four or more contributors and is deemed inconclusive.
- If any locus has greater than 4 alleles then the number of total autosomal alleles needs to be counted.
- If there are greater than 97 total autosomal alleles (63 in PP16HS) the sample is most likely a four person mix and is deemed inconclusive.
- If there are between 90 and 97 (between 59 and 63 in PP16HS) total autosomal alleles then the mixture could be a three or four person mixture and will be interpreted with caution.
- If there are less than 90 (59 in PP16HS) total autosomal alleles then the mixture is most likely a 3 person mixture and may be analyzed.
- If no locus has more than 4 alleles then the peak height ratios will be examined to insure they are consistent with a two person mixture.
- If there is a dominant profile present in the mixture, one can determine any inclusions or exclusions by comparing the profiles from known reference samples with the dominant DNA types. Dominant types of a mixture can be assigned based on peak heights as well as peak height ratios.
- Profile frequency estimates and/or source attribution can be reported for the dominant DNA profile.
- Information can be gained from minor profiles observed in mixtures as to possible inclusion or exclusions of sources. Mixture statistics will be applied to the entire profile where the minor contributor cannot be clearly determined. Use of the ArmedXpert software can assist in the separating the mixture. RMP stats may be applied to deduced minors.
- When using ArmedXpert and more than one source of DNA is detected but cannot be separated, then all likely genotype combinations must be considered for each locus. (restricted RMP)

- In the event of a complex mixture where the number of contributors is determined to be 3 or more the sample can be marked as inconclusive. The interpretation and use of a complex mixture of this nature requires approval of the DNA Casework Supervisor, DNA Technical Leader, or the CODIS Administrator.

9.6.2.2.10 INCOMPLETE / PARTIAL STR PROFILES

The possibility exists that not every locus will amplify. This can occur if the DNA is of limited quantity, severely degraded, or if the DNA sample contains PCR inhibitors. Since loci are independent, any locus that shows results can be evaluated. Statistical applications can be used on the loci that give results above 175 RFU for PowerPlex 16 HS and PowerPlex Fusion 6C. However there is a decrease in peak height heterozygosity with lower levels of DNA. One must interpret a homozygote near the threshold of interpretation with caution. Incomplete samples may be reamplified with increased template amounts up to 5ng per reaction.

9.6.2.2.11 PARTIAL MIXED STR PROFILES

It is possible in a mixture that the entire profile from one of the contributors is not represented. This may be due to allele drop out or allele masking in a stutter position. In this situation an individual cannot necessarily be excluded from contributing to the mixed DNA profile and will be reported as “cannot be excluded from contributing to the mixed profile from ...” The affected areas will be left out of the statistical calculation.

9.6.2.2.12 STR PROFILE INTERPRETATION

Following GeneMapper analysis, each sample is evaluated at each locus by visual identification of amplified product(s). The alleles are recorded and comparisons are made between the question samples and reference standards. Determining whether the genotype of one sample is consistent with the genotype of another sample is based on the analyst’s professional, trained judgment.

Inclusion: If the reference standard sample genotype(s) is/are present in the evidentiary or questioned sample(s), at all loci tested, the reference individual is included as a possible source of the DNA. If the evidence sample is degraded or limited alleles are obtained, the suspect can still be included if his/her alleles are consistent with that of the evidence. If the evidence sample is a mixture, and the suspect’s alleles are included in that mixture, he/she can still be included.

Exclusion: If at any locus tested, the reference standard sample genotype(s) is/are not present in the evidentiary or questioned single source sample(s), the reference individual is excluded as a possible source of the DNA. Exclusions in mixtures or degraded (partial) profiles will be determined by locus to locus comparison. Exclusions cannot be made on profiles that have been deemed too limited for interpretational value.

Inconclusive: It is possible to obtain a STR profile that contains a complex mixture from multiple individuals, contains alleles that do not meet the analytical or stochastic threshold, or have poor peak morphology. In these cases the result may be reported as uninterpretable or inconclusive. If a sample is reported as inconclusive then a reason must be given in the report, (a. the complexity of the mixture, b. insufficient quality of data, c. limited amount of DNA) Example "The DNA profile obtained from Q1 is inconclusive for comparative purposes due to the complexity of the mixture ".

Criminal Paternity: In criminal paternity and missing person's cases (identity), exclusions are only reported if there are two or more loci inconsistent with the unknown individual when compared to each relative to account for mutations. It is noted that mutation rates can be obtained from the NIST STR-Base website and the mutation must be included on the report. Any mutation occurring from father to male child will have Y-STR analysis performed for confirmation.

9.6.2.2.13 STATISTICAL CALCULATIONS

The frequency of occurrence between allele fragments of samples reported as being consistent is determined for each polymorphic locus within a racial group.

The frequency associated with a particular pattern of alleles from a sample is based upon principles of Hardy-Weinberg equilibrium.

If the sample under analysis demonstrates two alleles, the frequency is determined by the equation $2pq$, where p and q represent the frequencies of allele #1 and #2.

If the sample under analysis consists of a single allele, the frequency is determined by the equation $p^2 + p(1-p)\theta = 0.01$ and p represents the frequency of the allele.

If a known sample consists of more than two alleles at a particular locus, no frequency data will be generated for that locus.

The frequency for the overall DNA pattern resulting from the alleles detected at different loci, termed a profile, is determined by multiplying the genotype frequency obtained from each locus.

Procedure for calculating allele and genotype frequencies:

The following represents an example of data collected from a PCR database and the procedures used to determine the allele and genotype frequencies.

Example: TH01 locus in Caucasian population (n = 209)

Allele frequency:

Frequency of allele = Number of times the allele was observed out of all possible alleles for a particular locus/2n.

Minimum Allele Frequency (NRC II, 1996)

NOTE: This method requires that a minimum of 5 copies of an allele before the allele frequency can be used for calculation of genotype frequency.

This estimate is strictly driven by database size:

Minimum allele frequency = $5/2N$

N = the number of individuals in the database

For the 13 allele at vWA:

Actual allele frequency = $2/392 = .0051$

Minimal allele frequency = $5/392 = .0128$

This method is conservative and also addresses some substructure effects.

Expected Genotype Frequency:

Based on the assumption that the TH01 genetic locus is in Hardy-Weinberg equilibrium, the expected genotype frequencies are calculated from the allele frequencies, as in the following examples:

TH01 Genotype 7, 7:

$$(\text{Frequency of 7 allele})^2 + \text{Frequency of the 7 allele (1-Frequency of 7 allele)}\theta = (0.141)^2 + 0.141(1-0.141)0.01 = 0.021$$

OR

TH01 Genotype 7, 9.3:

$$2(\text{Frequency of 7 allele})(\text{Frequency of 9.3 allele}) = 2(0.141)(0.340) = 0.096$$

9.6.2.2.14 ARMEDXPRT

ArmedXpert software allows an analyst to determine the probability of drawing a specific DNA profile at random from a given population. The calculations show whether the probability of a random match with the DNA profile in question is high or low.

- a) A high probability indicates that the profile's characteristics are quite common within the population. Thus, the profile does not distinguish itself from others in the population
- b) A low probability indicates that the profile's characteristics are quite rare. This strongly indicates that the profile represents the individual in question.

9.6.2.2.15 SINGLE SOURCE STAIN

Statistical significance for single source stains will be calculated according to the following:

- a) Statistical significance will be expressed as an inverse probability of inclusion. (profile frequency = 0.00020 = 1 in 5,000)
- b) For homozygotes (AA),

Recommendation 4.1 – National Research Council report “The Evaluation of Forensic DNA Evidence” 1996, the following formula will be used:

$$p^2 + p(1-p)\theta$$

$\theta = 0.01$ for general US population

$\theta = 0.03$ for isolated groups (American Indians)

- c) For heterozygotes (AB), the formula : $F = 2pq$
- d) For all loci to identify the match: $F = (f_1 \times f_2 \times f_3 \dots)$
- e) Inverse probability = $1/F$

9.6.2.2.16 MIXED DNA STAINS

If the profile is to be treated as a DNA mixture, then the profile can be analyzed in one of the following manners:

- a) **Mixture formula:** *based on the genotypes selected for calculation. Formula used for calculation can be seen on the calculation page in ArmedXpert.*

The inverse probability ($1/F$) will be reported.

- b) **Likelihood ratio:** For each mixed DNA profile E, the likelihood ratio,

$$L = P(E|C_x) / P(E|C_y)$$

For comparing two explanations, C_x and C_y , this mixed profile is calculated where $P(E|C_x)$ is the probability of the profile E to have arisen under explanation C_x . An input screen with three grids allows the user of Popstats to enter the mixed profile; the alleles of the mixed profile which are believed to come from x unknown contributors under explanation C_x ; and the alleles of the mixed profile which are believed to come from y unknown contributors under explanation C_y . The user also has to specify what the number of unknowns, x and y , are for explanations C_x and C_y , respectively. The number of unknown contributors must be strictly greater than half of the number of those bands/alleles they contribute for each locus. **For example:** If there are 3 bands for locus Th01, 4 bands for locus vWA, and 2 alleles for locus TPOX from x contributors, then x has to be strictly greater than $3/2$, $4/2$ and $2/2$. Therefore, $x \geq 2$.

- c) **Probability of Exclusion (PE)**

**Note* Probability of Exclusion is retained primarily as a statistical calculation for kinship and historical data that cannot be reanalyzed with more current methods. CPE / CPI can only be performed on loci that do not show signs of dropout (peaks below the stochastic threshold, or otherwise indicated on historical data.)*

Example: STR Alleles in a mixture: 11, 13, 15

Given the allele frequencies in the Caucasian population below:

Allele Frequency 11 = 0.122

Allele Frequency 13 = 0.176

Allele Frequency 15 = 0.041

- P (probability) = 0.339 , $Q = 1 - P = 0.661$
- P.E. (probability of exclusion)
- CPE (Combined Probability of Exclusion)
- $CPE = 1(1-PE_i)(1-PE_j)(1-PE_k)$
- $CPE = 1-(1-.885)(1-.398)(1-.505)$
- $CPE = 1-(.115)(.602)(.459)$
- $CPE = 1-(0.034)$
- $CPE = 0.966$

With a CPE of 0.966, 96.6 % of unrelated (Caucasians) would be expected to be excluded as contributors to the observed DNA Mixture.

CPI (Combined Probability of Inclusion)

- 3.4% of unrelated (Caucasians) could not be excluded as contributors to the observed DNA mixture.

9.6.2.2.17 KINSHIP

Statistical significance for kinship will be calculated using Popstats native to the CODIS v.8.0 software package. (Explanation of Popstats calculations as listed in CODIS 8.0 Help files can be seen in Appendix C). The typical calculations include:

- Paternity Trio and Reverse Paternity Trio
- Single Parent Kinship
- Full-Sibling Kinship
- Additional comparisons may be used but reporting guidelines have not been defined and will require consultation with the Technical leader and DNA Supervisor.

9.6.2.2.18 POPULATION DATABASE

Beginning with CODIS v8.0, the ASCL began using the 2017 Revised National Institute of Standards and Technology U.S. Population Dataset (NIST SRD 1036). Available populations include African American, Asian, Caucasian, and Hispanic, as well as a Combined dataset.

References:

- Hill, C.R., Duewer, D.L., Kline, M.C., Coble, M.D., Butler, J.M. (2013) U.S. population data for 29 autosomal STR loci. *Forensic Sci. Int. Genet.* 7: e82-e83.
- Steffen, C.R., [Corrigendum to 'U.S. Population Data for 29 Autosomal STR Loci' \(2017\)](#) *Forensic Science International: Genetics*

9.6.2.3 ANALYSIS OF AUTOSOMAL PROFILES WITH ARMEDXPRT SOFTWARE

9.6.2.4 Y-STR INTERPRETATION GUIDELINE

The interpretation of results in casework is a matter of professional judgment and expertise. Not every situation can or should be covered by a pre-set rule. However, it is important that the laboratory develops and adheres to minimum criteria for interpretation of analytical results. These criteria are based on validation studies, literature references, and casework. It is to be expected that these interpretation guidelines will continue to evolve as the technology and collective experience of the laboratory grows.

The purpose of these guidelines is to establish a general framework and outline minimum standards to ensure that:

- Conclusions in casework reports are scientifically supported by the analytical data, including that obtained from appropriate standards and controls;
- Interpretations are made as objectively as possible, consistently from analyst to analyst, and within established limits.
 - The evaluation of question items includes identifying artifacts and variant alleles, determining the number of contributors, and examining any other quality indicators to assess the suitability of the profile for comparison and (if applicable) for statistical rarity calculations, prior to comparison to one or more known reference items.
 - Known reference items, with few exceptions, are expected to consist of DNA from only one individual but as with question items, must also be evaluated for suitability prior to comparison. Additionally, known reference items must be assessed for the probative value of a comparison to an item of evidence prior to the comparison. Comparisons which cannot provide probative information may be evaluated to allow further deconvolution by assuming a contribution or be omitted entirely, as appropriate.

The goal of the evaluation and interpretation of amplified STR data is to determine the DNA profile(s) of the donor(s) of the questioned samples for comparison to reference sample profiles.

- A peak is defined as a distinct, triangular section of an electropherogram.
- Haplotypes are determined from the diagnostic peaks of the appropriate color and size range for a particular locus.

9.6.2.4.1 ANALYTICAL THRESHOLD (AT)

A minimum peak height threshold will be set for GeneMapper ID-X software recognition of a peak. Optimal peak height values range between 1000-4000 RFU, although acceptable and typeable signals may occur outside of this range.

If no alleles are detected in a locus then a single dash (-) may be placed on the call sheet for the locus.

PowerPlex Y23: 175 RFU in all channels (*historical data only*)

Yfiler Plus: 100 RFU in all channels

9.6.2.4.2 OFF LADDER VARIANTS

Off ladder (OL) calls are first converted to size in base pairs (bp), then compared to the size of the appropriate ladder alleles and the allelic designation determined. If the OL is not a “perfect” repeat, but rather varies by 1, 2 or 3 bp from a ladder allele, then it will be designated as an integer of that variation. For example, in Y23 if a green OL peak size is 238.39 bp, and the 13 allele of the **DYS19** ladder is 236.32 bp, then the peak will be designated a **DYS19** 13.2. If an allele falls above the largest or below the smallest peak of the sizing ladder, the allele will be designated as either greater than (>) or less than (<) the respective ladder allele.

The analyst will either re-amplify or re-inject, then type any sample containing a peak not properly interpreted as an allele by the software. An off ladder variant which has been seen and confirmed at least two times in the population sampled at the ASCL is no longer considered a rare variant. These peaks can be confidently and accurately called without confirmation.

9.6.2.4.3 ARTIFACTS

Artifacts can occur and need to be recognized. These may include, but are not limited to, the following: spikes, pull-up, stutter, and non-template nucleotide addition.

9.6.2.4.3.1 SPIKES

Spikes are artifact peaks usually observed in at least two colors. Spikes can be caused by urea crystals in the capillary, power surges, or other instrument related issues. A spike will not exhibit the same morphology as a peak, but will be sharper or “spike” shaped. Spikes are unique to fragments analyzed using capillary electrophoresis. Spikes will have identical fragment sizes in the ABI 3500xl data, and fragment sizes which vary only slightly in the ABI 3500xl data. Above threshold spikes will be noted and may be re-injected.

9.6.2.4.3.2 NON-TEMPLATE NUCLEOTIDE ADDITION (-A)

Amplification conditions have been set to maximize the non-template addition of a 3’ terminal nucleotide by AmpliTaq Gold DNA polymerase. Failure to attain complete terminal nucleotide addition results in two peaks, one base apart. This is most often seen when an excessive amount of DNA is amplified or the amplification is performed under sub-optimal PCR conditions.

9.6.2.4.3.3 PULL-UP/PULL-DOWN (PU)

Small artifact peaks can appear in other colors under true peaks. This phenomenon is termed “pull-up”. Pull-up is a result of spectral overlap between the dyes, which is normally corrected for by the spectral. If a pull-up peak is above the minimum peak height detection threshold, it will be sized at the same size as the true peak. Pull-up can occur as a result of the following:

- Application of a sub-optimal spectral can cause pull-up. If necessary, spectral standards can be injected on the same capillary after the analytical run and a new spectral can be made and applied.
- Amplification using excess input DNA can lead to off-scale peaks. The matrix may not perform properly with off-scale data.

9.6.2.4.3.4 STUTTER (ST)

These are artifacts due to template slippage during the amplification process. These peaks may be observed in the 2bp, 3bp, 4bp or 5bp positions of major peaks and will have a smaller peak height. GeneMapper ID-X will apply a filter based on the observed stutter percentage seen in validation. As there is potential for true peaks to be filtered and not all stutter peaks will always be filtered, the analyst must examine all profiles carefully.

Approved YSTR Stutter Ratios can be seen in table form in Appendix E.

9.6.2.4.3.5 SPIKES

Spikes are artifactual peaks usually observed in at least two colors. Spikes can be caused by urea crystals in the capillary, power surges, or other instrument related issues. A spike will not exhibit the same morphology as a peak, but will be sharper or “spike” shaped. Spikes are unique to fragments analyzed using capillary electrophoresis. Spikes will have identical fragment sizes in the ABI 3500xl data, and fragment sizes which vary only slightly in the ABI 3500xl data. Above threshold spikes will be noted and may be re-injected.

9.6.2.4.3.6 NON-TEMPLATE NUCLEOTIDE ADDITION (-A)

Amplification conditions have been set to maximize the non-template addition of a 3' terminal nucleotide by AmpliTaq Gold DNA polymerase. Failure to attain complete terminal nucleotide addition results in “band splitting”, visualized as two peaks one base apart. This is most often seen when an excessive amount of DNA is amplified or amplification is performed under sub-optimal PCR conditions.

9.6.2.4.3.7 PULL-UP

Small artifact peaks can appear in other colors under true peaks. This phenomenon is termed “pull-up”. Pull-up is a result of spectral overlap between the dyes, which is normally corrected for by the spectral. If a pull-up peak is above the minimum peak height detection threshold, it will be sized at the same size as the true peak. Pull-up can occur as a result of the following:

- Application of a sub-optimal spectral can cause pull-up. If necessary, spectral standards can be injected on the same capillary after the analytical run and a new spectral can be made and applied.
- Amplification using excess input DNA can lead to off-scale peaks. The matrix may not perform properly with off-scale data.

9.6.2.4.3.8 OTHER

In addition to amplification artifacts described above the following anomalies can arise during electrophoresis and analysis:

Significant room temperature fluctuation may result in size variation between injections such that allelic ladder peaks differ by more than 0.5 bp from allelic peaks in other injections. This will disrupt sample analysis using the GeneMapper ID program. Analyzing samples with an injection of allelic ladder nearest the questioned samples may alleviate this problem. If desired, the sample(s) and an allelic ladder may be re-injected to confirm the typing.

Artifact peaks of a single color will not display the typical spectral overlap characteristic of the five fluorescent dyes in the raw data. Peak width may not be similar to the peaks resulting from dye-labeled DNA. These peaks can be shown to be of an artifact nature by re-injection of the sample.

9.6.2.4.4 MULTI-ALLELIC LOCI

A multi-allelic system is one which contains several distinct alleles, rather than the normal one (or two in DYS385, DYS389, or DYS387S1). In order to insure that the sample is a true multi-allelic specimen, the sample will be re-amplified and run a second time. However, if observed in overlapping systems or in multiple samples from the case, multi-allelic loci may be considered confirmed. If there is not enough extract left for re-amplification, the sample may be re-loaded. However, if the multi-allelic sample cannot be confirmed, the locus may be reported as inconclusive or a technical note may be recorded in the case file (the Casework Supervisor or Technical Leader may need to be notified to determine how to report the locus). Confirmed multi-allelic areas will not be used for statistical calculations.

9.6.2.4.5 DETECTION OF SINGLE MALE CONTRIBUTOR

A sample may be considered to represent a single male haplotype when the observed number

of alleles at each locus is one (except DYS385, DYS389, or DYS387S1) and the signal intensity ratio of alleles at a duplicated locus is consistent with a profile from a single contributor. All loci will be evaluated in making this determination. It will be noted that individuals have been typed who exhibit multiple locus duplications.

9.6.2.4.6 DETECTION OF MIXTURES

Mixed DNA samples are commonly encountered. All loci must be taken into consideration when interpreting a mixture. Less intense peaks that fall in the common stutter positions will be interpreted with caution based on the analyst's training and experience. As a guideline, the maximum expected stutter percentages for each locus are listed in tables above. If a profile is determined to have more than one contributor, then the maximal number of contributors should also be determined. The validation of PowerPlex Y23 examined mixtures with two contributors. For this reason, any historical Y23 mixture with more than two contributors must be considered inconclusive. The validation for Yfiler Plus examined mixtures with up to three contributors and for this reason, any mixtures with more than three contributors must be considered inconclusive.

9.6.2.4.7 INTERPRETATION OF MIXED SAMPLES

- Mixtures with Major/Minor Male Contributors

A sample may be considered to consist of a mixture of major and minor male contributors if a distinct contrast in signal intensity exists among the alleles from loci with good amplification quality. A ratio between contributors will be estimated, with all loci of good quality will be evaluated in making this determination. If a major component cannot be fully deconvoluted from the mixture at all loci, the remaining loci with alleles from both contributors may still be used in the statistical calculator by including both alleles and searching in the mixture configuration.

PPY23: Based on the Y23 validation, a Mixture Interpretation Guideline (MIG) of 175 rfu above analytical threshold has been established for the interpretation of loci with only one allele. For an example using a 2:1 ratio between contributors, the minor component should be expected to be at least 350rfu. The actual allele must therefore be over 1050 rfu (700rfu+350rfu) before the minor contributor may be considered.

Based on the Mixture Interpretation Guideline, loci with only one allele, less than 350rfu, should not be assigned to either contributor due to the possibility of drop-out for both major and minor contributors.

Yfiler Plus: Based on the Yfiler validation data, any two-male mixture for which the major contributor is estimated to exceed 75% of the total template, the largest allele(s) at each loci are recommended to be designated as part of the major contributor profile. Additionally, alleles should also be designated as part of the major profile based on a minimum 2:1 ratio at each loci if the majority of loci in a two-male mixture shows a minimum 2:1 ratio.

For the three-male mixtures, the major alleles may be identified when the peak heights are approximately twice the remaining allele peak heights for each loci, and may be further deconvoluted by the assumption of either the middle or minor contributor's

profile. Alleles from the middle or minor contributor are more challenging to attribute and should not be attempted unless assisted by the assumption of either the middle or minor contributor's profile (obligate peaks or over 500 rfu).

- Mixtures with Known Male Contributor(s)

In some cases such as when a male may be an assumed contributor (e.g., the victim), the genetic profile of the unknown male contributor may be inferred. Depending on the profiles in the specific instance, this can be accomplished by subtracting the contribution of the known male donor from the mixed profile.

- Mixtures with Indistinguishable Male Contributors

When major or minor male contributors cannot be distinguished because of similarity in signal intensities or the presence of shared or masked alleles, individual males may still be included or excluded as possible contributors. Indistinguishable mixtures can be processed using the Y mixture tool (YSTR_STATS_v4.3). The mixture is copied or typed into the sheet and all possible Y-STR profiles are compared against the US Y-STR database. The results are reported as the number of profiles that could be included in the mixture and the percent of the population that would be expected to be excluded.

Note: Any result discrepancies between two qualified analysts that cannot be resolved may be mediated and interpreted by a third qualified DNA analyst. The Supervisor or Technical Leader will render all final allele determinations when consensus cannot be reached.

9.6.2.4.8 INCOMPLETE Y-STR PROFILES

The possibility exists that not every locus will amplify. This can occur if the DNA is degraded, if the DNA sample contains PCR inhibitors or if a very small quantity of DNA has been amplified. Since each locus is an independent marker whose results are not based upon information provided by the other markers, results can generally still be interpreted from the loci that do amplify. For both Y23 and Yfiler Plus, profiles with 9 or more loci are generally acceptable for interpretation, profiles with less than 6 should generally be considered very marginal and only be used when the specific case warrants it (such as for exclusion or number of contributors considerations).

9.6.2.4.9 Y-STR PROFILE INTERPRETATION

Following GeneMapper analysis, each sample is evaluated at each locus by visual identification of amplified product(s). The alleles are recorded and comparisons are made between the question samples and reference standards. Determining whether the genotype of one sample is consistent with the genotype of another sample is based on the analyst's professional, trained judgment.

Inclusion: If the reference standard sample genotype(s) is/are present in the evidentiary or questioned sample(s), at all loci tested, the reference individual is included as a possible source of the DNA. If the evidence sample is degraded or limited alleles are

obtained, the suspect can still be included if his/her alleles are consistent with that of the evidence. If the evidence sample is a mixture, and the suspect's alleles are included in that mixture, he/she can still be included.

Exclusion: If at any locus tested, the reference standard sample genotype(s) is/are not present in the evidentiary or questioned single source sample(s), the reference individual is excluded as a possible source of the DNA. Exclusions in mixtures or degraded (partial) profiles will be determined by locus to locus comparison. Exclusions cannot be made on profiles that have been deemed too limited for interpretational value.

Too Limited for Comparative Purposes: This may occur when the allele signals are weak or only very limited genetic information is obtained. Example: Only results from one or two loci are obtained with very light signal, possibly allelic drop out, allelic drop in. This type of genetic information would be too limited for interpretational value.

Inconclusive: It is possible to obtain a STR profile that contains a complex mixture from multiple individuals and contains alleles that do not meet the analytical threshold or peak morphology. In these cases the result may be reported as uninterpretable or inconclusive. If a sample is reported as inconclusive then a reason must be given in the report, (a. the complexity of the mixture, b. insufficient quality of data, c. limited amount of DNA) Example "The DNA profile obtained from Q1 is inconclusive for comparative purposes due to the complexity of the mixture."

9.6.2.4.10 STATISTICAL CALCULATIONS

Recommendations of the *SWGDM Interpretation Guidelines for Y-Chromosomal Typing, 2014*, are followed for the interpretation of YSTR profiles. The counting method is the basis of the preferred way to perform statistical calculations for Y-STRs due to the lack of independent recombination between loci. The counting method involves searching a given haplotype against a database to determine the number of times the haplotype was observed in that database. The search of the haplotype and all statistical calculations are performed using the *YSTR_STATS* excel sheet which originated from the *California DOJ Y-Mix Database Filter Tool* utilizing the US Y-STR Database and adapted for use by the ASCL. The US Y-STR Database is located at the following location: <http://www.usystrdatabase.org/newdefault.aspx>.

In most circumstances, single-source and fully deconvoluted mixture profiles will be searched in the *YSTR_STATS_vX* tool as single source samples. If the reference profile cannot be excluded from the evidence profile, the results will be reported as the number of observations in the database for each population. Any conclusion will include the likelihood of exclusion, with the match probability reported as a likelihood ratio for each population.

Under typical circumstances, indistinguishable mixture profiles may be searched in the *YSTR_STATS_vX* tool as multiple source samples. If the reference profile cannot be excluded from the mixture profile, the results will be reported as the number of observations in the

database for each population. Any conclusion will include the likelihood of exclusion, with the match probability for each population reported as an expected profile frequency.

Due to the different sizes of the Yfiler Plus, and Y23 databases, which make up the US-Y-STR Database, differing strategies are needed to maximize the potential value of the differing profiles. When comparing a Y23 profile, the standard method is to use the entire profile in a limited search against the other Y23 profiles in the database. These results should be compared to a limited search against the original Yfiler core loci or even an unlimited search against the entire database. The Y23 search results can then be safely reported. However, the Yfiler Plus profile cannot likewise be searched against the more limited Yfiler Plus profile database, as the database is smaller and the appropriate theta values have not been experimentally derived. Therefore, the most appropriate search method for Yfiler Plus is to limit the entered loci to the original Yfiler core and use a limited search setting. This is also the most appropriate result to report when comparing Yfiler or Yfiler Plus profile to a Y23 profile. See Appendix D for further discussion of Y-STR Statistical considerations.

9.7 DETECTION & CONTROL OF CONTAMINATION

The ASCL employs several safeguards to detect any contamination that might occur. The reagent blank detects contamination during extraction, and the amplification blank detects contamination during the setup of amplification. In order to reduce the possibility of contamination, the ASCL has devised procedures listed in the section on evidence handling and processing.

Additional information on instrument cleaning can be found in Section 10 and other general contamination control information can be found in Section 18.

If contamination has been discovered, the laboratory will try to discover the source of the contamination. The incident will be documented on a *Deviations/Non-Conformance Form* ([CODIS-FORM-17](#)). If a DNA employee is found to be the source of the contamination, the Casework Supervisor will be notified and take the necessary corrective actions. If the contamination is from outside the DNA section, the appropriate supervisor will be notified to address the contamination source. If the contamination is systemic issue, the lab wide Quality Manager will be notified and a Quality Assurance Concern (QAC) may be necessary.

10 EQUIPMENT

10.1 BACKGROUND

Only suitable and properly operating equipment will be employed and only authorized personnel will operate the equipment. The purpose of the procedures in this section is to ensure that the parameters of the testing process are routinely monitored in the manner necessary to maintain the success and reliability of the testing procedures. The ASCL Forensic DNA section does not use equipment outside of ASCL permanent control.

In order to safeguard irreplaceable and/or limited samples, quality control (QC) procedures will focus as much as possible on preventing problems before they occur rather than dealing with them after they happen. As such, it is the responsibility of all DNA personnel to report quality issues to the DNA Quality Manager, DNA Supervisor, and/or DNA Technical Leader. In the event a quality issue is found which may affect analyzed samples, it is preferable that effected samples be reprocessed. However, where the samples are irreplaceable and/or limited in amount, reprocessing may not be a viable option. In such a case, it is possible to verify “after the fact” that the equipment, materials and reagents used in an analysis have not significantly affected the reliability of the results.

For example, controls utilized during each phase of the testing procedure are designed to signal potential problems in the analysis. If acceptable results are obtained on these controls, it is reasonable to assume that the results from other samples analyzed simultaneously are also reliable.

If the controls indicate a problem with the analysis, it may be possible to determine the source of the problem and make corrections. Depending on the nature of the problem, re-analysis of the samples may be required.

10.2 INSTRUMENT & EQUIPMENT

New employees shall be trained on the appropriate equipment during their training program and be authorized to operate the equipment. This authorization will be documented on Analyst & Technician Competency Authorization, ASCL-FORM-62, and shall be maintained in Qualtrax. Validation of new equipment, procedures, and software shall require training of personnel before authorization. Only individuals trained in the proper use of the equipment shall be authorized to operate it independently. Instructions on the use and maintenance of equipment shall be available for use.

10.2.1 CRITICAL INSTRUMENTS

The following Category 1 equipment is considered to be critical for the Forensic DNA section:

Pipettes	Thermocyclers	EZ-1
3500xl	7500	Qiagility
Qiacube	NIST-Thermometer	Drift-Con
Heat Blocks		

10.2.2 INVENTORY

An inventory log will be maintained on the FB drive for each instrument or piece of equipment considered to be essential for DNA analysis. This log may include the manufacturer, model number, serial number, purchase date, replacement date, and if present, asset number and all additional requirements of the *ASCL QM*.

10.2.3 OPERATING MANUALS

Warranty information and operating manuals will be filed in the laboratory and readily available to all operators of instruments and equipment in either paper or electronic form.

10.3 PERFORMANCE CHECKS

Any new critical instruments or equipment that has been serviced requires a performance check to ensure it is operating properly before being used for casework analysis. The performance check will be documented and approved by the DNA technical leader.

- a) 7500: Following the maintenance, repair, or moving of a 7500, a performance check will be performed. The performance check requires a set of standards be run (that have already been QC checked) and have a passing R2 value of .98 or above and the top standard be within 2 standard deviations of the validation values.
- b) 3500xL: Following the maintenance, repair, or moving of a 3500xl, a performance check will be performed. The performance check requires a ladder to be injected using the standard protocol. The run will then be analyzed in GeneMapper ID-X to ensure that the ladder passes the requirements setup in GeneMapper ID-X.
- c) Thermocycler: Following maintenance, repair, or moving, a performance check will be performed. The performance check requires a set (minimum of 2) of positive controls (2800M, CG, etc) and an AMP_Neg to be amplified according to the current Autosomal STR amplification protocol. The samples will then be run on the 3500xl and analyzed in GeneMapper ID-X to ensure the samples amplified properly. All samples are required to amplify properly to pass the performance check. The DNA Technical Leader can override this requirement if there are documented reasons for the failure.
- d) Qiagility: Following maintenance, repair, or moving, a performance check will be performed. The performance check requires a set of standards be run on the 7500 (that have already been QC checked) and have a passing R2 value of .98 or above and the top standard be within 2 standard deviations of the validation values.

- e) Qiagen EZ1: Following maintenance, repair, or moving, a performance check will be performed. The performance check requires a set (minimum of 2) of blood with known profiles on FTA to be extracted, quantified, amplified, and run on a 3500xl. The set will then be analyzed with GeneMapper ID-X to ensure the extraction occurred properly. A passing performance check is when the amount of DNA extracted is at least 0.05 ng/μL and the sample produces the expected DNA profile.
- f) Qiagen Qiacube: Following maintenance, repair, or moving, a performance check will be performed. The performance check requires a set (minimum of 2) of Semen-containing sample. These samples will be prepared by mixing saliva swab with semen. A passing performance check will show a useable male contribution in the semen fraction by analyzing the quantitation data.
- g) NIST-Traceable Thermometer (new), Drift-Con, and Pipettes: performance checks will be performed by calibrating vendor and documented in the associated vendor records as the “As Left” value.
- h) Heat Blocks/Incubators used in analytical procedures: performance checks will be performed on new instruments or annually with a NIST-Traceable Thermometer to ensure that each is operating within specification. As all thermometers are NIST-Traceable, the daily temperature logs shall be sufficient to verify the continued performance of each heat block.

10.4 MAINTENANCE SCHEDULES AND RECORDS

DNA testing methods do not result in reports of metrological data. The DNA sections are not required to establish an Uncertainty based on measurements. However, it is desirable that equipment which can influence laboratory activities be treated as critical to the overall findings.

Each instrument or piece of equipment considered essential for DNA typing will be maintained and calibrated or verified with appropriate schedule. A schedule for maintenance is found in the *DNA-FORM-12 DNA Equipment Care Schedule*. A maintenance log entry is maintained for any instrument or piece of equipment in which the following has occurred: damage, malfunction or modification or repair to equipment. After expiration of any initial warranty period, the AB7500, AB3500xl, EZ1xl advanced, Qiacube, and Qiagility will have Annual Maintenance contracts with the manufacturers which will include an annual Preventative Maintenance visit. At a minimum, each instrument will pass a performance check annually. Any calibrated or verified equipment with a defined period of validity will be labeled to indicate the verification status. The date any equipment is removed from service is recorded and maintained on the FB drive for a minimum of one full accreditation cycle.

10.4.1 ANNUALLY (OR AS NEEDED)

- Spatial for 3500xls (whenever array window door is opened a spatial must be performed according to the manufacturer)
- Spectral for 3500xls must be performed in the following instances:
 - Use of a dye set that does not have a valid calibration on the instrument

- Change the capillary array
- Maintenance involves an optical service procedure (realignment of optics, replacement of laser or CCD camera)
- An increase in pull-up peaks is seen in DNA profiles
- Pipettes – performance-check and calibration for traceability, no MOU estimation needed.
 - Repairs, calibration and performance check to be performed by an outside vendor meeting ASCL-DOC-01 6.5.1.1 specifications.
- The acceptability criteria for ‘as found’ calibration is 8% or less for single channel micropipettes. The criteria will be doubled for multichannel pipettes. NIST Traceable Thermometer – A NIST-traceable thermometer will be purchased annually to ensure continuous traceability for all DNA thermometers. No performance check needed.
- Thermometer – performance check and verification for traceability.
 - Verification to be performed by laboratory personnel.
 - Annually or prior to being placed into service (unless currently NIST-traceable)
 - Traceability criteria: detailed on DNA-Form-19
- Drift-con – (Thermocycler calibration system) performance-check and calibration for traceability.
 - Calibration and performance check to be performed by an outside vendor meeting ASCL-DOC-01 6.5.1.1 specifications.
 - Traceability criteria: $t_{90-t} \leq 0.25^{\circ}\text{C}$ @ 30 °C, 60 °C, 90 °C, and 95 °C
- Thermocyclers and Quantitative PCR Thermocyclers – Drift-con temperature verification
 - Verification to be performed by laboratory personnel
 - Traceability criteria:
 - Accuracy: +/- 1°C @ 30 °C, 50 °C, 60 °C, 70 °C, 90 °C, & 95 °C @ 15, 30, & 90 seconds
 - Spread: +/- 1°C @ 30 °C, 50 °C, 60 °C, 70 °C, 90 °C, & 95 °C @ 15, 30, & 90 seconds
 - If test fails, an outside company is called for service and unit is taken out of service.
- Balances – performance check and verification
 - Verification to be performed by laboratory personnel
 - NIST-traceable weights are calibrated or replaced every 10 years
 - Traceability criteria: detailed on DNA-FORM-06
 - Accuracy (BAL-2): +/- 1% @ 1g, 2g, 3g, 5g, 10g, 20g, 30g, 50g, and 100g
 - Accuracy (BAL-1): +/- 5% @ 1g, 2g, 3g, 5g, 10g, 20g, 30g, 50g, 100g, and 500g

10.4.2 QUARTERLY

- Biological safety hoods – serviced and calibrated by outside company, if needed. Monitoring and Management is performed on a lab-wide basis beyond the scope of this manual.

10.4.3 MONTHLY

- None currently

10.4.4 BI-WEEKLY (BY LABORATORY PERSONNEL, AS NEEDED)

- The 3500xl and computers shall be restarted.
- Wet the seals on the 3500xl.
- Polymer is changed on the 3500xl.
- Conditioning wash is performed on the 3500xl.
- Change buffer containers, septa, and reagents on the 3500xl.

10.4.5 WEEKLY (BY LABORATORY PERSONNEL, AS NEEDED)

- Grease O-rings on the EZ1 robots, if used.

10.4.6 EACH DAY OF USE (BY LABORATORY PERSONNEL, AS NEEDED)

- Autoclave – check water levels before use.
- Check temperature of refrigerators and freezers in pre-amp and post-amp rooms (DNA-FORM-17) if lab space is used.
- Qiagility is decontaminated and documented on DNA-FORM-38, if used.
- Heat Blocks – temperature checked prior to use (DNA-FORM-17).
- Bench tops – CODIS & DNA (pre-amp): After each use, the bench tops must be cleaned with a 10% bleach solution and documented on DNA-FORM-11.
- EZ1 - End of day (after last protocol), if used:
 - Clean Piercing unit
 - Close Door
 - Press “2” MAN (Manual Function), then press “3” Clean
 - Press “Start”, then open door.
 - Clean piercing units with a soft wipe and alcohol. ****Piercing unit is sharp!****
 - Wipe piercing unit with deionized water.
 - Close Door and Press “ENT”, then press “ESC”
 - Check that the tray and racks are clean, if needed, clean with ethanol and then deionized water.
 - Run UV decontamination cycle for 20 minutes.
 - Document decontamination on DNA-FORM-41

10.4.7 INSTRUMENT OR EQUIPMENT CLEANING PROCEDURES

CENTRIFUGES

Wipe out the inside of the centrifuge with 10% bleach solution as needed, or appropriate cleaner as recommended by manufacturer.

BIOLOGICAL SAFETY HOOD

After each use, wipe down inside of hood with 10% bleach.

10.4.8 TRANSPORT/STORAGE OF EQUIPMENT

In the event the equipment needs to be stored or transported the following precautions will be taken to ensure proper functioning and to prevent contamination and deterioration.

STORAGE

Equipment will be decontaminated and processed for storage according to manufacturer recommendations.

TRANSPORT

Equipment will be prepared for movement if necessary according to manufacturer's recommendations. Non-portable equipment sensitive to movement (eg. 3500xl) will be, at a minimum, performance checked according to Section 7.6.

10.4.9 SERVICE RECORDS

Anytime an instrument or piece of equipment requires calibration, service or, maintenance, that information will be documented. Maintenance logs will be maintained either on the FB drive or on the applicable instrument control computer(s). Copies will be posted to the appropriate Qualtrax Quality Records folder for ease of access, as practicable.

In the event that any piece of equipment fails or does not pass its specific requirements, the equipment must be taken out of service until it can be maintained properly.

- a) All equipment failures must be documented in the instrument log.
- b) A sign must be placed on the equipment as "Out of Service".
- c) No equipment will be placed back into service until proper performance is demonstrated.
- d) The DNA Quality Manager must inform the DNA TL and Casework Supervisor of all equipment failure.
- e) A QAC workflow will be initiated if needed as noted in the *ASCL QM*.
- f) If an adjustment/repair is performed because a calibration does not meet specifications, then pre- and post-adjustment/repair data will be retained

11 REPORTS

11.1 CASEFILE NOTES

The testing period is defined in the examination notes from the date on the extraction worksheet to the date the report is generated. Standardized examination notes have been adopted by the Forensic DNA section and instructions for their use can be found in Appendix A of the DNA QM. Standardization allows certain SOP elements to be assumed by default (such as the association of a set of pipettes with a benchtop), with only deviation from the default needing to be noted. Supplementary or alternate forms of analyst notes, including hand-written notations, are acceptable when appropriate and shall at a minimum include name of processor, date of notation, and associated casefiles.

Any examination records prepared by an individual other than the analyst who interprets the findings and/or authors the case report will have the preparing staff member's name or initials included on the worksheet. All examination records will be retained in the casefile.

A master list for abbreviations will be placed on the FB drive. Novel abbreviations may be added by staff as needed and the DNA TL approved or "secure" list will be updated when significant changes are warranted.

11.2 REPORT CONTENTS

The policies regarding laboratory reports conform to the lab-wide policies and may be found in the *ASCL QM* section 7.8. All current case reports and records are stored electronically with the aid of JusticeTrax LIMS-plus software program. Once review is complete, the electronic version is considered the official case record, and the paper file can be destroyed.

Prior to authorizing a formal report, all casework is subject to technical and administrative reviews by qualified individuals. In the event that the author of the report did not generate all of the data used in the report, the signature on the report will indicate that all data used for reporting was reviewed by the author of the report.

Per the *ASCL QM*, when opinions or interpretations are directly communicated by dialogue to a customer, a record of the communication will be retained.

Per the *ASCL QM*, when an error is found on an issued report, an "Amended Report" will be created in LIMS. The edit will be identified and the reason for the change will be included on the report. When the error causes the change of analytical results, the DNA Technical Leader, DNA Supervisor, or DNA Quality Manager will perform the technical review on the amended request.

See the *ASCL QM* for a list of instances not requiring a laboratory report.

11.2.1 ELEMENTS OF THE CASE REPORT

All reports shall contain the following. For a list of additional ASCL report elements, see *ASCL QM* section 7.8.

- Case identifier
- Description of evidence examined
- A description of methodology and/or technology
- Loci examined or amplification system (if STR analysis is performed)
- Results and/or conclusions
- An interpretative statement (either quantitative or qualitative)
- Date issued
- Disposition of evidence
- A statement regarding the initial entry or search against CODIS, if needed.
- A signature and title or equivalent identification of the person(s) accepting responsibility of the content of the report.
- A statement that addresses the fact that only samples listed on the report were tested.

Guidelines for authoring a report can be found in Appendix F

11.3 CONFIDENTIALITY

See the *ASCL QM* for the policy on the release of information. See Statute 12-12-312 Records confidential and privilege.

12 CASEFILE REVIEW

The testing period is defined in the examination notes as the date on the extraction worksheet to the date the report is generated.

Any examination records prepared by an individual other than the analyst who interprets the findings and/or authors the case report will have the preparing staff member's name or initials included on the worksheet.

Prior to authorizing a formal report, all casework is subject to technical and administrative reviews by qualified individuals. In the event that the author of the report did not generate all of the data used in the report, the signature on the report will indicate that all data used for reporting was reviewed by the author of the report.

12.1 REVIEWS

The Forensic DNA section complies with all *ASCL QM* lab wide review requirements.

12.1.1 TECHNICAL REVIEW

The technical reviewer shall be or have been an analyst qualified in the methodology being reviewed and not the author of the current report. The technical reviewer will review all documentation in the case file to ensure that there is sufficient basis for the scientific conclusion(s) in the report and then complete and sign the technical review sheet indicating that a technical review has been completed. The technical reviewer will electronically initial that the technical review was completed in JusticeTrax. If a discrepancy is found and an agreement is not reached between the DNA analyst and the reviewer(s), the Casework Supervisor will be consulted. The Technical Leader will be notified of all technical issues and consulted for a final decision if there is still a discrepancy.

12.1.1.1 CASE FILE

The case file is maintained electronically and contains the following information (as applicable):

- Submission Sheet
- Extraction Sheet
- Worksheets (* When appropriate)
 - Quantitation Sheets
 - STR AMP Sheets
 - Master Mix Sheet
 - Plate Loading Sheet *
 - Call Sheets
 - PopStats and/or ArmedXpert*
 - CODIS *
- GeneMapper Data

- Review Sheet
- Case Report

Any corrections made to a file released for the review process will be documented in our JusticeTrax LIMS system.

12.2 TECHNICAL REVIEW SHEET

The technical review for regular casework must review all of the criteria described on the *Forensic DNA Case Review form* ([DNA-FORM-37](#)). The criteria have been duplicated below.

- Are notes present which adequately describe the packaging and description of the evidence?
- Were all necessary analyses performed and documented according to established guidelines?
- Was the request of the agency addressed by the work performed in the case (reasonable)?
- Have all out of bin microvariants been confirmed?
- Have all controls, internal lane standards and allelic ladders been verified for expected results?
- Are all genotypes correct and all peaks meet the required threshold(s)?
- Are all genotypes correct and transcribed (including proficiency)?
- Have all the necessary sample files been imported into the GeneMapper ID-X project, and are all the imported sample files appropriate and acceptable?
- Are the conclusions (both inclusions and exclusions) and statistics (if applicable) correct?
- Is the report free of all errors and understandable to persons who will read the report?
- Has GeneMapper ID-X Profile Comparison and/or ArmedXpert Samples Comparison been performed in this case?
- If DNA testing results are inconclusive or of no probative value, has all appropriate evidence been examined or submitted for further testing (i.e., Serology – Tape Lifts, Trace – Retained Hairs, etc.)?
- Are all CODIS requirements addressed: eligibility, appropriate specimen category, appropriate samples(s), etc.?
- Have appropriate specimen with correct allele calls and specimen categories been entered into CODIS?

12.3 ADMINISTRATIVE REVIEW

An administrative reviewer does not need to be qualified in the technology used in the case, but the administrative reviewer must be trained and qualified to perform administrative reviews. The administrative reviewer evaluates the report and supporting documentation for completeness and for editorial correctness. If the administrative reviewer finds an error in the case file, the error will be corrected after consultation with the DNA analyst and/or technical reviewer. Once the error has been corrected, the administrative reviewer will sign the administrative review sheet and scan the review sheet into case images in JusticeTrax. The administrative reviewer will electronically initial that the administrative review was completed in JusticeTrax and send one (1) copy of the report out to the submitting agency on iResults. The administrative review cannot be performed by the author of the report.

12.3.1.1 ADMINISTRATIVE REVIEW SHEET

The administrative review must review all of the criteria described on the administrative review sheet. The criteria have been duplicated below.

- Does all examination documentation have the dates indicating when the work was performed, ASCL case number and is it stored in the appropriate folder in 'Requests'?
- Does all administrative documentation (e.g., contact forms, faxes, subpoena) contain the ASCL case number, and is it stored in 'Case Images'?
- Has the chain of custody been reviewed for disposition of evidence?
- Is the report consistent with laboratory guidelines and editorial correctness?
- If this is a proficiency test, are all transcriptions correct on proficiency provider's forms?
- Are all corrections in the case file made consistent with laboratory policy?
- Is the request date in JusticeTrax consistent with the date evidence was submitted for DNA analysis?
- Has the Technical Review been documented completely?

12.4 DISCREPANCY IN CONCLUSIONS

In the event an analyst and their casefile reviewer come to differing conclusions from a set of data, they shall discuss their differences and come to a collaborative conclusion. If the matter cannot be resolved to the satisfaction of both, the matter will be forwarded to the DNA Supervisor and/or DNA TL for resolution. The decision of the DNA TL shall be final on all matters related to quality or technologies.

12.5 DATABASE MATCHES

Database matches are addressed in the CODIS QM

12.6 REVIEW FOR NON-AUTHORED CASE TESTIMONY

Testimony may be rendered by another qualified DNA analyst upon review of the case file. ASCL-FORM-57 shall be filled out and scanned into the case file.

12.7 REVIEW FOR OUTSOURCED CASES

A review of data from samples outsourced to a vendor laboratory by the ASCL must be performed prior to the release of the vendor laboratory report to the submitting agency. This review will ensure the necessary analysis has been performed and documented by the vendor laboratory. If the reviewing analyst determines that additional analysis or re-analysis is not needed based on the vendor documentation, then they will complete the DNA Contract Case Review form ([DNA-FORM-43](#)), roll the administrative milestone in JusticeTrax, and release the vendor report to the submitting agency. The criteria are listed below:

- Were all necessary analyses performed and documented according to established guidelines?
- Have all controls, internal lane standards, and allelic ladders been verified for expected results?
- Are all genotypes correct and do all called peaks meet the required threshold(s)?
- Are all genotypes called and transcribed correctly?
- Are the conclusions (both inclusions and exclusions) and statistics (if applicable) correct?
- Does the vendor report address all items sent to the vendor laboratory?
- Has the vendor noted and corrected all errors, both technical and administrative?
- Is the vendor report free of all errors and understandable to person(s) who will read the report?
- Have the vendor report, all vendor casefile notes, and corrective action documentation been securely stored?
- Are all CODIS requirements addressed: eligibility, appropriate specimen category; appropriate sample(s) etc.?
- If CODIS eligible, has the outsourcing request in JusticeTrax been administratively reviewed and has the vendor report been released to the agency?

If data is CODIS eligible, then the analyst will open a new JusticeTrax request to document and report the CODIS entry, which will be reviewed by another CODIS-approved analyst. The criteria are listed below:

- Have the appropriate specimens with correct allele calls and specimen categories been entered into CODIS?
- Has an ASCL report been created accurately reflecting which profile(s) have been entered into CODIS?

13 PROFICIENCY TESTING

Proficiency testing is used periodically to demonstrate the quality performance of the DNA laboratory and serves as a mechanism for critical self-evaluation. This is accomplished by the analysis and reporting of results from appropriate biological specimens, submitted to the laboratory as open and/or blind case evidence.

All specimens submitted as part of a proficiency test must be analyzed and interpreted according to the DNA analysis protocol approved by the laboratory at the time of the proficiency test.

Since the proficiency-testing program is a critical element of a successful QA program, it is an essential requirement. When possible, the ASCL utilizes proficiency testing offered from approved ISO/IEC 17043 providers.

Open proficiency test specimens are presented to the laboratory and its staff as proficiency specimens and are used to demonstrate the reliability of the laboratory's analytical methods as well as the interpretive capability of the DNA Analyst. Participation in the open proficiency test program is the primary means by which the quality performance of this DNA laboratory is judged and is an essential requirement since this laboratory performs casework.

13.1 PERSONNEL AND FREQUENCY

Proficiency testing pertains to those DNA personnel actively engaged in DNA testing. Each proficiency test may consist of dried specimens of blood and/or other physiological fluids, either singly or as a mixture. Each sample to be tested should contain an amount sufficient so that a conclusion can be drawn from the results of the analysis.

External, (or Inter-Laboratory) Proficiency tests are performed semi-annually for each DNA Analyst, (once in the first six months of the year and a second in the second six months of the year). There must be at least four months between each test, and not more than eight months between tests. Tests are taken quarterly with individual analysts alternating between test-taker and reviewer roles to ensure separation between test answers and test takers.

Newly qualified personnel will complete an external proficiency test within 6 months of their qualification.

In the event that an external Proficiency test is missed (such as due to medical leave or military service) an internal (or Intra-Laboratory) Proficiency will be taken before resuming casework or reviews. An expired external Proficiency test may be used as an internal test. The individual will resume external Proficiency testing as soon as is practicable.

13.1.1 PER TECHNOLOGY

All analysts and technical reviewers shall be external proficiency tested at least once per year in each of the DNA technologies which they perform analysis or review.

Current Technologies: STR, Y-STR

13.1.2 PER TEST KIT

All analysts and technical reviewers shall be external proficiency tested at least once per year in each of the test kits for DNA typing in which they perform analysis or reviews.

Current Kits: QuantPro, PowerPlex Fusion 6C, Y-FilerPLUS

13.1.3 PER METHODOLOGY

All analysts, technical reviewers, and processors shall be external proficiency tested at least once per year in at least one method of each methodology for which they perform analytical procedures.

Current Methods: EZ1, Differential-EZ1 (manual/robotic), QuantPro (manual/robotic), STR(manual/robotic), YSTR(manual), 3500XL CE

13.1.4 ASSIGNMENT

DNA personnel shall conduct all portions of a test up to the limit of their qualification, alone and without selecting or accepting any assistance from other persons. Additional personnel may be assigned to complete aspects of the test for which the original individual is not qualified.

Violation may result in disciplinary action for those receiving and those rendering assistance. If the personnel have any questions or require assistance, they will contact the DNA TL. In order to avoid unfair advantages to other personnel at different stages of analyzing the same proficiency test samples, they may not consult one another with regard to their samples, procedures, analysis or interpretations. To do so defeats the purpose of proficiency testing for the individual and the laboratory.

13.2 PROFICIENCY PROVIDER

The laboratory shall use an external proficiency test provider that is accredited to the current applicable standard of the International Organization for Standardization and the applicable test is included on the proficiency test provider's scope of accreditation. External proficiency testing shall be an open proficiency testing program and shall be submitted to the proficiency testing provider in order to be included in the provider's published external summary report.

Current Provider: BODE IQAS

13.3 DATE OF PERFORMANCE

Beginning January 1, 2017, the date of proficiency submission to the proficiency provider has been designated as the date of test performance or completion for external proficiencies. For internal

proficiencies, the date of proficiency submission for Proficiency Review to the DNA TL has been designated as the date of test completion.

13.4 DOCUMENTATION OF PROFICIENCY TEST RESULTS

See the *ASCL QM* for additional information.

When the proficiency test is complete, all results (proficiency test case file) will be given to the Technical Leader or designee. The official case file is stored in JusticeTrax. The official electronic version must include all administration, examination documentation, how samples were obtained or created (if internal test), results from provider, and any corrective action reports.

The Technical Leader will provide a yearly summary of who was tested and status of their performance. This information will be documented in a separate secure filing system. Documentation of any discrepancies will be submitted to the Casework CODIS Administrator.

**It is noted that all proficiency tests must be processed consistent with the normal processing of casework, including all associated documentation (technical and administrative review.)*

- Data Documentation

Upon the completion of a proficiency test, at a minimum, the following proficiency test data and information will be collected and submitted to the Technical Leader. The Technical Leader (or their appointed person) will be responsible for providing to the external test source the required data for evaluation:

- 1) Proficiency Test Set Identifier
- 2) Identity of DNA Analyst
- 3) Dates of Analysis and Completion
- 4) Copies of all Work Sheets/Notes and supporting conclusions
- 5) GeneMapper ID worksheets
- 6) Any discrepancies noted
- 7) Corrective actions taken (if applicable)
- 8) Test Results

- Report Format for DNA Analyst's Test Findings

Some conclusion is required as to whether the unknown and known specimens could have a common origin or whether an exclusion can be demonstrated. Adequate and correct discrimination must be demonstrated in order to pass the proficiency test.

- Review and Reporting of Proficiency Test Results

The Technical Leader and either the Casework Supervisor or CODIS Administrator (depending on proficiency cycle) reviews all test materials and compares results to the information from the test

manufacturer and informs the DNA Analysts of the tests results and documents their performance. The Assistant Director will also review the results of the Casework Supervisor and/or CODIS Administrator and document it in the proficiency workflow. This review will be conducted in a timely manner. The electronic copy of the proficiency test is the official copy.

13.5 EVALUATION OF PROFICIENCY TESTS

PROFICIENCY TEST REVIEW GUIDELINES

- 1) No analyst performing/assigned to a proficiency test will be involved in the proficiency review process except for the technical leader, see #2.
- 2) The technical leader must review and initial on [DNA-FORM-36](#) (DNA Proficiency Review Form) that any inconclusive result complies with the laboratory's guidelines.
- 3) All final reports are graded as satisfactory or unsatisfactory.
 - a) A satisfactory grade is attained when there are no analytical errors for the DNA profile typing data. Administrative errors shall be documented and action taken to minimize the error in the future.
 - i. All reported major and minor alleles are correct according to ASCL DNA interpretation guidelines and consensus results.
 - ii. All reported inclusions and exclusions are correct.
 - iii. All reported genotypes and/or phenotypes are correct according to consensus genotypes/phenotypes or within established empirically determined ranges.
 - iv. All reports reported as inclusive or un-interpretable are consistent with written laboratory guidelines. The basis for inconclusive interpretations in proficiency tests must be documented.
 - v. Minor allele calls: If there is a discrepancy between the provider results versus the analyst's results, the test can be graded satisfactory if the minor alleles meet interpretational guidelines (refer to Section 6.2.2.2).
 - b) An unsatisfactory grade is attained when any of the above satisfactory criteria are not met. The Section Chief must initiate a QAC in Qualtrax.
- 4) Proficiency tests are documented in Qualtrax in the Proficiency Testing Workflow. The date that the PT results are submitted to the proficiency provider is considered the Date of Completion. The date under Results Review indicates the date the results from the proficiency provider are reviewed.
- 5) If there is a discrepancy between the expected results and the experimental results, the Casework Supervisor and/or DNA Technical Leader must notify the lab wide QA Manager. Minor discrepancies may be deemed satisfactory based on the following factors with approval of the lab wide QA Manager: Discipline interpretation guidelines or Consensus results.
- 6) All discrepancies/errors and subsequent corrective actions must be documented.
- 7) All proficiency test participants shall be informed of the final test results.

PROFICIENCY TEST REVIEW PROCEDURE

- 1) All proficiency tests will be reviewed the same as casework. See section 9 for technical and administrative review procedures.
- 2) Since reports do not include the locus and alleles, the proficiency test documentation to be sent to the proficiency provider must be technically reviewed to eliminate transcription errors. As a further measure to additionally eliminate any transcription errors, the Administrative Reviewer must also examine the locus and alleles that are being transcribed onto the proficiency provider's worksheets.
- 3) Submission Review - In addition to the normal technical and administrative casefile reviews, a specific review of the proficiency results paperwork will be performed and documented on [DNA-FORM-36](#) (DNA Proficiency Review Form) by the DNA TL, Casework Supervisor, or CODIS Administrator, whichever is not assigned a test in the set. This review will ensure that the correct electronic paperwork will be submitted to the proficiency provider.
- 4) Consensus Assessment - When the results are available from the proficiency provider, the submitted results will be compared to the consensus results by the TL and another non-tested analyst, typically the Casework Supervisor or the CODIS Administrator to ensure a complete and thorough review. This review will be documented on DNA-FORM-36 (DNA Proficiency Review Form). Any discrepancies will be noted and any explanations or Corrective Actions will be documented.

13.6 NOTIFICATION

Upon completion of the Proficiency Test Review and evaluation of results, the final reviewer shall notify the test participant(s), the DNA TL, and if unsatisfactory, the CODIS Administrator.

The results of evaluation of the proficiency tests and corresponding identifiers are kept in the Qualtrax Proficiency Testing Workflow. Any corrective action needed due to one of the following discrepancies must be documented in Qualtrax.

13.7 CORRECTIVE ACTION FOR PROFICIENCY TEST ERRORS

The following are the specific policies, procedures and criteria for any corrective action taken as a result of a discrepancy in a proficiency test. These terms as used in this section are limited to proficiency testing in the Forensic DNA and CODIS sections.

13.7.1 AUTHORITY & ACCOUNTABILITY

It is the responsibility of the Casework Supervisor and DNA TL to assure that discrepancies are acknowledged and that any corrective action is documented.

13.7.2 TYPES OF ERRORS (DNA PT TESTING ONLY)

13.7.2.1 ADMINISTRATIVE ERROR: LEVEL 2 NONCONFORMITY

Any significant discrepancy in a proficiency test determined to be the result of administrative error (clerical, sample mix-up, improper storage, documentation, etc.) may be corrected as follows:

- 1) A second sample set may be submitted to an individual within one week if the Casework Supervisor believes discrepancies occurred in the first test sample set. The second sample or test material will be different than the first sample but will apply to the same subject matter under testing. The individual will immediately examine the second sample upon receipt.
- 2) If an error of this type is not detected until the Analyst has concluded their analysis, and therefore negates their work, they must be issued an additional proficiency test set. The duplication of analysis due to administrative error in no way reflects negatively on the analyst. However, the cause of the error will be found and eliminated from future proficiency tests.
- 3) If an error is due to any clerical or administrative error (typographical or otherwise – not including analyst sample mix-up or improper storage), the internal review processing steps must be evaluated to eliminate or reduce errors.

13.7.2.2 SYSTEMIC ERROR: LEVEL 1 NONCONFORMITY

Any significant discrepancy in a proficiency test determined to be the result of a systematic error (equipment, materials, environment) may require a review of all relevant case work since the DNA unit's last successfully completed proficiency test. Once the cause of the discrepancy has been identified and corrective action taken, all DNA Analysts will be made aware of the appropriate corrective action in order to minimize the recurrence of the discrepancy.

13.7.2.3 ANALYTICAL / INTERPRETATIVE

- 1) Any significant discrepancy in a proficiency test result determined to be the consequence of an analytical /interpretative discrepancy must prohibit the individuals involved in producing the discrepant result from further examination of case evidence until the cause of the problem is identified and corrected. The Technical Leader determines the need to audit prior cases based upon the type of error and its cause.
- 2) Before resuming analysis or interpretation of casework, an additional set of open proficiency samples must be successfully completed by the individual responsible for the discrepancy.

13.8 STORAGE

Once the proficiency has been completed it will be transferred to proficiency storage, and may serve as training samples until it is consumed or destroyed.

14 CORRECTIVE ACTIONS

Corrective actions will be performed according to the *ASCL QM*. See section 13.7 for policies regarding Proficiency Test Corrective Actions.

14.1 NONCONFORMING WORK

Nonconforming testing is testing in which Forensic DNA procedures are not followed or the agreed-upon requirements of the customer (e.g., testing of standards and controls, test precision and accuracy, the care and handling of evidence, instrument performance) are not met. All Forensic DNA staff, including analysts and supervisory personnel, must be vigilant for any indication of nonconforming testing.

For Forensic DNA, there are three key levels of non-conforming work, each of which requires a different response:

- Simple corrections in which an isolated incident can be resolved immediately and documented in the casefile or record, when appropriate.
- Simple nonconformities requiring *Non-Conformance Form (CODIS-FORM-17)* to ensure technical justification, supervisor acknowledgement, and authorization for performing or reporting the deviation.
- Level 1 & 2 Nonconformities which require a *QAC* workflow to be initiated. See the *ASCL QM* for more information

14.2 CORRECTIVE ACTION

The Nonconformance Form or QAC shall include:

- A description of the non-conformance,
- the identification (when possible) of the cause(s) of the nonconformity,
- corrective actions taken with time frames (where applicable),
- preventive measures taken (where applicable) to minimize its reoccurrence.
- Corrective action plans shall be approved by the technical leader prior to implementation.
- The casework CODIS administrator shall be notified when the nonconformity impacts DNA records entered into CODIS.

14.2.1 AUTHORITY & ACCOUNTABILITY

The DNA Supervisor will be responsible to assure that discrepancies are acknowledged and corrective actions are documented according to the *ASCL QM*. Corrective actions shall not be implemented without the documented approval of the technical leader. Any deviation from the *DNA QM* shall be approved by the DNA Supervisor and DNA TL. A log will be kept of each deviation from the *DNA QM*.

15 AUDITS

Audits are an important aspect of the QA program. They are an independent review conducted to compare various aspect of the DNA laboratory's performance with a standard for that performance. The audits are not punitive in nature, but are intended to provide management with an evaluation of the laboratory's performance in meeting its quality policies and objectives.

15.1 OVERALL REQUIREMENTS

The DNA laboratory shall be audited annually in accordance with these standards. The annual audits shall occur every calendar year and shall be at least six months and no more than 18 months apart.

15.2 EXTERNAL AUDIT REQUIREMENTS

At least once every two years, an external audit shall be conducted by one or more auditor(s) from a second agency(ies). At least one auditor shall be or have been an analyst previously qualified in the laboratory's current DNA technologies and platforms.

15.2.1 PERSONNEL REVIEW

Each analyst, technical reviewer, casework CODIS administrator, and technical leader shall have his/her education, experience, and training qualifications evaluated and approved during two successive, separate external audits. Approval of an individual's education, experience, and training qualifications shall be documented in the Audit Document.

An analyst or technical reviewer that receives additional qualification in an additional technology(ies), typing test kit(s), or platform(s) shall have the additional training qualifications evaluated and approved during one external audit. Approval of additional training qualifications shall be documented in the Audit Document.

15.2.2 VALIDATION EVALUATION

Each validation study shall be evaluated and approved during one external audit. Approved validation studies shall be documented in the Audit Document.

15.3 INTERNAL AUDIT REQUIREMENTS

Internal audits shall be conducted by an audit team that includes at least one auditor. At least one audit team member shall be or have been an analyst previously qualified in the DNA laboratory's current DNA technologies and platforms.

15.4 QAS REQUIREMENT

Internal and external audits shall be conducted utilizing the FBI DNA QAS Audit Document in effect at the time of the audit.

15.5 DNA TL REVIEW

Internal and external audit documentation and, if applicable, corrective action(s) shall be reviewed by the technical leader to ensure that findings, if any, were appropriately addressed and this review shall be documented.

15.5.1 CODIS ADMINISTRATOR NOTIFICATION

Internal and external audit documentation, and if applicable, corrective action(s) shall be provided to the CODIS administrator.

15.5.2 NDIS CUSTODIAN NOTIFICATION

For NDIS participating laboratories, all external audit documentation and laboratory responses shall be provided to the FBI within 30 days of laboratory receipt of the Audit Document or report.

15.6 DOCUMENT RETENTION

Internal and external audit documentation shall be retained and available for inspection during subsequent audits.

16 PROFESSIONAL DEVELOPMENT

CONTINUING EDUCATION AND DOCUMENTATION

The technical leader, casework CODIS administrator, analyst(s), and technical reviewers shall stay abreast of topics relevant to the field of forensic DNA analysis by attending seminars, courses, professional meetings, or other documented lectures or classes in relevant subject areas for a minimum of eight cumulative hours each calendar year.

The continuing education hours shall be documented through the *DNA/CODIS TL Continuing Education Approval* workflow in Qualtrax. Attendance at a regional, national, or international conference with content including topics relevant to the field of forensic DNA analysis shall be deemed to provide a minimum of eight hours of continuing education. Documentation of attendance such as certificates, attendance lists, or travel documentation shall be maintained in the QTx Personnel tab and are the responsibility of the individual.

With the exception of approved conferences, the laboratory shall maintain documentation of content through a mechanism such as agenda/syllabus, record of presentation content, or the curriculum vitae of the presenter. These records shall be maintained in the QTx Personnel tab and are the responsibility of the individual.

CEUs based on electronic delivery shall be subject to the approval of the DNA TL. Approved content can be found in the *CEU List.xlsx* file on the FB Drive. These completed forms shall be uploaded to the workflow along with any certificate or other documentation to demonstrate completion of the training. Approval for CEUs without prior approval can be requested through the same Qualtrax workflow. Any internal continuing education must be documented, including title, CV of presenter, attendance, dates, and notes or records of the presentation. Records of training should also be maintained in the QTx Personnel tab and are the responsibility of the individual. The TL will ensure that each analyst has a planned activity for meeting the 8 hour minimum requirement by mid-year. The TL will be responsible for an annual review of all DNA personnel training to ensure quality and completeness of continuing education.

REVIEW OF SCIENTIFIC LITERATURE

The laboratory has a requirement for the periodic review of scientific literature that documents the analysts' ongoing reading of scientific literature on a quarterly basis. Prior to Q4 of 2024, performance was documented on the *Literature Review.xlsx* located in the Literature folder of the FB Drive. Beginning Q4 of 2023, performance for each individual will be recorded via Qualtrax Training workflow initiated by the TL.

Access to current FSI:Genetics is available in the Literature folder of the FB Drive. Requests for other journal articles can be directed to the Assistant Director or DNA TL via the section supervisor. Articles of particular interest can be shared via the literature folder within the DNA/CODIS discipline on Qualtrax. The DNA sections are also in possession of several common DNA Typing texts.

TESTIMONY REVIEW

The Forensic DNA section shall follow the ASCL QM policy 7.7.1.2.3 regarding testimony review. The testimony review shall be documented on a *Testimony Evaluation Form* (ASCL-FORM-04) and be provided to the testifying individual. Any deficiency and subsequent corrective actions, as applicable, shall be documented per ASCL policy.

All qualified analysts shall have their testimony technically reviewed by a technically competent and authorized reviewer at least once per ANAB audit cycle, as practicable. This review may be via direct observation or review of transcripts, or other method as approved by the supervisor. Technically competent reviewers include: DNA or CODIS supervisors, DNA Technical Leader, or other fully authorized DNA analysts.

For years in which a technical review of testimony is not performed for an analyst, a review by direct observation by court or other personnel will be performed, as practicable. This review shall also be documented on the *Testimony Evaluation Form*.

17 OUTSOURCING

17.1 QAS COMPLIANCE

The ASCL will only outsource to a vendor laboratory that complies with Quality Assurance Standards and accreditation requirements of federal law and can provide documentation of the compliance. The accreditation documentation will be stored in Qualtrax. All vendor laboratories must also comply with standards set forth in the *ASCL QM*. Prior to any outsourcing of data generation, the DNA Technical Leader will document the approval of the technical specifications.

17.2 PRIOR APPROVAL

The DNA TL shall approve the technical specifications of the outsourcing agreement between the ASCL and any vendor laboratory before it is awarded. If a vendor laboratory is performing forensic DNA analysis on behalf of a law enforcement agency or other entity for the purposes of ownership by the ASCL, the vendor laboratory shall not initiate analysis until approval has been obtained from the DNA TL.

For instances, such as court ordered testing, where the ASCL is requested to take ownership and no outsourcing agreement exists, the DNA TL shall document the following prior to acceptance of ownership of product(s) of forensic DNA analyses from the vendor laboratory:

- Approval of the CODIS administrator and written permission from the NDIS Custodian for any scenario that involves CODIS entry or searching;
- Approval of the technical specifications of testing;
- Conduct or review the documentation of an on-site visit of the vendor laboratory from within 18 months in accordance with DNA QM 17.4.2.

17.3 OWNERSHIP REVIEW

The data generated from samples that are outsourced by the ASCL may be technically and administratively reviewed by the vendor laboratory, or may be re-analyzed by a qualified, proficient DNA analyst in the methodology used by the vendor laboratory, depending on the approved technical specifications and specific scenario of the case. The re-analysis and/or CODIS eligibility review will give ownership of the data to the analyst performing the task and shall verify specimen eligibility and the correct specimen category prior to entry into CODIS. The ownership review shall be documented on [DNA-FORM-43](#) and shall include the following elements:

- A review of all DNA types that the ASCL will take ownership of to verify that they are supported by the raw and/or analyzed data (electropherograms or images).

- A review of all associated analytical controls, internal size standards and allelic ladders to verify that the expected results were obtained.
- A review of the final report (if provided) to verify that the results/conclusions are supported by the data.
- If samples are to be entered into CODIS, verification of the DNA types, eligibility, and the correct specimen category by a current CODIS user.

If re-analyzed, a new report will be generated by the ASCL analyst, and the data must be technically reviewed prior to being searched in the CODIS system. If no reanalysis is performed, the vendor laboratory report will be forwarded to the requesting agency and any associated CODIS entry will be reported by the ASCL in a new DNA request. After CODIS entry, the casefile will then get an administrative review before the report can be released.

17.4 ON-SITE VISIT

The DNA Technical Leader or his/her designee will conduct an initial on-site visit to the vendor laboratory to assess analytical performance. If the contract extends beyond one year, an annual on-site visit will be required between 6- and 18-months. The laboratory may accept the findings of an on-site visit conducted by another NDIS participating laboratory in lieu of conducting an on-site visit in person. See [DNA-FORM-34](#) for the on-site visit documentation.

17.5 INTERLABORATORY EVIDENCE TRANSFER

If the ASCL finds it necessary to transfer evidence to an outside laboratory (e.g. FBI, UNT), an *Inter-Laboratory Evidence Transfer Form* (see [ASCL-FORM-07](#)) must be completed and entered into the case file. The Inter-Laboratory Evidence Form may be waived for items funded out of a grant and/or items under a contract. Any cost incurred by the laboratory must be approved by the Fiscal Officer. If there will be a cost incurred to the customer, the customer must be notified and approve of the arrangement. This must be documented and placed in the case file. The Quality Assurance Manager maintains a register of all subcontractors used for testing and/or calibrations and maintains documentation of their competency and compliance.

18 MISCELLANEOUS

18.1 SAFETY

All safety protocol and information is contained in *ASCL Health & Safety Manual* ([ASCL-DOC-08](#)). The safety manual covers general laboratory safety. The Arkansas State Crime Laboratory tries to maintain a safe working environment. It is the responsibility of the DNA/CODIS staff to familiarize themselves with all exit doors, safety showers and fire extinguishers. The crime lab provides training in chemical hygiene, blood borne pathogens, CPR, and first aid to all of the employees.

18.2 DNA LABORATORY CONTAMINATION PREVENTION

The ASCL Forensic DNA and CODIS Databasing sections share several laboratory spaces for analytical processes. In an effort to ensure that all Databasing and Forensic DNA staff consistently employ work habits that minimize the risk of DNA contamination — either sample to sample or laboratory staff to sample— the following list of basic preventive measures will be employed as necessary by analysts when performing DNA analysis. Some of the measures listed below may not be practicable or relevant at all times, but the principles of contamination prevention will apply. Shared analytical spaces include:

Cleanrooms:	301 (SAK Room), 309 (Window Room), 311(Windowless Room), and 312 (Bone Room)
Post-PCR rooms:	314 (DNA Post), 272 (CODIS Post)
Other rooms:	313 (Reagent Room), 272 (CODIS Alternate)

18.2.1 PERSONAL PROTECTIVE EQUIPMENT

Lab coats with cuffs that can be covered with disposable gloves will be worn in Cleanrooms.

Lab coats will be changed and laundered on a regular basis. If the risk of contamination is heightened based upon the activities that have occurred while wearing a lab coat, it should be replaced with a newly laundered one. Examples of when to change a lab coat include but are not limited to: after the processing of a case consisting of several items of bloody clothing or after an analyst knows that the exterior surfaces of a lab coat may have become contaminated with DNA, such as after a sneeze.

Lab coats will be worn when collecting biohazardous waste for disposal. They will be decontaminated properly when the activity is complete.

Face masks will be used for all analytical activities in the Cleanroom spaces. Face masks will be worn such that the nose and mouth will be completely covered. Facemasks and other personal effects such as glasses should not be handled directly during the course of evidence examination and special care should be taken to avoid the use of gloved hands to manipulate such items.

Personnel should avoid talking over evidence during evidence screening and/or sampling.

Personnel should only touch items of evidence with fresh, clean gloves.

Prior to use, personnel should visually inspect gloves for defects; if any damage is observed before or during examination of evidence, new gloves should be used.

Gloves should be changed with high frequency. Generally, if an analyst cannot recall when they last put on fresh gloves, the gloves should be changed.

Personnel should not use gloves that have come in contact with evidence to also touch computer keyboards, iPads, pens, pencils, etc., unless those items are specifically designated for use during the analytical process.

Cellular phone calls should not be answered and text messages/emails should not be exchanged during the processing and examination of evidence.

18.2.2 TOOLS AND REAGENTS

Computers in the laboratory spaces will be decontaminated regularly by wiping mice and keyboards (or keyboard covers) with a bleach-saturated towel. A “gloves-off” policy for all shared computers in laboratory spaces will be implemented.

For electronic equipment shared between administrative and analytical workspaces, special care should be taken to avoid cross contamination. At a minimum, a washable cover of sufficient size to cover input controls, such as touchscreen or keys and mouse pad, should be used.

“Analytical-use only” pens, pencils, markers, rulers, etc. will be used during evidence examination. When not in use, they should be stored in a location that is less susceptible to contamination. These items should be decontaminated on a regular basis.

Water dropper bottles used during analysis should only be handled with gloves and should be stored in a location that is less susceptible to contamination. The bottles should be regularly decontaminated and refreshed with clean, autoclaved deionized water. Water dropper bottles shall not leave the Cleanroom spaces except for sterilization. In addition, the analyst should avoid touching the swab with the dropper bottles.

Clean gloves shall be used when handling swab packaging when the swabs will be used for DNA sample collection. Swab heads should not touch anything other than the item being swabbed.

18.2.3 DECONTAMINATION

A dilute bleach solution (or product containing bleach) will be used to clean workspaces and tools prior to evidence processing. Alcohol (ethanol and isopropanol are both acceptable) or clean deionized water should be used to rinse residual bleach from those items that will come in direct contact with the evidence. Commercial disinfectant products (such as Clorox wipes) will not be used for the purposes of decontamination unless they contain bleach or are designed specifically for laboratory surface decontamination.

Analysts will adopt a “bleach-in-bleach-out” approach. Prior to initiating evidence screening and/or sampling at the beginning of a given work day, work surface(s) and tools will be decontaminated. Additional decontamination will continue as appropriate throughout the day. A final decontamination should occur at the close of the work-session.

A regular workspace decontamination schedule will be established. This will include benches, cabinets, drawer pulls, computer keyboards, mice, exteriors of reagent bottles, cameras, etc.

18.2.4 GENERAL EVIDENCE HANDLING

An enclosed biohood must be available in every Cleanroom. Analysts should use these hoods for the processing of liquid blood or other biohazardous samples.

Clean paper or other bench covering shall be used under items of evidence. Paper or other covering material will be changed between items. Bench covering material should not be stored uncovered outside of the Cleanroom workspaces.

Evidence should not be placed directly on top of external packaging and or in a location that will come into direct contact with external packaging. Evidence packaging is often handled without gloves and cross-contamination from the packaging to the evidence may occur.

18.3 COMPLAINTS

See the *ASCL QM* section 7.9 for the lab wide policy for addressing Complaints

19 APPENDIX A LABORATORY STANDARD OPERATING PROCEDURES

Note: Due to the high variety of DNA samples submitted, the sampling plan for each extraction type is at best a recommendation based on typical amounts of DNA obtained from each sample type in a typical case scenario under optimal conditions. It is the responsibility of the authorized DNA personnel to determine for each sample the appropriate manner and amount of sample collected based on sample condition, sample volume, case scenario, etc. DNA samples are not homogenous and the sampling methods will be considered non-statistical. Therefore, Forensic DNA findings may only be applied to the portion of the sample consumed.

In some circumstances, deviation in methods and procedures may be necessary. At such times the *Deviations/Non-Conformance Form (CODIS-FORM-17)* must be completed and signed by the CODIS Administrator and/or the DNA Technical Leader to ensure the proposed deviation is within validated guidelines.

19.1 SAMPLING PROCEDURES

19.1.1 PACKAGING AND SEALING

See the *ASCL QM* to find Test Item Packaging and Sealing requirements. Key points are listed below:

DNA evidence will be sealed so that the contents cannot escape and that opening the container results in obvious damage or alteration.

A proper seal includes the initial of the person sealing the evidence across the seal. As soon as is practicable once the examination is complete at least one layer of packaging will be properly sealed.

DNA evidence will be protected from loss, cross-transfer, contamination, and deleterious change.

Whenever practical, the original seal will be left intact when opening a container.

If the original packaging cannot be kept, complete documentation and a picture of original packaging must be retained in the case record.

See the *ASCL QM* and the *DNA QM* for Chain-of-Custody guidelines.

19.1.2 SAMPLING AND TECHNICAL RECORDS

Sampling and Technical Records will be maintained whenever sampling or examination is performed, including (where relevant):

- Identification of the sampling and examination methods used
- The date and time of sampling or examination
- The identification and description of the sample

- Identification of the person performing the sampling or examination
- Identification of any equipment used
- Environmental or transport conditions
- Identification of the sampling or examination location
- Any deviation, addition, or exclusion from the sampling or examination method and plan

The forensic DNA section will use approved forms and methods for collecting the above listed sampling and examination records. These may include the DNA Filemaker evidence reports or the paper-based equivalents.

Deviations from the sampling plan and procedures outside of normal variation may be requested by the customer or deemed appropriate by the analyst. At such times the *Deviations/Non-Conformance Form (CODIS-FORM-17)* must be completed and signed by the DNA Supervisor and/or the DNA Technical Leader and maintained in the case record.

All examination records (or copies of printouts) will be stored in the “Request” folder in the LIMS case file. As the analytical instrument data is generally incompatible with JusticeTrax storage, the electronic data will be stored on the FB shared drive or the FileMaker server.

If data, an observation, or a calculation is rejected, the reason and date of the rejection and the identity of the person rejecting must be recorded on the records.

19.1.3 ARRESTEE SAMPLES WITH SUBMITTED CASES

If arrestee samples are submitted to the CODIS Section with case numbers referencing specific cases in which the arrest was made, the sample can be processed for both the database and for the DNA Casework Section. The sample can also be processed if documentation from the submitting agency or the prosecutor requesting the Arrestee sample be referenced to the specific case the individual was arrested. In order for the sample to be used for both sections the qualifying violation the individual was sampled for must also be the case submitted to the DNA Section.

- A) Prior to use in Casework an ‘Arrestee Confirmation Sheet’ (CODIS-FORM-43) must be completed. Once the ‘Arrestee Confirmation Sheet’ is completed it will be scanned in JusticeTrax along with biographical information.
- B) An ‘Arrestee’ Request in JusticeTrax must be created and canceled to inform an analyst that a sample related to his/her case is in the CODIS Section.
- C) A duplicate sample is not re-run in the CODIS Section. DNA Casework can work the sample if necessary and retain it with the appropriate evidence. It is noted that this can be changed on a case-by-case basis upon approval of the CODIS Administrator and/or the Casework Supervisor.
- D) If an arrestee sample that is referenced to an ASCL case number is given to the CODIS Section, and it is deemed to have a non-qualifying violation, the sample can be stored for the DNA Casework Section.

- E) All completed 'Arrestee Confirmation Sheets' are stored along the completed CODIS Hit information. Any additional hits from the arrestee sample will need to have the DNA profile confirmed.
- F) All arrestee profiles (autosomal and Y-STR) will be developed and entered into Specimen Manager by a CODIS Analyst for the Casework Analyst to obtain. This can be changed on a case-by-case basis upon approval of the CODIS Administrator and/or Casework Supervisor.

19.1.4 SEXUAL ASSAULT KITS PROCESSING (SA KITS OR SAKS)

Sexual Assault Kits fall under specific legislation in Arkansas. Act 839 (2019) amended AR Code 12-12-406 to include language which directs the ASCL to test all newly submitted SA Kits with a goal of 60 days for completion. Any inactive or unsubmitted SA kits (SAFER, Act 1168 (2015), or Anonymous) will also be accepted for processing but active SA investigations will be given priority. To deliver results to investigating agencies within the given timeframe, swabs from sexual assault kits in active investigations will not be screened for serological results prior to DNA extraction. Intake and cutting of samples for extraction may be completed by either Physical Evidence or Forensic DNA personnel. Physical Evidence may elect to include cuttings of stains from underwear submitted in the SA kit with the initial round of swab testing. SA kit oral swabs will not be included in the initial round of testing unless oral assault is believed likely in the case scenario or if no victim reference sample was included. Oral swabs, or other intimate swab sample, will be processed as evidentiary until it is determined that they are single-source and appropriate to use as an assumed reference profile. Autosomal- and Y-STR processing will be based on the quantitation results. Additional bulk evidence such as bedding and clothing items will be screened by the Physical Evidence section, if deemed necessary.

PROCESSING OF THE SEXUAL ASSAULT KIT IN PHYSICAL EVIDENCE

- 1) Outer and inner packaging of the kit will be documented per the SER-DOC-01 Quality Manual. Samples of SA Kit swabs will be placed into appropriately labeled DNA extraction tubes and placed into secure storage for extraction and analysis by a DNA Processor.

PROCESSING OF THE SEXUAL ASSAULT KIT IN DNA

- 1) If not processed by Physical Evidence, the outer packaging of the kit will be documented in Filemaker Pro (front and back photos showing seals are sufficient, notes are optional); a scale is preferred in all photographs. If Filemaker Pro is not available, DNA-FORM-05 forms may be used.
- 2) The kit will be opened and the inner contents of the kit will be documented with the same specificity as the outer packaging (front and back, seals, etc.).
- 3) Individual photos or descriptions of the samples will be documented in Filemaker Pro.
- 4) The extraction information will be documented in Filemaker Pro, DNA-FORM-01, or DNA-FORM-05.

- 5) Samples will be quantitated with the current validated Quantitation kit to screen for suitable DNA template. Only a qualified DNA analyst will interpret the Quantitation data to make the determination of which samples will be amplified.
- 6) Suitable samples will be amplified with current validated Amplification kit and analyzed on the 3500xl Genetic Analyzer. A qualified DNA analyst will interpret the run data for reporting.
- 7) When analysis is complete and the reports have been reviewed, the final reviewer will mark that testing is completed for SA Kits tracked in the Arkansas Sexual Assault Kit Tracking website.

JUSTICETRAX DOCUMENTATION OF SEXUAL ASSAULT KITS:

If the SA kit is processed in Forensic DNA, the items within the kit will be itemized in JusticeTrax. The sexual assault kit will be returned to a Secure Storage by the processors. Any retained sample items will remain in the possession of the processor or in DNA laboratory secure storage. Maintenance and storage of the DNA extracts will be the responsibility of the DNA Processors recorded in each step of the process. Once processing is finished, retained samples and processing extracts will be transferred to DNA long term storage.

QUANTITATION:

Qiagen Quantitation kits will be utilized as a screening tool for total human autosomal and Y-chromosomal DNA. No further processing is necessary if samples fail to have sufficient amount of DNA or sufficient amount of a male contributor. Cases that are considered "Stop at Quant" will be assessed for additional evidence and assigned to Physical Evidence as necessary. Cases with samples containing the adequate amount of DNA for further processing will proceed to data analysis. If multiple samples are submitted, STR processing may be further restricted to the sample deemed to have the highest probability of producing a suspect profile (highest total DNA with largest percentage of male contributor).

DATA ANALYSIS:

The DNA analyst will examine the data and determine if there are usable profiles. If not or if there are multiple perpetrators, the analyst will further assess the case and determine if additional evidence or Y-STR processing is needed. The Physical Evidence section will be contacted if there is additional evidence to be examined.

19.1.5 ROUTINE CASEWORK PROCESSING

Examination of DNA evidence items is restricted to DNA Analysts or Processors specifically authorized to process samples for DNA extraction.

PROCESSING OF THE SUBMITTED SAMPLES

- 1) Outer packaging of the submitted samples will be documented in Filemaker Pro (front and back photos showing seals are sufficient, notes are optional); a scale is preferred in all photographs. If Filemaker Pro is not available, DNA-FORM-05 forms may be used.

- 2) The packaging will be opened and the inner contents of the package will be documented with the same specificity as the outer packaging (front and back, seals, etc.).
- 3) Individual photos or descriptions of the samples will be documented in Filemaker Pro or DNA-FORM-05.
- 4) The extraction information will be documented in Filemaker Pro, DNA-FORM-01, or DNA-FORM-05.
- 5) Samples will be quantitated with the current validated Quantitation kit to screen for suitable DNA template. Only a qualified DNA analyst will interpret the Quantitation data to make the determination of which samples will be amplified. Quantitation, while preferred for all samples, may be omitted for Known Reference samples; it is recommended that more than one concentration of extract be amplified. Likewise, Extraction Reagent Blanks (RB) may proceed without quantitation but must be amplified at the maximum concentration with a currently validated amplification kit.
- 6) Suitable samples will be amplified with current validated Amplification kit and analyzed on the 3500xl Genetic Analyzer. A qualified DNA analyst will interpret the run data for reporting.

JUSTICETRAX DOCUMENTATION:

Most items submitted will already be itemized in JusticeTrax. Additional itemization may be recorded in JusticeTrax as needed. DNA extracts will remain in the DNA cleanrooms with the remaining samples, to be dried and stored with the original sample when testing is complete. No subitemization of the extracts is needed for most DNA samples. DNA samples and extracts will remain the processor's responsibility until final storage; this person will assure the proper storage of the extracts and the original samples. Once processing is finished, retained samples and extracts will be transferred to DNA long term storage.

QUANTITATION:

Cases that are considered "Stop at Quant" will be assessed for additional evidence and assigned to Physical Evidence as necessary. Cases with samples containing the adequate amount of DNA for further processing will proceed to data analysis.

DATA ANALYSIS:

The assigned DNA analyst is responsible for the examination of the data and will determine if there are usable profiles. If there is no profile obtained or there is an inconclusive profile, the assigned analyst will further assess the case and determine if Y-STR processing is needed and/or the Physical Evidence section will be contacted if there is additional evidence to be examined.

19.2 EXTRACTION PROTOCOLS

**Note: All extraction steps must be performed in the Pre-PCR Laboratory. Use of the Pre-PCR lab requires Personal Protective Equipment in the form of Lab coat, disposable gloves, and disposable face mask. Access to the Pre-PCR lab space is restricted to authorized individuals due to the presence of evidence and the cleanroom nature of the lab space. Use separate reagents and pipettes dedicated to each area and clean each area thoroughly after use. Extraction tubes are stored in the Pre-PCR laboratory refrigerators until cases are completed and samples are stored long term.*

**Note: Known reference samples must be extracted at a different time and/or space than questioned samples. Extracts from reference samples are not routinely dried down, however it is recommended if the entire sample was used during extraction.*

**Note: DTT or additional ProK may be added to most sample types without deleterious effects. A Deviation Request is not necessary for instances where the analyst decides DTT or additional ProK is desirable in an extraction, however a note in the extraction documentation is necessary.*

19.2.1 WHOLE BLOOD

**Note: When liquid blood samples are submitted, samples will be dried and retained on appropriate paper for storage. Stains will be air dried and stored in individual envelopes at room temperature.*

- 1) Label appropriate 2.0 mL EZ1 sample tube.
- 2) Add 200 μ L of whole blood to the labeled sterile 2.0 mL EZ1 sample tube.
- 3) Add 190 μ L of DILUTED G2 buffer. (Diluted G2 buffer is a 1:1 dilution with diH₂O)
Additional DILUTED G2 buffer may be added to absorbent samples to ensure \sim 190 μ L of liquid in the tube.
- 4) Add 10 μ L of Proteinase K, mix by vortexing. (DO NOT add additional Proteinase K, even if increased volume of G2 is used.)
- 5) Incubate at 56 $^{\circ}$ C for a minimum of 15 minutes.
- 6) If necessary, centrifuge briefly.
- 7) Process on EZ1 with Trace protocol. (see protocol below, 6.2.4.12)
- 8) Estimate the amount of DNA in the sample. (See Quantitation SOP)
- 9) The samples are now ready for PCR amplification.

19.2.2 TRACE SAMPLES

Includes: Dried Blood Stains (Swabs, Filter Paper, & FTA), Forensic Surface Samples, Cigarette Butts, Stamps, Envelope Flaps, and Tape-Lift Swabs. For tape-lifts from sperm(+) and p30(+) samples, please refer to the modified semen extraction method.

- 1) Label 2.0 mL EZ1 sample tube.
- 2) Add appropriate sample to the sample tube (as listed below):
 - Dried Blood Stains
Cut the stain, approximately 3mm x 3mm in size and place into the labeled sterile 2.0 mL EZ1 sample tube.
 - Forensic Surface Samples (Shirt collars, transfer evidence etc...)
Cut approximately 3 mm x 3mm portion of the gauze or filter paper, or an appropriate portion of a swab and place into the labeled sterile 2.0 mL EZ1 sample tube.
 - Cigarette Butts
Cut an approximately 5 mm wide strip from the cigarette butt (including filter) in the area which would have been in contact with the mouth and place into the labeled sterile 2.0 mL EZ1 sample tube.
 - Stamps / Envelope Flaps
Carefully open envelope flap or remove stamp using steam and clean tweezers. Using a sterile cotton swab moistened in sterile, distilled, deionized water, swab gummed envelope flap or stamp. Cut cotton swab from stick and place into the labeled sterile 2.0 mL EZ1 sample tube. Cuttings may also be used for this extraction.
 - Tape-Lift Swabs
Using a sterile cotton swab moistened in sterile, distilled, deionized water, swab the entire tape lift to remove any epithelial cells which may be present. Cut cotton swab from stick and place into the labeled sterile 2.0 mL EZ1 sample tube.
- 3) Add 190 µL of DILUTED G2 buffer. (Diluted G2 buffer is a 1:1 dilution with diH₂O)
Additional DILUTED G2 buffer may be added to absorbent samples to ensure ~190 µL of liquid in the tube.
- 4) Add 10 µL of Proteinase K, mix by vortexing. (DO NOT add additional Proteinase K, even if increased volume of G2 is used)
- 5) Incubate at 56 °C for a minimum of 15 minutes.
- 6) If necessary, centrifuge briefly.
- 7) Process on EZ1 with Trace TD protocol. (see protocol below, 6.2.4.12)
- 8) Estimate the amount of DNA in the sample. (See Quantitation Kit SOP)
- 9) The samples are now ready for PCR amplification.

19.2.3 SEMEN-CONTAINING STAINS, QIACUBE (2-6 SAMPLES)

- 1) Label appropriate 1.5 mL Qiacube sample tube as Semen Fraction (SF) and label appropriate 2.0 mL EZ-1 sample tube as Epithelial Fraction (EF).
- 2) Cut an appropriate-size sample and place into a labeled 1.5 mL Qiacube sample tube.
- 3) Add 480 μ L G2 buffer, then 20 μ L of Proteinase K, mix by vortexing.
- 4) Incubate at 56 $^{\circ}$ C for a minimum of 15 minutes.
- 5) Centrifuge tube briefly to remove drop from lid.
- 6) Remove any solid material from tube. Use toothpick to remove cloth or swab from tube, twisting to remove excess fluid. Discard solid material in appropriate waste.
- 7) Samples are now ready for Qiacube separation:
 - a) Ensure Qiacube is on.
 - b) Press DNA.
 - c) Select PIPETTING and Press SELECT.
 - d) Select EPITHELIAL AND SPERM CELL and Press SELECT.
 - e) Select SEPARATION AND LYSIS 6 and Press SELECT.
 - f) Follow steps on screen to setup workstation:
 - i. Press START.
 - ii. Empty waste drawer and fill tip racks with 1000 μ L wide-bore tips.
 - iii. Fill reagent bottle to fill line with G2 Buffer and place in Position 1 in the Reagent Bottle Rack.
 - iv. Mix Sperm Lysis Buffer according to chart below, then place it in a 2mL screw top tube and place in Position A in the Tip Rack.
 - v. Load 1.5 mL Qiacube tubes with samples from step 6 into Position 3 in the Rotor Adapters.
 - vi. Place rotor adaptors in rotor according to chart below (also found on side of Qiacube).
 - vii. Place empty 2 mL EZ1 sample tubes in the shaker following the setup above. Ensure the plastic nubs are in the holes next to each tube.

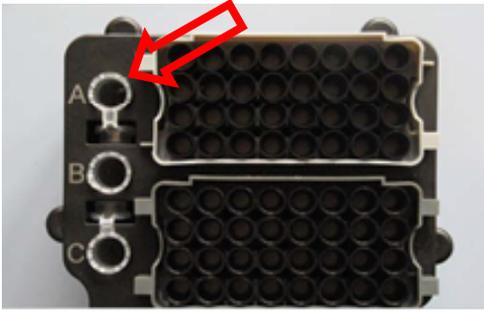
QIACube Rotor Loading Chart (2-6 samples)

Sperm Lysis Buffer (μ L)	G2 (μ L)	ProK (μ L)	DTT (μ L)	
2	500	374	26	100
3	750	561	39	150
4	1000	748	52	200
5	1250	935	65	250
6	1500	1122	78	300

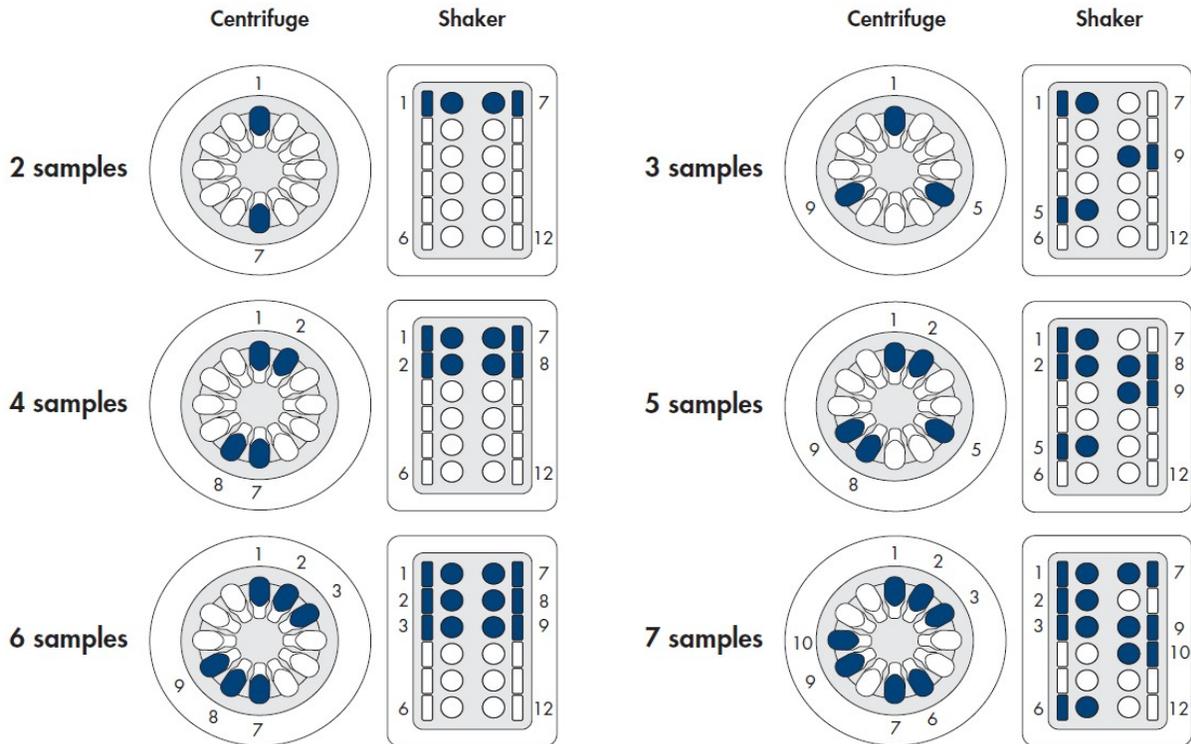
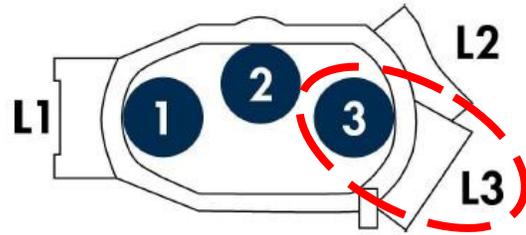
Reagent Bottle Rack – Position 1



Tip Rack – Position A



Rotor Adapter – Position 3



- 8) Process Epithelial Fraction on EZ1 with Trace protocol. (See protocol below, 6.2.4.12) and save samples for step 15.
- 9) Remove 1.5 mL tube from the rotor adapter and close tube.
- 10) Incubate at 56 °C for a minimum of 10 minutes.
- 11) Centrifuge tube briefly to remove drops from lid.
- 12) Transfer sample from the 1.5 mL tube to a labeled 2.0 mL EZ1 sample tube.
- 13) Process Sperm Fraction on EZ1 with Trace protocol. (see protocol below, 6.2.4.12)
- 14) Estimate the amount of DNA in the sample. (See Quantitation Kit SOP)
- 15) The samples are now ready for PCR amplification.

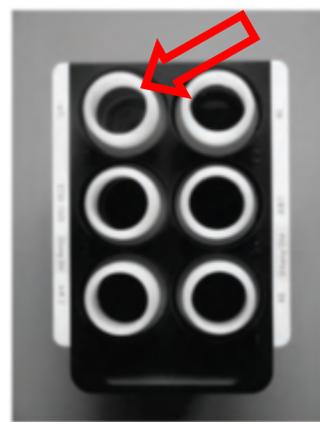
19.2.4 SEMEN-CONTAINING STAINS, QIACUBE (7-12 SAMPLES)

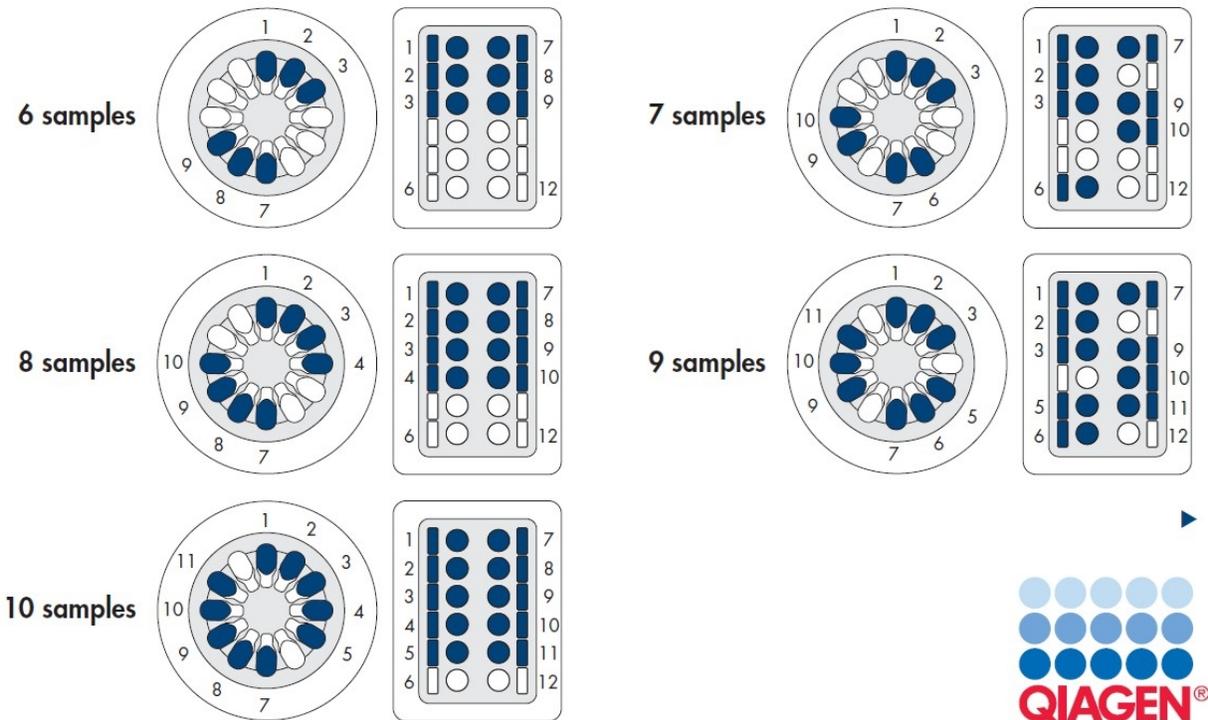
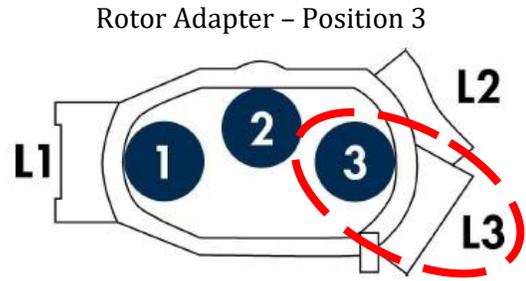
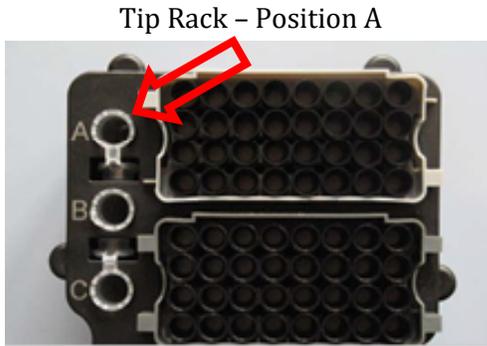
- 1) Label appropriate 1.5 mL Qiacube sample tube as Semen Fraction (SF) and label appropriate 2.0 mL EZ-1 sample tube as Epithelial Fraction (EF).
- 2) Cut an appropriate-size sample and place into a labeled 1.5 mL Qiacube sample tube.
- 3) Add 480 μL G2 buffer, then 20 μL of Proteinase K, mix by vortexing.
- 4) Incubate at 56 $^{\circ}\text{C}$ for a minimum of 15 minutes.
- 5) Centrifuge tube briefly to remove drop from lid.
- 6) Remove any solid material from tube. Use toothpick to remove cloth or swab from tube, twisting to remove excess fluid. Discard solid material in appropriate waste.
- 7) Samples are now ready for Qiacube separation:
 - g) Ensure Qiacube is on.
 - h) Press DNA.
 - i) Select PIPETTING and Press SELECT.
 - j) Select EPITHELIAL AND SPERM CELL and Press SELECT.
 - k) Select SEPARATION AND LYSIS 12 A and Press SELECT.
 - l) Follow steps on screen to setup workstation:
 - i. Press START.
 - ii. Empty waste drawer and fill tip racks with 1000 μL wide-bore tips.
 - iii. Fill reagent bottle to fill line with G2 Buffer and place in Position 1 in the Reagent Bottle Rack.
 - iv. Mix Sperm Lysis Buffer according to chart below, then place it in a 2mL screw top tube and place in Position A in the Tip Rack.
 - v. Load 1.5 mL QIACube tubes with samples from step 6 into Position 3 in the Rotor Adapters.
 - vi. Place rotor adaptors in rotor according to chart below (also found on side of Qiacube).
 - vii. Place empty 2 mL EZ1 sample tubes in the shaker following the setup above. Ensure the plastic nubs are in the holes next to each tube.

QIACube Rotor Loading Chart (7-12 samples)

Sperm Lysis Buffer (μL)		G2 (μL)	Pro K (μL)	DTT (μL)
7	1150	862	58	230
8	1300	975	65	260
9	1475	1106	74	295
10	1625	1219	81	325
12	1960	1470	98	392

Reagent Bottle Rack – Position 1





- 8) Process Epithelial Fraction on EZ1 with Trace protocol. (See protocol below, 6.2.4.12) and save samples for step 16. (This step can be done alongside step 15)
- 9) Sample is now ready to continue the Qiacube separation:
 - a) Press DNA.
 - b) Select Pipetting and Press Select.
 - c) Select Epithelial and Sperm Cell and Press Select.
 - d) Select Separation and Lysis 12 B and Press Select.
 - e) Follow steps on screen to setup workstation
 - i. Press Start.

- ii. Fill tips racks with 1000µL wide-bore tips.
 - iii. Press Start.
- 10) Remove 1.5 mL tube from the rotor adapter and close tube.
 - 11) Incubate at 56°C for a minimum of 10 minutes.
 - 12) Centrifuge tube briefly to remove drops from lid.
 - 13) Transfer sample from the 1.5 mL tube to a labeled 2.0 mL EZ1 sample tube.
 - 14) Process Sperm Fraction on EZ1 with Trace protocol. (see protocol below, 6.2.4.12)
 - 15) Estimate the amount of DNA in the sample. (See Quantitation Kit SOP)
 - 16) The samples are now ready for PCR amplification

19.2.5 SEMEN-CONTAINING STAINS, (MANUAL)

- 1) Label appropriate 2.0 mL EZ1 sample tube.
- 2) Cut an appropriately size sample and place into the labeled sterile 2.0 mL EZ1 sample tube.
- 3) Add 190 μ L G2 buffer. Additional G2 buffer may be added to absorbent samples to ensure \sim 190 μ L of liquid in the tube.
- 4) Add 10 μ L of Proteinase K, mix by vortexing. (**DO NOT** add additional Proteinase K, even if increased volume of G2 is used.)
- 5) Incubate at 56 $^{\circ}$ C for a minimum of 15 minutes.
- 6) Centrifuge tube briefly to remove drop from lid.
- 7) Remove any solid material from tube. Use a toothpick to remove cloth or swab from tube. Twist sample on side of tube to remove excess fluid. Discard solid material in appropriate waste.
- 8) Centrifuge tube at approximately 15000 x g for 5 minutes. Carefully transfer the supernatant (epithelial fraction) to a new tube without disturbing the sperm cell pellet. (NOTE: sperm cell pellet may not be visible)
- 9) Process Epithelial Fraction on EZ1 with Trace protocol and save samples for step 18. (see protocol below, 6.2.4.12)
- 10) Wash sperm cell pellet by adding 500 μ L of G2 buffer. Vortex and centrifuge tube at approximately 15000 x g for 5 minutes. Discard supernatant.
- 11) Repeat step 10 two (2) times for a total of three (3) washes.
- 12) Add 180 μ L G2 buffer to the sample tube.
- 13) Add 10 μ L Proteinase K and 10 μ L 1 M DTT.
- 14) Vortex for 10 seconds.
- 15) Incubate at 56 $^{\circ}$ C for a minimum of 10 minutes.
- 16) Centrifuge tube briefly to remove drops from lid.
- 17) Process Sperm Fraction on EZ1 with Trace protocol. (see protocol below, 6.2.4.12)
- 18) Estimate the amount of DNA in the sample. (See Quantitation Kit SOP)
- 19) The samples are now ready for PCR amplification.

19.2.6 MODIFIED SEMEN-CONTAINING STAIN EXTRACTION

(Samples may contain undetected sperm cells e.g., p30(+) samples, or tape-lifts from sperm(+) and p30(+) samples, etc.)

- 1) Label appropriate 2.0 mL EZ1 sample tube.
- 2) Cut an appropriately size sample and place into the labeled sterile 2.0 mL EZ1 sample tube.
- 3) Add 190 μ L G2 buffer. Additional G2 buffer may be added to absorbent samples to ensure ~190 μ L of liquid in the tube.
- 4) Add 10 μ L Proteinase K and 10 μ L 1M DTT, mix by vortexing. (DO NOT add additional Proteinase K, even if increased volume of G2 is used.)
- 5) Incubate at 56 $^{\circ}$ C for a minimum of 10 minutes.
- 6) Centrifuge tube briefly to remove drops from lid.
- 7) Remove any solid material from tube with tweezers or a toothpick. Try to remove as much liquid from the material as possible.
- 8) Process on EZ1. (see protocol below, 6.2.4.12)
- 9) Estimate the amount of DNA in the sample. (See Quantitation Kits SOP)
- 10) The sample is now ready for PCR amplification.

19.2.7 HAIR EXTRACTION

- 1) Label appropriate 2.0 mL EZ1 sample tube. One tube is for the hair root and the other is for the hair shaft.
- 2) Cut an appropriately size sample and place into the labeled sterile 2.0 mL EZ1 sample tube.
- 3) Add 180 μ L G2 buffer to the sample tube.
- 4) Add 10 μ L Proteinase K and 10 μ L 1 M DTT.
- 5) Incubate at 56 $^{\circ}$ C for a minimum of 30 minutes.
- 6) Centrifuge tube briefly to remove drops from lid.
- 7) Process on EZ1 with Trace TD protocol. (see protocol below, 6.2.4.12)
- 8) Estimate the amount of DNA in the sample. (See Quantitation Kits SOP)
- 9) The sample is now ready for PCR amplification

19.2.8 NAIL CLIPPINGS & GUM EXTRACTION

- 1) Label appropriate 2.0 mL EZ1 sample tube.
- 2) Cut an appropriately size sample and place into the labeled sterile 2.0 mL EZ1 sample tube.
- 3) Add 190 μ L G2 buffer to the sample tube.
- 4) Add 10 μ L Proteinase K.
- 5) Incubate at 56 $^{\circ}$ C for a minimum of 15 minutes.
- 6) Centrifuge tube briefly to remove drops from lid.
- 7) Remove any solid material from tube with tweezers or a toothpick. Try to remove as much liquid from the material as possible.
- 8) Process on EZ1 with Trace protocol. (see protocol below, 6.2.4.12)
- 9) Estimate the amount of DNA in the sample. (See Quantitation Kits SOP)
- 10) The sample is now ready for PCR amplification.

19.2.9 TISSUE EXTRACTION

**Note* Separation of fetal tissue from maternal tissue may be aided by rinsing and then submerging the tissues in PBS (phosphate-buffered saline) in a disposable petri dish in a cleanroom hood. Chorionic villi may be visualized around the fringes of the fetal tissues. These villi can be collected with a sterile scalpel for testing. See [Johnson, et.al, JFS 2Nov2010.pdf](#) in the Literature folder of the FB drive for further clarification.*

- 1) Label appropriate 2.0 mL EZ1 sample tube.
- 2) Cut an appropriately size sample and place into the labeled sterile 2.0 mL EZ1 sample tube.
- 3) Add 190 μ L G2 buffer to the sample tube.
- 4) Add 10 μ L Proteinase K.
- 5) Incubate at 56 $^{\circ}$ C for a minimum of 3 hour.
- 6) Centrifuge tube briefly to remove drops from lid.
- 7) Process on EZ1 with Trace TD protocol. (see protocol below, 6.2.4.12)
- 8) Estimate the amount of DNA in the sample. (See Quantitation Kits SOP)
- 9) The sample is now ready for PCR amplification.

19.2.10 TOOTH EXTRACTION

- 1) Label an appropriate number of 2.0 mL EZ1 sample tubes (typically 3 to 5).
- 2) Remove dirt and debris, if present, from the exterior of the tooth by rinsing with sterile water or scrubbing with a disposable toothbrush.
- 3) Grind the tooth to a fine powder in an appropriate grinder.
- 4) Divide the total volume of tooth powder equally into the 2.0 mL EZ1 sample tubes. It is not recommended to exceed 150mg of powdered product per tube.
- 5) To each sample tube:
 - a) Add 225 μ L of G2 buffer.
 - b) Add 25 μ L of Proteinase K.
 - c) Add 250 μ L 0.5M EDTA, pH 8.0.
 - d) Mix by inverting the tube several times and incubate at 56 $^{\circ}$ C in a heated orbital incubator for 24 hours.
 - e) Centrifuge at 6000 rpm for 4 minutes to pellet the remaining debris.
 - f) Transfer the supernatant to a labeled 2.0 mL EZ1 sample tube. Discard tube with pellet.
 - g) Add 400 μ L MTL buffer to the supernatant tube.
 - h) Add 50 μ L 3M NaOAc, pH 5.0 to each sample tube.
 - i) Add 1 μ L carrier RNA to each sample tube (optional).
- 6) Process all extraction tubes on an EZ1 with "Large Volume" protocol with 40 μ L. (see protocol below, 19.3)
- 7) Label a Microcon[®] DNA centrifugal device tube. And insert a Microcon[®] filter device into the tube.
- 8) Combine eluted DNA from duplicate tubes into a single Microcon[®] filter. (0.5 mL maximum volume). Seal with the attached cap.
- 9) Centrifuge at 500 x g until an appropriate liquid volume remains on top of the filter.
- 10) Place a new, labeled tube over the top of the Microcon[®] filter device and invert the filter in the assembly.
- 11) Spin at 1,000 x g for three minutes to transfer concentrate to tube.
- 12) Remove Microcon[®] filter device from the tube and discard.
- 13) Estimate the amount of DNA in the sample. (See Quantitation Kit SOP)
- 14) The samples are now ready for PCR amplification.

19.2.11 BONE EXTRACTION (DREMEL)

- 1) Inspect the sample visually, noting amount available and the state of the bone. Determine if there is sufficient sample available for any follow-up testing (if needed). If not, consult with the DNA Supervisor, DNA Technical Leader, or the CODIS Administrator.
- 2) Label an appropriate number of 2.0 mL EZ1 sample tubes.
- 3) Prepare Bone:

Remove dirt and debris, if present, from the exterior of the bone by: scrubbing with dish soap and water using a disposable brush; cleaning with 10% bleach solution; rinsing with sterile water; and/or abrading a section of the outer surface with the Dremel in the hood with the sash opened for maximum airflow.
- 4) Using the Dremel with a fresh 1/8 inch drill bit, bore numerous holes along a 1 inch long section of the cleaned bone in the hood positioned so that the ground bone can be collected on a weigh boat or weigh paper. Discard drill bit after use.
- 5) Divide the total volume of bone powder equally into the 2.0 mL EZ1 sample tubes. Do not exceed 150µl of powdered bone in a single tube.
- 6) Add 225 µL of G2 buffer.
- 7) Add 25 µL of Proteinase K.
- 8) Add 250 µL of 0.5M EDTA, pH 8.0.
- 9) Mix by inverting the tube(s) several times.
- 10) Incubate at 56 °C preferably in a heated orbital incubator for 24 hours.
- 11) Centrifuge at 6000 rpm for 4 minutes to pellet the remaining debris.
- 12) Transfer the supernatant to a 2.0 mL EZ1 sample tube.
- 13) Add 400 µL MTL buffer and 50 µL of 3M NaOAc, pH 5.0 to each 2.0 mL EZ1 sample tube.
- 14) Add 1 µL carrier RNA to each 2.0 mL EZ1 sample tube (optional).
- 15) Process all extraction tubes on an EZ1 with "Large Volume" protocol with 40µL. (see protocol 19.3)
- 16) Label a Microcon® DNA centrifugal device tube. And insert a Microcon® filter device into the tube. Combine eluted DNA from duplicate tubes into a single Microcon® filter. (0.5 mL maximum volume). Seal with the attached cap.
- 17) Centrifuge at 500 x g until an appropriate liquid volume remains on top of the filter.
- 18) Place a new, labeled tube over the top of the Microcon® filter device and invert the filter in the assembly.
- 19) Spin at 1,000 x g for three minutes to transfer concentrate to tube.
- 20) Remove Microcon® filter device from the tube and discard.
- 21) The samples are now ready for quantification.

19.2.12 BONE EXTRACTION (FREEZER MILL, not currently in use)

- 1) Inspect the sample visually, noting amount available and the state of the bone. Determine if there is sufficient sample available for any follow-up testing (if needed). If not, consult with the DNA Supervisor, DNA Technical Leader, or the CODIS Administrator.
- 2) Label an appropriate number of 2.0 mL EZ1 sample tubes.
- 3) Prepare Bone:

Remove dirt and debris, if present, from the exterior of the bone by: scrubbing with dish soap and water using a disposable brush; cleaning with 10% bleach solution; rinsing with sterile water; and/or abrading a section of the outer surface with the Dremel in the hood with the sash opened for maximum airflow.
- 4) Using the Dremel with a cutting disc, remove a 1 inch long quarter-section window of the cleaned bone in the hood.
- 5) Place the section of bone in a freshly cleaned freezer mill vial and chill by submersion in the liquid nitrogen. Grind the bone in the freezer mill.
- 6) Remove the vial from the mill and quickly transfer the contents into labeled sample tubes. Thoroughly clean the vial and vial components with hot water and dishwashing detergent using a non-scratch silicone scrub brush, followed by heavy soaking with 10% bleach spray. The parts will be rinsed with sterile dH₂O and allowed to dry.
- 7) Once dry, the parts will be swabbed with a moist swab, which will then be extracted to ensure the cleaning has successfully decontaminated all parts before reuse.
- 8) Divide the total volume of bone powder equally into the 2.0 mL EZ1 sample tubes. Do not exceed 150µl of powdered bone in a single tube.
- 9) Add 225 µL of G2 buffer, 25 µL of Proteinase K and 250 µL of 0.5M EDTA, pH 8.0.
- 10) Mix by inverting the tube(s) several times.
- 11) Incubate at 56 °C, preferably in a heated orbital incubator for 24 hours.
- 12) Centrifuge at 6000 rpm for 4 minutes to pellet the remaining debris.
- 13) Transfer the supernatant to a 2.0 mL EZ1 sample tube.
- 14) Add 400 µL MTL buffer and 50 µL of 3M NaOAc, pH 5.0 to each 2.0 mL EZ1 sample tube.
- 15) Add 1 µL carrier RNA to each 2.0 mL EZ1 sample tube (optional).
- 16) Process all extraction tubes on an EZ1 with “Large Volume” protocol with 40µL. (see protocol 19.3)
- 17) Label a Microcon® DNA centrifugal device tube. And insert a Microcon® filter device into the tube. Combine eluted DNA from duplicate tubes into a single Microcon® filter. (0.5 mL maximum volume). Seal with the attached cap.
- 18) Centrifuge at 500 x g until an appropriate liquid volume remains on top of the filter.
- 19) Place a new, labeled tube over the top of the Microcon® filter device and invert the filter in the assembly.
- 20) Spin at 1,000 x g for three minutes to transfer concentrate to tube.
- 21) Remove Microcon® filter device from the tube and discard.
- 22) The samples are now ready for quantification.

19.3 PROCESSING SAMPLES ON EZ1

- 1) Ensure EZ1 workstation is on.
- 2) Press START to start protocol setup.
- 3) Press ESC (for no report).
- 4) Press 1 or 2 (for Trace or Trace TD protocol), or 3 (for Large-Volume).
- 5) Press 2 (for elution in TE buffer).
- 6) Choose elution volume (most applications will be 50 µL, but highly concentrated samples can be diluted in larger volumes).
- 7) Press any key to continue.
- 8) Follow steps on screen to setup workstation:
- 9) Load cartridges into the rack.
- 10) Load opened 1.5 mL elution tubes in Row 1 of tip rack.
- 11) Load tip holders and tips in Row 2 of tip rack.
- 12) Load opened 2.0 mL sample tubes in Row 4 of tip rack.
- 13) Close workstation door.
- 14) Press START to start protocol.
- 15) Once display show PROTOCOL FINISHED, remove elution tubes. Discard waste appropriately.
- 16) Estimate the amount of DNA in the sample. (See Quantitation Kits SOP)
- 17) The sample is now ready for PCR amplification.

19.4 EXCEL SAMPLE MANAGEMENT (DNA-FORM-01)

- 1) Open form from FB Drive\Excel Form\
 - 2) Enable macros (if needed)
 - 3) Select the type of run.
 - 4) Select location to save and then save the file with a unique identifier (AA_YYMMDD)(AA = initials)
 - 5) Enter information as queried.
 - 6) Enter Case number and Samples Name on the SAMPLES tab.
 - 7) Press the CONTINUE TO QUANT setup button.
 - 8) Select location to save and then save the text file for the labels.
 - a) On the computer in the Clean Rooms select DNA LABELS on the desktop
 - b) Select Menu item TOOLS, then IMPORT DATA, then ADVANCED
 - c) Data Source is TEXT then Press NEXT
 - d) Press BROWSE and select the file saved at the beginning of Step 8
 - e) Select Delimiter TAB then Press NEXT
 - f) Select USE EXISTING OBJECTS located in the middle of the screen, then Press NEXT
 - g) Press NEXT
 - h) Press NEXT

- i) Press NEXT
 - j) Press NEXT
 - k) Select Copies to 2
 - l) Press FINISH
 - m) Select Menu item FILE, then PRINT
 - n) Press PRINT
 - o) Complete Extraction and return to the Excel Sheet
- 9) On Quant Set-up Sheet, enter the DATE and name of the Processor
 - 10) Press Print page button and select the printer to print to.
 - 11) Press the SAVE TXT FOR 7500 button.
 - 12) Select location to save and then save the file with the run name.
 - 13) Write in LOT NUMBERS and Standard prep. info on printed sheet.
 - 14) Setup Quant. in clean room
 - 15) Go to Post room, and start the 7500 program, open a new run, select HYres or QuantPro as template.
 - 16) Click FILE IMPORT SAMPLE SETUP, select the text file saved on the flash drive.
 - 17) Save the file then START QUANT.
 - 18) While Quant is running, enter lot numbers and standard prep info into Excel file.
 - 19) After Quant is complete, click FILE, EXPORT, RESULTS. Then select the flash drive and click SAVE.
 - 20) Go to QUANT SETUP in Excel sheet and click IMPORT QUANT DATA button.
 - 21) Select the file saved from the 7500 (It will be a .cvs file) click OK.
 - 22) Now go to TOTAL DNA QUANTITY TAB and examine the data.
 - 23) Adjust any dilutions as needed and then Press the CONTINUE TO STR AMP PAGE.
 - 24) Record the Thermocycler used, add the controls to the end of the list. Change the amount of DNA to the appropriate amount if need.
 - 25) Press PRINT SHEETS FOR AMPLIFICATION button.
 - 26) Select injections needed from list.
 - 27) Select location and then 'save file as' XXXX(Run Name),
 - 28) Take flash drive to 3500xl.
 - 29) On the 3500xl in the Plate manager, click the IMPORT PLATE BUTTON.
 - 30) Select the txt file saved on the flash drive and click OK.
 - 31) 3500xl will say that it imported OK. If gives an error of invalid symbol or other issue with the name, there is possibly had a space in a sample name on the first page.
 - 32) Start RUN.
 - 33) Press PRINT WORKSHEETS TO JUSTICETRAX IMAGING and Select JUSTICETRAX IMAGING.
 - 34) Once the 3500xl run is completed, copy the files and analyze with GeneMapper ID-X.
 - 35) Once all files have been analyzed, go back to the main GeneMapper windows and change the table settings to the export selection.

- 36) Next, click FILE, EXPORT COMBINED TABLE.
- 37) Select ONE LINE PER SAMPLE on the right
- 38) Place the file where it can be found later.
- 39) Click EXPORT COMBINED TABLE.
- 40) In the Excel file on the FINAL tab select the samples for each injection time, if needed.
- 41) Click GENERATE CALL SHEETS.
- 42) Press the injection time that needs to have data imported to, if needed
- 43) Select the file and click OK.
- 44) Correct all calls on the call sheets
- 45) For YSTR statistics, select desired profiles on the FINAL tab, click the Y-STATS button.
- 46) Open, then select and copy the desired YSTR profile. Press the open YSTR STATS button, and paste the selection into the desired cells.

19.5 QUANTITATION

19.5.1 PREPARING THE DNA QUANTIFICATION STANDARD

Quant Pro Qiagility Preparation

- Label 0.2ml tubes A-E, and NTC. Vortex the Kit DNA Standard 3-5 sec.
- Transfer 120 uL of the standard into each of the 0.2ul tubes labeled A.
- Transfer 77 uL of the diluent into each of the 0.2ul tubes labeled NTC.
- Transfer the remaining Diluent into one of the remaining 1.5ml tubes
- Prepare Master Mix with 144 uL Reaction Mix and 144 uL Primer into the last 1.5ml tube.
- Turn on the Qiagility instrument, open the template called QuantPro Standards on the computer desktop.
- Set up the instrument deck by replacing the 50ul tips (top left position) with the 200ul tips from the cabinet.
- Place the Master Mix tube in the center well and the Diluent tube in the bottom left well of the 5 tube holder block.
- Place all 12 of the tubes labeled A-E, and NTC in the location for Standards.
- Place a labeled plate on the instrument deck.
- Run the program. When done, cover plate with a clear adhesive cover.
- Continue below:

Quant Pro Manual Preparation

- Label 0.2ml tubes A-E, and NTC. Vortex the Kit DNA Standard 3-5 sec.
- Transfer 99 uL of the standard into each of the 0.2ul tubes labeled A.
- Transfer 99 uL of the diluent into each of the 0.2ul tubes labeled B-E and NTC.
- Transfer 9 uL of STD A into each STD B tube. Vortex to mix.
- Transfer 9 uL of STD B into each STD C tube. Vortex to mix.
- Transfer 9 uL of STD C into each STD D tube. Vortex to mix.
- Transfer 9 uL of STD D into each STD E tube. Vortex to mix.
- Prepare Master Mix with 144 uL Reaction Mix and 144 uL Primer into the last 1.5ml tube.
- Label a 96-well optical amplification plate.
- Aliquot 18 uL reaction mix in wells 1A-1F and 2A-2F.
- Load 2 uL of each STD per the default QuantPro plate setup. Cover plate with clear adhesive cover.
- Continue below:

- Place plate on the 7500 instrument. Run the default template for *QuantPro*; there is no need to import a sample setup.
- Export the run results.
- Open the *QuantPro QC Check.xlsm* file from the S drive. Instructions can be found on the *Instructions* sheet if needed. Go to *Input CSV* sheet.
- Delete all present data if needed. Click *Yes*.
- Go to the *Data* tab and select *From Text*. Import your exported results file.
- Select *Delimited*, then *Next*. Check *Tab* and *Comma*, then click *Finish* and *OK*.
- Go to *QC Check* sheet and make sure there are green “Pass” boxes for standards A-E listed. If passing, check/update the lot number and preparation and expiration dates on *QC Check*. Click *Export* button to export as a .pdf and record the new standards in the *Quant STD QC.xls*.
- Hyperlink information from *QuantPro QC* excel file to *QuantPro QC Check* data in the *QCSheets* folder.
- Remove old Standard Curve dilutions and place one set of new labeled standards in each clean room.

19.5.2 PREPARING THE QUANTITATION REACTION

Manual Preparation

- Prepare Quantitation kit master mix per the instructions on the DNA Quantitation worksheet (DNA-FORM-1a):
 - # wells (+ 3-5 extra) x 9 μ L PCR Reaction Mix
 - # wells (+ 3-5 extra) x 9 μ L Primer Mix
- Vortex and dispense 18 μ L of the master mix into each well of a 96-well reaction plate.
- Add a total of 2 μ L of sample, standard or control to the appropriate well.
- Seal the reaction plate with the optical adhesive cover.
- Centrifuge the plate at 3000rpm for about 20 seconds.

Qiagility Preparation

- Prepare Quantitation kit master mix per the instructions on the DNA Quantitation worksheet (DNA-FORM-1a):
 - # wells (+ 3-5 extra) x 9 μ L PCR Reaction Mix
 - # wells (+ 3-5 extra) x 9 μ L Primer Mix
- Turn on the Qiagility.
- Start the program called [*Kit*] *7500*.
- Put the Master Mix in the center well of the 5 tube holder block.
- Place the Standard Curve Tubes in the block for Standards.
- Put a labeled plate on the machine.
- Place sample tubes in the sample blocks according to the Qiagility Setup sheet that is printed from the excel sheet.
- Press the *GREEN TRIANGLE* Button to start run.

- Seal the reaction plate with the optical adhesive cover.
- Centrifuge the plate at 3000rpm for about 20 seconds.

19.6 RUNNING THE REACTIONS AND ANALYSIS OF RESULTS

- 1) Running the Reactions:
 - a) Turn on the computer and then turn on the 7500 instrument.
 - b) Position the plate in the 7500 instrument thermal block so that well A1 is in the upper-left corner.
 - c) Initialize the ABI data collection software.
 - d) Select New from the File menu.
 - e) From the drop-down menu under Template, select Quant Pro.
 - f) Select Import Samples Setup from File menu.
 - g) Save As with the file name (i.e., Init_YYMMDD.sds)
 - h) On Instrument tab, press start when ready to run.
- 2) Data Analysis:
 - a) Press the Green Triangle icon to automatically analyze the run. All analyzed data is viewed under the Results tab.
 - b) In the Results tab, select the Standard Curve tab. Examine the standard curve to see if $R^2 \geq 0.98$. If not, outlying standard results can be eliminated to a minimum of one set of 5 standard measurements. If it still does not have a $R^2 \geq 0.98$, then the DNA quantities will be used with caution.
- 3) Results of analysis:
 - a) If samples results are negative, amplify using the maximum volume of extract allowed for the amplification kit.
 - b) Overblown samples ($>10\text{ng}/\mu\text{L}$) can be diluted appropriately and amplified.
 - c) Stopping further analysis based on quantitation results:
 - i. If total DNA quantitation result is $.0025\text{ ng}/\mu\text{L}$ or below then the sample does not need to be further processed for STR analysis. (See report sections for report wording)
 - ii. If a sexual assault sample contains 5% or less of male contributor (Quant Pro: Male quantitation result / Total quantitation result * 100) then the sample does not need to be further processed for STR analysis. (See report sections for report wording)
 - iii. If the semen fraction of a sexual assault case is processed for STR analysis then the corresponding epithelial fraction will be processed regardless of the percent male contribution in the epithelial fraction.
 - iv. If all question (Q) items are stopped because of quantitation then victim knowns do not need to be processed for STR analysis. Suspect knowns will be processed for STR analysis.
 - d) Y-STR analysis with Yfiler Plus has a threshold for low or undetectable male quantitation results below which amplification is not expected to yield probative results. However, any question items may be eligible for analysis with Yfiler Plus if determined to be necessary by

the analyst. Additionally, case specific factors may dictate that some samples that meet the quantitation threshold will not be processed for Y-STR analysis. These include:

- i. In cases with multiple samples, low or undetected male samples may be reserved pending Y-STR results from samples with good male quantitation results,
- ii. Number of suspected male perpetrators,
- iii. Number of male contributors to the autosomal mixture exceeds two.

19.6.1 AMPLIFICATION SET UP

PowerPlex Fusion 6C

Manual Plate Set Up:

- Prepare Fusion 6C master mix per the instructions on the STR Master Mix worksheet (DNA-FORM-1d):
 - # wells (+ 3-5 extra) x 5 µL PCR Reaction Mix
 - # wells (+ 3-5 extra) x 5 µL Primer Mix
- Dispense 10 µL of master mix and 15 µL of sample into each well on a 96-well amp plate as indicated by the STR Amplification Worksheet (DNA-FORM-1c).
- Cover the plate with PCR septa.

Qiagility Plate Set Up:

- Prepare Fusion 6C master mix per the instructions on the STR Master Mix worksheet (DNA-FORM-1d):
 - # wells (+ 3-5 extra) x 5 µL PCR Reaction Mix
 - # wells (+ 3-5 extra) x 5 µL Primer Mix
- Export the sample setup data from the STR Amplification Worksheet (DNA-FORM-1c) onto a USB memory stick.
- Turn on the Qiagility.
- Start the Fusion setup program.
- Import the sample setup .QAS file as indicated on the Qiagility Amp Setup Sheet that is printed from the STR Amplification Worksheet.
- Put the Master Mix in the appropriate well of the 5 tube holder block.
- Place the 2800M Positive PCR control in the appropriate location in the Standards block.
- Put a labeled plate on the machine.
- Place sample tubes in the sample blocks according to the Qiagility Amp Setup Sheet.
- Press the Green Triangle Button to start run.
- Cover the plate with a PCR septa.

Briefly spin the plate in the centrifuge and place into the thermocycler. To start the Amplification run, follow these steps:

- 1) Turn on the power to the thermocycler.
- 2) Select the appropriate program.
- 3) Ensure the proper volume is entered.
- 4) Start the program.
- 5) Wait for confirmation that the program has begun before leaving.

The following are the thermocycler parameters used for amplification of PowerPlex Fusion 6C:

96°C	1min
96°C	5sec
60°C	1min 29cycles
60°C	10min
4°C	forever

Yfiler Plus

Manual Plate Set Up (no Qiagility Set Up available):

- Prepare Yfiler Plus master mix per the STR Master Mix worksheet instructions (DNA-FORM-1d):
 - # wells (+ 3-5 extra) x 10 µL Master Mix
 - # wells (+ 3-5 extra) x 5 µL Primer Set
- Dispense 15 µL of master mix and 10 µL of sample into each well on a 96-well amp plate as indicated by the STR Amplification Worksheet (DNA-Form-1c).
- Cover the plate with PCR septa.
- Briefly spin the plate in the centrifuge and place into the thermocycler. To start the run, follow these steps:
 - 1) Turn on the power to the thermocycler
 - 2) Select the appropriate program
 - 3) Ensure the proper volume is entered
 - 4) Start the program.
 - 5) Wait for confirmation that the program has begun before leaving.

The following are the thermocycler parameters used for amplification of Yfiler Plus:

Initial Incubation Step	Optimum Cycle Number: 29		Final Extension	Final Hold
	Denature	Anneal/Extend		
95°C	94°C	61.5°C	60°C	4°C
1 minute	4 seconds	1 minute	22 minutes	∞

19.6.2 3500XL SAMPLE SET UP

After amplification is complete, samples are set up for the 3500xl. A 96 Opti-Well plate is used. It is best to pre-warm the oven approximately 15 minutes before the run starts.

PowerPlex Fusion 6C & Yfiler Plus

- 1) Create a master mix solution in the following ratios:

PowerPlex Fusion 6C	Yfiler Plus
0.5 µL Internal Lane Standard (WEN_ILS_500)	0.4 µL GeneScan™ 600 LIZ™ Size Standard v2.0
9.5 µL of HiDi Formamide	9.6 µL of HiDi Formamide

- 2) Pipette 10 μL of mix into each well used.
- 3) Ensure that all the wells of an injection contain master mix. The 3500xl should never inject sample from a dry well.
- 4) Add 1 μL of sample to each well (a multi-channel pipette is beneficial).
- 5) Add 1 μL of ladder to each ladder sample. At minimum, 1 ladder per plate must be present.
- 6) Briefly spin the plate in the centrifuge.
- 7) Heat the plate for approximately 3 minutes (for Fusion 6C)/10 minutes (for Yfiler Plus).
- 8) Chill the plate for approximately 3 minutes.
- 9) Place the plate into the 3500xl instrument. The plate only fits into the instrument in one orientation.
- 10) On the 3500xl computer, go to Library, and click on Import.
- 11) Select the .txt file to import. The typical setup is for a single 24 second injection at 1.2 kV Fusion6C or Yfiler Plus by default. Edit settings as necessary and click Okay.
- 12) Go to the Dashboard and press the Pre-Heat Button.
- 13) Link the appropriate plate to the plate map under the Load Plates for Run.
- 14) To start the run, click on the Start Run Button.

19.7 STR ANALYSIS

19.7.1 ANALYSIS OF RAW DATA/GENEMAPPER ID-X

GeneMapper ID-X (GM) analysis software is used to analyze the raw data collected by the 3500xl Genetic Analyzer.

***Note: PowerPlex 16HS and PowerPlex Y23 information is restricted to reanalysis of historical data files by Technical Leader-approved analysts. A memorandum of authorization and competency test is required if this reanalysis is more than 2 years from the date of completion of the last proficiency test with this technology.*

- A matrix file is applied to the raw data to create a single baseline as well as to correct for spectral overlap and produce peaks of the five individual colors.
 - A size curve is created using co-injected DNA fragments of known size and the unknown peaks are assigned a size by interpolation.
- 1) Open the GeneMapper ID-X program with a blank project window and select FILE>ADD SAMPLES TO PROJECT.
 - 2) Select the appropriate run folder saved on the FB drive and click ADD TO LIST. Once all appropriate samples have been added to the list, click ADD to import the files.
 - 3) In the SAMPLE TYPE column, assign the correct sample type to each sample (i.e., sample, ladder, control)
 - 4) Select ANALYSIS METHOD:

ASCL_Fusion6C/ASCL_Fusion6C_AXPT	for PowerPlex Fusion 6C data.
ASCL_Yfiler+_v1.0	for Yfiler Plus data.
ASCL_PP16HS/ASCL_PP16HS_AXPT/ASCL_Y23	for historical PP16HS/PPY23 data.
 - 5) Select Panel:

- | | |
|---|-----------------------------------|
| PowerPlex_Fusion_6C_Panels_IDX_v1.1 | for PowerPlex Fusion 6C data. |
| Yfiler_Plus_Panel_v4_ASCL | for Yfiler Plus data. |
| PowerPlex_16_IDX_Alpha/ PowerPlexY23_IDX_v2.0 | for historical PP16HS/PPY23 data. |
- 6) Select Size Standard:

WEN_ILS_500_CS	for PowerPlex Fusion 6C data.
GS600_LIZ_(60-460)	for Yfiler Plus data.
ILS 600/WEN_ILS_500_IDX_Y23	for historical PP16HS/PPY23 data.
 - 7) Click the **GREEN ARROW** to analyze the project.
 - 8) View the raw data to examine the sizing standards. Verify that the analysis range is between 60bp and 600bp and the peaks are correctly labeled.
 - 9) Review controls:
 - Display each control (including positive and negative amplification controls, and blank controls).
 - If peaks above analytical threshold are observed in the negative controls, the sample can be re-injected.
 - Examine the Positive control and verify the correct calls of the alleles.
 - 10) Examine the allelic ladders.
 - Verify that the allelic ladder is called correctly for each marker.
 - 11) Analyzed samples can be viewed as a group or individually by highlighting the samples to view. After selecting the sample click the **DISPLAY PLOTS** button. There are several options available to view the electropherogram.
 - 12) Edit any labels as appropriate (e.g., spike, background, -A)
 - 13) Review the remaining sample files. Evaluate the following parameters:
 - Peak shape and height (optimal values between 1000-6000 RFU, although acceptable and type able signals may occur outside of this range).
 - Matrix quality (baselines should be relatively flat and there should not be a pattern of pronounced peaks or dips below true DNA peaks in the other four colors).

19.7.2 ANALYSIS OF AUTOSOMAL PROFILES WITH ARMEDXPRT SOFTWARE

ArmedXpert is a Mixture analysis tool that assists the analyst in deconvoluting a mixture based on the peak heights detected and parameters set from validation studies. The software calculates the probable genotypes then the analyst selects the genotype(s) to associate with each contributor. All mixtures are to go through ArmedXpert (AX) interpretation, except if the sample has a major that will not be used for statistics and the minor is inconclusive, in this case the major will be designated on the call sheet and the JusticeTrax electros become the accurate representation of the calls. Appendix B is a Generalized Guideline for Mixture Interpretation Workflow. The workflow and the guidelines below allow for the interpretation of the majority of samples in the DNA section of the ASCL. Any significant deviation from the workflow or guidelines below needs to be discussed and approved by the DNA Technical Leader.

***NOTE: PowerPlex 16 HS is restricted to reanalysis of historical data files by Technical Leader-approved analysts. A memorandum of authorization is required if this reanalysis is more than 2 years from the date of completion of the last proficiency test with this technology*

Combine 12 and 24 second injections of a run into one GeneMapper Project.

- Add samples to GM project as usual starting with the 12sec injection and analyze as usual with ASCL_PP16HS Analysis Method
- Once it has been determined which samples require reinjection at 24sec, import those samples from the 24sec injection data into the same GM Project. This will show up as a second branch on the Project tree on the left side of the screen. Note that all samples (12 & 24 sec) can be viewed by selecting the top-most “project” header, or samples for only 12 or 24 sec injection can be viewed by selecting the respective name from the project tree.
- If both 12 second and 24seconds samples are analyzed on the same GM project, change the Sample Name in the GM Project to indicate 24sec injection (e.g., add “_24” suffix to the sample name). This allows differentiation between 12 and 24 sec data on the electropherogram and call sheets. Also do this for all necessary 24sec controls.

PowerPlex Fusion 6C and PowerPlex 16 HS:

- 1) Mixtures that need interpretation will be reanalyzed using ASCL Fusion6C AXPT or ASCL PP16HS AXPT Analysis Method. This will remove GM stutter filter before the sample is exported to AX. Non-stutter artifacts should be deleted in GM before export.
- 2) Exporting samples to Excel and ArmedXpert from GeneMapper:
 - a) In GM, select ARMEDXPERT EXPORT from the Table Setting drop down menu (for PowerPlex 16HS, make sure to select the top line of the PROJECT tree so that both 12 and 24 sec samples are exported.)
 - i. FILE -> EXPORT COMBINED TABLE
 - ii. In pop up window select ONE LINE PER SAMPLE (all other defaults are correct) and export file to the AX folder on the FB drive
 - b) Import this data to make the call sheet in Excel:
 - i. On the “Final” tab of the DNA-FORM-1 Excel workbook (located on the FB drive) there is a set of buttons titled For PP16HS and For PPF6C to the right of the old ones; use these to import the AX export file and print the call sheets. For single source samples, this is the sheet that needs to match the JTX electro calls. For samples that will require mixture interpretation, these will be deconvoluted and additional data will be provided (described further in section 5) to specify major/ minor or other interpretations.
 - ii. On the Excel call sheets, use the radio buttons to the right of each sample name to make notations for reinjection, etc. PowerPlex Fusion 6C Loci with alleles <600RFU (and PowerPlex 16HS loci with alleles <500RFU) will be shaded in grey automatically.

- c) In ArmedXpert: Click the HELIX button, click IMPORT, click OTHER and select file to import. This will open an Excel-style sheet with all of the samples and allele calls listed.
- 3) Sample Comparison Check. This not triggered automatically in AX so it must be performed manually it on each call sheet (described above in 2.d.).
- a) In AX main page on the top bar menu, select REPORTING tab, click the SAMPLES COMPARISON button.
 - b) In the pop up window, select the name of the text file in both the REFERENCE box and the COMPARISON box. (This will compare the project to itself.) On the bottom right of the pop up window, scroll down and select STAFF (all other defaults are correct). Press the MATCH button.
 - c) An excel-style COMPARISON SHEET will be produced. If there are any TRUE matches (e.g., contamination to staff or other samples) (far right column), the page needs to be printed and documented in the applicable case file(s). If there are no true matches, this page does not need to be printed.
 - d) Save the comparison with the project name (regardless of if there are matches) to the ArmedXpert folder on the FB drive.
- 4) Statistics on single source profiles: on “Interpretation” tab, select the desired stat button (e.g., RMP or Single Source) and use the mouse to select the sample on the table desired for stats.
- a) Note that SINGLE SOURCE should be used for a straight profile and RMP should be used for a deconvoluted mixture (even if that is on the major component of the mixture)
 - b) Print the statistics for the file: Select the helix button on the top left of the AX screen and select PRINT in the pop up menu. The follow settings are suggested: PORTRAIT, FIT TO PAGE 1 WIDE, 2 TALL.
- 5) Mixture Interpretation: on “Interpretation” tab, select “Begin Mixture Interpretation” and select (via mouse or drop down menu) the sample desired.
- a) Check the MULTI PHR button
 - b) Change the number of contributors if necessary
 - c) Change the Stutter to 100% then check the APPLY GLOBALLY box
 - d) Apply a reference if appropriate (only set apply a reference if it is an intimate source sample or if it is stated to be from that individual)
 - i. Click REFERENCES button
 - ii. Click SELECT A REFERENCE TO APPLY
 - iii. Select sample
 - iv. The AUTOCALL REFERENCE button can be used to automatically select the reference genotype for each loci.
 - e) Select genotypes for each contributor at each locus (e.g., using Popout calls).
 - i. Note that minor alleles do not necessarily have to be assigned to a contributor (e.g., if a minor will be called inconclusive).

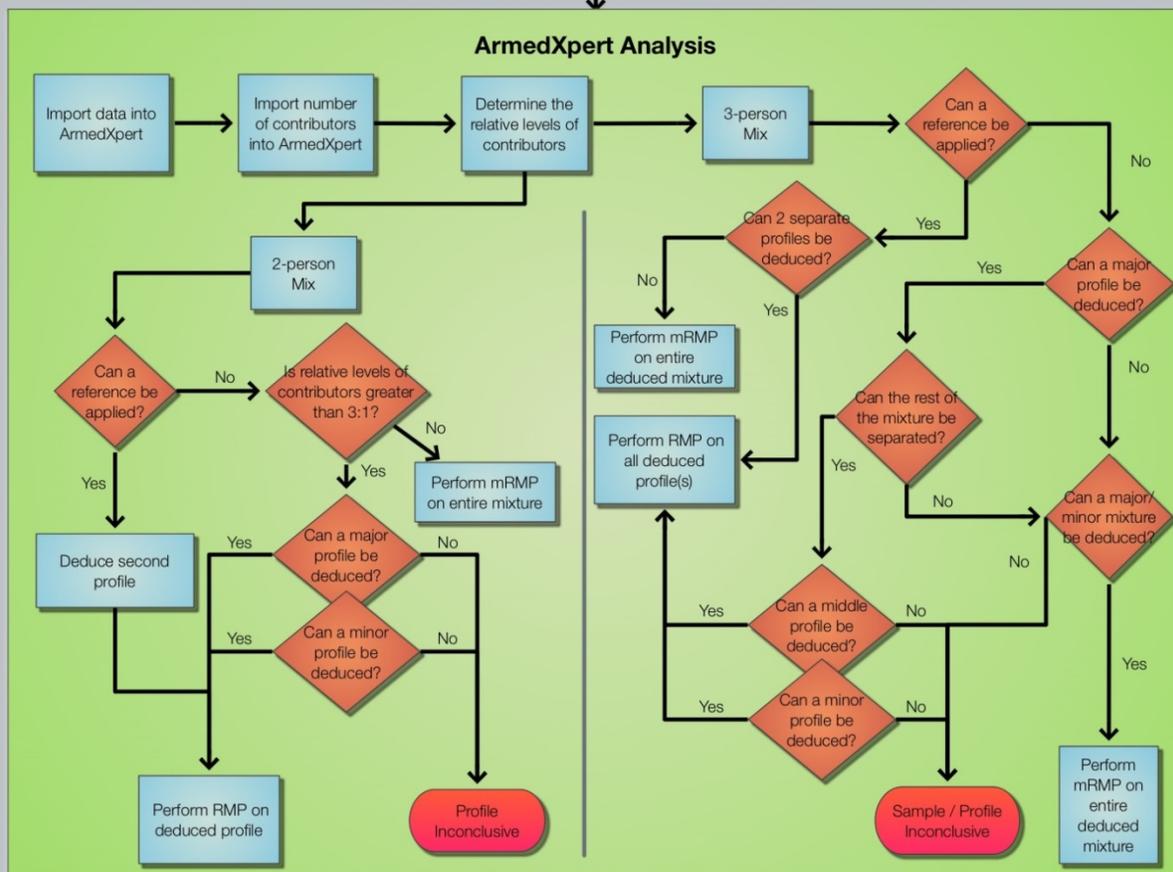
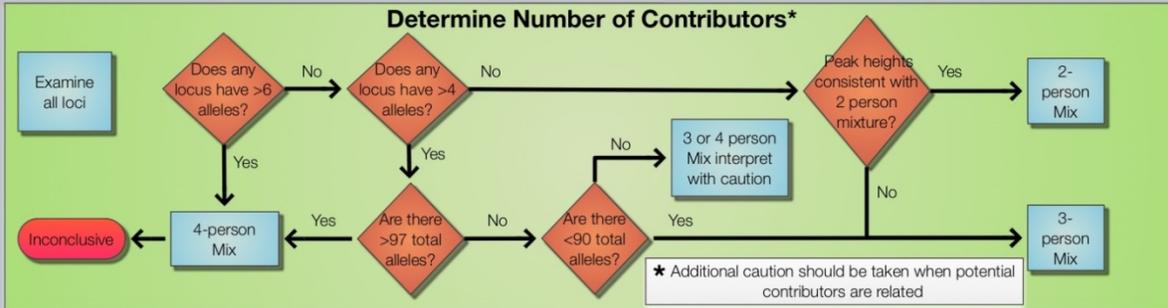
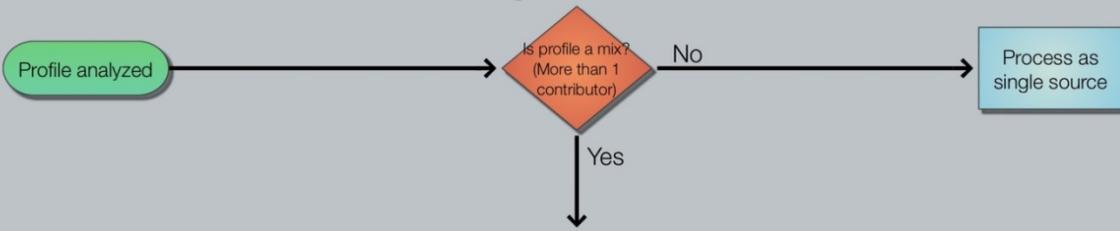
- ii. Name designations for contributors should be the default “Profile 1, Profile 2, etc.” with the major component being Profile 1 and any profiles with a Reference applied designated such as with a “(K#)” suffix (e.g., Profile 1 (K1) noting the known sample applied to that profile.
- f) Troubleshooting: Note that the procedures described in steps i. and ii. below will affect only the locus in question – once the interpretation is started, these changes will not be applied globally (to the entire profile)
- i. If peak height imbalance is causing the mixture information to advise that there are no options for this locus, this can be addressed by adjusting the PHr button on the MIXTURE INTERPRETATION page. Usually, toggling that down a bit will help.
 - ii. When AX accounts for stutter, it reduces the allele peak height by the stutter percentage. Occasionally, this will cause true minor peaks to fall below analytical threshold. If this has happened with the sample, stutter can be reduced from 100% at the loci. (Keep in mind that stutter ratios applied are the max expected values from the validation at that locus and can vary between alleles within a locus) Typically if the peak height of a stutter allele that has had 100% stutter removed is between 60-174 rfu it indicates that it could be a true minor peak and the stutter percentage should be lowered to 60% to see if the peak is recovered. If it is not recovered by lowering stutter percentage, but it has been determined it to be a true minor allele, select CONSIDER ALLELE from the pop-out calls window and make a note in the ADD COMMENTS box. If it is not possible to determine if an allele is real or artifact, it may be included as a possible allele in the interpretation, with an appropriate note in the ADD COMMENT box (“Considered X, possible allele, 165 rfu @ 60%). If the obligate sister allele is below stochastic threshold, the possible allele is included in the 2p (allele, any) statistic. If however, the obligate sister is above stochastic threshold, then the possible allele should be included as one of the options in the statistics, but the possible allele should not also be an obligate allele.
 - iii. If other adjustments have been made to the interpretation of that locus it should be noted using the ADD COMMENT button (use the button itself, not it’s drop-down menu)
 - iv. Notes that apply to the entire mixture interpretation (e.g., assumptions) should be noted using the ADD COMMENT drop-down menu option “Add comment to Mixture Interpretation”
 - v. These modifications & comments will show up in the final MIXTURE INTERPRETATION notes generated by AX.
 - vi. When selecting genotype possibilities in ArmedXpert variation in the relative contribution should remain consistent for the entire profile. Any given loci should not deviate more than 10% points (eg. If it is an 80% /

20% mix the minor genotypes combinations should be listed as 10-30% of the mixture). If the sample is have degradation or inhibition issues than 15% points can be used. Greater than 15% points is possible, but should only occur in a small number of loci, otherwise it is an indication of possibly more contributors or other issues with the sample.

- g) Recording the mixture deconvolution: On mixture interpretation page, click the “view call report” button. This will open an excel-style workbook.
 - i. The CALLS page shows the mixture in different formats; the entire mixture, and the deconvoluted components.
 - 1. The allele calls for the un-deconvoluted profile on this sheet are what needs to match the electros in JTX. It is recommended that the mixture sample electros be re-analyzed using the usual Analysis Method (which will remove most stutter) and add back in any true peaks as determined by AX before imaging the electro into JTX.
 - 2. Print this page for the case file. Recommended settings: LANDSCAPE; FIT TO PAGES 1X1
 - ii. The MIX INTERP page shows the mixture interpretation details including any comments or adjustments that may have been made. Print this for the file if necessary. Note that printing MIX INTERP is not necessary in all circumstances (e.g., if a major is useable but minor will be reported as inconclusive). Recommended settings: Portrait, Zoom to 100%
 - iii. Before exiting, save the Mixture Interpretation to the AX folder on the FB drive (AX will prompt to save on exit)
- h) Statistics on a deconvoluted mixture: Start from the CALLS page of the call report (see above). From top bar menu, select “Interpretation” and then the stats desired (e.g., “RMP”) and use the mouse to highlight the sample desired (e.g., the major or minor component of the deconvoluted mixture). This will open an excel-style window with the statistics.
 - i. The FREQUENCIES tab will list the statistics. (separate tab in ArmedXpert v3.0.7 only)
 - 1. Adjust the number of contributors (box at the bottom) if necessary.
 - 2. Make any other changes needed / commented on during mixture deconvolution (e.g., homozygote not a viable option for X locus)
 - 3. Print the stats for the file. Recommended settings: Portrait; FIT TO PAGES 1X5 (it will automatically scale back if it can fit it in less pages)
 - iv. The CALCULATIONS tab is for reference and does not need to be printed. (ArmedXpert v3.0.7 only)
 - v. If any changes were made, it is recommended that the Frequency Analysis be saved to the AX folder on the FB drive (AX will prompt before closing that window)

- vi. Compare deconvoluted mixture to known samples if applicable (see 6.b. below).
- 6) Checking References: on the AX main page top bar menu, select MATCH & COMPARISON
 - a) FIND WHERE REFERENCE IS INCLUDED may be used when comparing a known to a batch or a sample
 - b) FIND INCLUDED IN THE REFERENCE may be used to compare deduced profiles to known samples
 - 7) Committing Samples to the database: On main AX top bar menu, select DATA tab, click COMMIT SAMPLES TO DATA SOURCE. In the pop-up window highlight the data file from the list on the left and use the ">" to add it to the right side of the window. Click the COMMIT button.
 - 8) Accessing ME sample profiles in AX: Under the DATA tab on the main page, select LOAD SAMPLES FROM DATA SOURCE. In the pop-up window "SEARCH:" field, type the ME sample # (or just "ME" and check the SEARCH PROFILES box. A list will show on the left side of the window. Select the sample(s) desired and move them to the right side of the window using the ">" button. Press the "LOAD" button.
- iv.

Arkansas State Crime Laboratory - Mixture Interpretation Workflow



21.1 PROBABILITY OF EXCLUSION

The Probability of Exclusion (PE) is defined as the probability of excluding a random individual as a parent, given the alleles of the child’s profile and the biological parent’s profile. The DNA profile of the alleged parent is not considered in calculating the PE. The Probability of Exclusion is equal to the frequency of all the people in the population who do not contain an allele that matches the obligate parental allele of the child. If the genotypes of the biological parent, child, and alleged parent do not match at one locus, then it is declared “no match” at that locus and the entire parentage test is declared “inconclusive.” If the genotypes of the known parent, child, and alleged parent do not match at two or more loci, then “no match” is declared for the entire parentage test.

A population group-specific mean power of exclusion for a locus can be calculated using the corresponding allele frequencies of the locus and the formula given by Butler as shown: $\bar{A} = PE_{avg} = H^2(1 - 2H(1 - H)^2)$

$$H = 1 - \sum_{j=1}^n p_j^2$$

where H denotes the degree of heterozygosity of a locus, defined as follows:

where n denotes the number of detectable alleles at a locus for a population, and p_j denotes the frequency of the j^{th} allele. The PI for an inconsistent locus is then: $PI = \mu / \bar{A}$.

The Combined Parentage Index (CPI) for the profile is calculated by multiplying together the individual locus

PI, as shown:
$$CPI = \prod_{locus} PI$$

$$CPE = 1 - \prod_{locus} (1 - PE_{locus}).$$

The combined probability of exclusion (CPE) is:

For a locus with inconsistency, \bar{A} is used for PE_{locus} .

All matched cases and their corresponding formulas for PI and PE are listed in the Parentage Formula Table.

PE for Parentage Trio

The Probability of Exclusion (PE) of parentage for a DNA profile is determined by the following equation:

$$PE = 1 - \prod_{loci} [1 - (PE_{locus})].$$

Note that the expression of $(1 - PE_{locus})$ is simply PI_{locus} , the locus probability of inclusion, and that $PI + PE = 1$ always.

The Probability of Parentage (W) for the alleged parent in a parentage trio mode is determined from the CPI

$$W = \frac{CPI \cdot P_{prior}}{CPI \cdot P_{prior} + (1 - P_{prior})}$$

by the following equation: with the default of value of 0.5 for P_{prior} . P_{prior} is the prior probability of parentage. The prior probability is user-configurable and its default value is set to the neutral value of 0.5 for every locus of the profile. That is, Popstats assumes there is a 50% probability that the alleged parent is the biological parent of the child, and a 50% probability that the alleged parent is not the biological parent of the child.

Note: The profile W is not calculated by multiplying the individual locus W s. The values arrived would not be the same as those arrived at using the CPI method. Thus, the individual locus W is not calculated.

21.2 PARENTAGE TRIO

Parentage Trio in Popstats calculates the Parentage Index and the Probability of Exclusion by using the equations shown in the following table that map to the applicable genotypes of the Biological Parent, Child, and Alleged Parent:

	Known Parent (KP)	Child (C)	Alleged Parent (AP)	Parentage Index (PI)	Probability of Exclusion (PE)
1	AA	AA	AA	$1 / a$	$(1 : a)^2$
	AB	AA	AA		
	BB	AB	AA		
	BC	AB	AA		
2	AA	AA	AB	$1 / 2a$	$(1 : a)^2$
	BB	AB	AB		
	BB	AB	AC		
	BC	AB	AD		
	BC	AB	AB		
	AB	AA	AB		
3	AA	AB	BB	$1 / b$	$(1 : b)^2$
	AC	AB	BB		
4	AA	AB	AB	$1 / 2b$	$(1 : b)^2$
	AA	AB	BC		
	AC	AB	BD		
	AC	AB	AB		
5	AB	AB	AB	$1 / a + b$	$[1 - 1(a + b)]^2$
6	AB	AB	AA	$1 / a + b$	$[1 - 1(a + b)]^2$
	AB	AB	BB		
7	AB	AB	AC	$1 / 2(a + b)$	$[1 - 1(a + b)]^2$
	AB	AB	BC		

Where a and b are the allele frequencies of A and B, respectively.

Note: If a or b is less than the minimum allele frequency, then the minimum allele frequency is used for calculation instead.

In the case where the alleged parent has an inconsistent genotype at one locus, then μ / \bar{A} will be calculated for the Parentage Index, where μ is the mutation rate of the locus and \bar{A} is the mean power of exclusion of the locus. If there are more than two loci with inconsistencies, then the parentage case is an exclusion.

Once the Parentage Index of each locus is determined for both the case of consistent genotypes and the case of mutation, the probability of parentage (W), the Combined Parentage Index (CPI), and the Combined Probability of Exclusion (CPE) can be calculated as before. Namely, the probability of parentage for each

$$W = \frac{PI \cdot (\text{prior probability } y)}{PI \cdot (\text{prior probability } y) + [1 - (\text{prior probability } y)]}$$

locus is:

The Combined Parentage Index is:

$$CPI = \prod_{loci} PI$$

The Combined Probability of Parentage is:

$$CW = \prod_{loci} W$$

The Combined Probability of Exclusion is:

$$\text{CPE} = 1 - \prod_{loci} (1 - \text{PE})$$

21.3 REVERSE PARENTAGE

The probability of exclusion of Reverse Parentage can be interpreted as the proportion of all of those individuals in the population that do not contain an allele that matches the biological mother and a second allele that matches the biological father. Similarly, note that a, b, c, and d denote the allele frequencies of alleles A, B, C, and D, respectively. The following table shows the RPI and PE formula for various Mother-Father-alleged child genotype combinations.

Biological Parent 1	Biological Parent 2	Alleged Child	Reverse Parentage Index	Probability of Exclusion	Genotype Combination Characteristics
AA	AB	AB	$1 / 4ab$	$1 - a(a + 2b)$	The evidence is heterozygous and is identical to one biological parent's genotype; the other biological parent is homozygous. Possible children's genotypes AA(50%), AB(50%) for AA, AB parents; and BB(50%), AB(50%) for BB, AB parents.
AB	AB	AB	$1 / 4ab$	$1 - a(a + b)^2$	All profiles are heterozygous and identical. Possible children's genotypes AA(25%), AB(50%), B(25%).
AA	AB	AA	$1 / 2a^2$	$1 - a(a + 2b)$	The evidence is homozygous and is identical to one biological parent's genotype; the other known biological is heterozygous.
AB	AB	A	$1 / 4a^2$	$1 - a(a + b)^2$	The evidence is homozygous; the known parents' genotypes are both heterozygous and identical. Possible children's genotypes are AA(25%), AB(50%), and BB(25%).
AA	BB	AB	$1 / 2ab$	$1 - 2ab$	The evidence is heterozygous and the parents' profiles are homozygous. Possible children's genotype is AB.
AA	BC	AB	$1 / 4ab$	$1 - 2a(b + c)$	The evidence is heterozygous; one biological parent is heterozygous; the other is homozygous; and the profiles of the biological parents do not share any alleles. For AB and CC, the possible children's genotypes are AC(50%) and BC(50%); for A and BC, the possible children's genotypes are AB(50%) and AC(50%);
AB	CD	AC	$1 / 8ac$	$1 - 2(a + b)(c + d)$	The evidence is heterozygous; both biological parents are heterozygous; and the biological parents' profiles do not share any alleles. The possible children's genotypes are AC (25%), BC (25%), AD (25%), BD (25%).
AB	BC	AC	$1 / 8ac$	$1 + b^2 - 2(a + b)(b + c)$	The evidence is heterozygous; both biological parents are heterozygous; and the biological parents' profiles share one allele. For AB and BC, the possible children's genotypes are AB (25%), BB (25%), AC (25%), BC (25%).
AB	BC	BC	$1 / 8bc$		
AB	BC	BB	$1 / 4b^2$	$1 + b - 2(a + b)(b + c)$	The evidence is homozygous; both of the biological parents are heterozygous; and the biological parents' profiles share one allele. The evidence must have the allele shared between the biological parents. Possible children's genotypes are AB(25%), BB(25%), AC(25%) & BC(25%)
AA	AA	AA	$1 / a^2$	$1 - a^2$	All profiles are homozygous and identical. The possible children's genotype is AA.

After the RPI for each locus is calculated, the Combined Reverse Parentage Index for the entire profile

is then calculated by the product rule:

$$\text{CRPI} = \prod_{locus} \text{RPI}_{locus}$$

The Combined Probability of Exclusion for Reverse Parentage for the whole profile is:

$$CPE = 1 - \prod_{\text{locus}} (1 - PE_{\text{locus}}).$$

21.4 GENERAL KINSHIP FORMULA

I-T-O kinship statistics evaluate the likelihood that the pair of given DNA profiles are associated by kinship as opposed to chance.

Popstats Kinship supports the following kinship relationships:

- Parent-Offspring
- Full Sibling
- First Cousin
- Double first cousin
- Half Sibling: Half Sibling, Uncle/Aunt-Nephew/Niece, Grandparent-Grandchild (parents are not related)
- Half Sibling-Sibling: Half Sibling, one of each person's parents are siblings with each other
- Half Siblings Half Sibling: Half Sibling, one of each person's parents are half-siblings with each other

Given a pair of DNA profiles, the likelihood ratio of the two DNA profiles being from relatives vs. the two DNA profiles being unrelated is calculated for each locus as follows:

Relationship Notation		Φ_2	Φ_1	Φ_0
Parent-Offspring	PO	0	1	0
Full Sibling	FS	1 / 4	1 / 2	1 / 4
Half-Sibling	HS	0	1 / 2	1 / 2
Half-Sibling Sibling	HS-S	1 / 8	1 / 2	3 / 8
Half-Sibling-Half-Sibling	HS-HS	1 / 16	1 / 2	1 / 16
First Cousin	1C	0	1 / 4	3 / 4
Double First Cousin	D	1 / 16	3 / 8	9 / 16

Where:

θ_0 is the probability that the locus genotypes of the individuals share no allele by descent for the specified kinship.

θ_1 is the probability that the locus genotypes of the individuals share one allele by descent for the specified kinship.

θ_2 is the probability that the locus genotypes of the individuals share two alleles by descent for the specified kinship.

	G _x (Reference)	G _y (Evidence)	Conditional Probability of G _y given G _x under:		
			I (2 alleles IBD) P ₂ (X,Y)	T (1 allele IBD) P ₁ (X,Y)	O (0 alleles IBD) P ₀ (X,Y)
1	AA	AA	1	a	a ²
2	AA	BB	0	0	b ²
3	AA	AB	0	b	2ab
4	AA	BC	0	0	2bc
5	AB	AA	0	a / 2	a ²
	AB	BB		b / 2	b ²
6	AB	CC	0	0	c ²
7	AB	AB	1	a + b / 2	2ab
8	AB	AC	0	c / 2	2ac
	AB	BC		c / 2	2bc
9	AB	CD	0	0	2cd

Where:

P₂(X,Y) = probability of G_y (reference) given G_x (evidence) with 2 of their alleles identical by descent (IBD);

P₁(X,Y) = probability of G_y (reference) given G_x (evidence) with 1 of their alleles identical by descent (IBD);

P₀(X,Y) = probability of G_y (reference) given G_x (evidence) with 0 of their alleles identical by descent (IBD);

The probability of observing the locus genotype G_y (reference) given G_x (evidence) for a specified kinship is:

$$P(\text{kinship}) = [P_2(X,Y) \times \theta_2] + [P_1(X,Y) \times \theta_1] + [P_0(X,Y) \times \theta_0]$$

The likelihood of the locus genotype G_y (reference) given G_x (evidence) being related by specified kinship vs. the locus genotypes being unrelated is: **LR(kinship) = P(kinship) / P(unrelated)**

To summarize, for each locus:

	Kinship Likelihood Ratio	Kinship Probability
Locus Formula	P(Kinship) / P(Unrelated)	P(Kinship)

The combined probability for the specified kinship is: **CP(kinship) = $\prod_{loci} P(\text{kinship})$**

and the combined likelihood ratio for the profiles to be related by the specified kinship vs. being unrelated is:

$$CLR(\text{kinship}) = \prod_{loci} LR(\text{kinship})$$

In a Kinship case with the single parentage calculation, if the genotypes of the reference and the evidence do not match at one or two loci, then the mutation analysis is applied in the calculation of Parentage Index (PI) for these loci. The Parentage index for a non-matching or inconsistent locus is: μ / \bar{A}

Where μ is the mutation rate of the locus and \bar{A} is the mean power of exclusion of the locus. Popstats applies mutation analysis for up to two non-matching or inconsistent loci.

21.5 SINGLE PARENTAGE KINSHIP

In the special case where the relationship is Parent-Offspring (PO), the calculation of the Parentage Index (PI) as stated in the General Kinship Formula can be simplified. This is the so-called "single parent" case, or the "motherless paternity" case. In addition to the Parentage Index, the probability of exclusion can be derived for the special case.

Using the tables in the General Kinship Formula topic, the formula for the Parentage Index is simplified as follows:

	Reference	Evidence	Parent-Offspring Index (PI)	Probability of exclusion (PE)
1	AA	AA	$1 / a$	$(1: a)^2$
2	AA	AB	$1 / 2a$	$(1: a)^2$
3	AB	AB	$a + b / 4ab$	$[1: (a + b)]^2$
4	AB	AA	$1 / 2a$	$[1: (a + b)]^2$
5	AB	AC	$1 / 4a$	$[1: (a + b)]^2$

For inconsistent loci (when the genotype of the alleged parent and the genotype of the child do not share any alleles), the formula are as follows:

	Child (C)	Alleged Parent (AP)	Parentage Index (PI)	Probability of Exclusion (PE)
1	AA	BB	μ / \bar{A}	$(1: a)^2$
2	AA	BC	μ / \bar{A}	$(1: a)^2$
3	AB	CD	μ / \bar{A}	$[1: (a + b)]^2$
4	AB	CC	μ / \bar{A}	$[1: (a + b)]^2$

where μ is the mutation rate of the locus and \bar{A} is the mean power of exclusion of the locus.

A population group-specific mean power of exclusion for a locus can be calculated using the corresponding allele frequencies of the locus and the formula given by Butler as shown: $\bar{A} = PE_{avg} = H^2(1-2H(1-H)^2)$, where H denotes the degree of heterozygosity of a locus, defined as follows:

$$H \equiv 1 - \sum_{j=1}^n p_j^2$$

, where n denotes the number of detectable alleles at a locus for a population, and p_j denotes the frequency of the j^{th} allele. The PI for an inconsistent locus is then: $PI = \mu / \bar{A}$

The Combined Parentage Index (CPI) for the profile is calculated by multiplying together the individual locus PI, as shown below:

$$CPI = \prod_{locus} PI$$

$$CPE = 1 - \prod_{locus} (1 - PE_{locus}).$$

The combined probability of exclusion (CPE) is:

For a locus with inconsistency, \bar{A} is used for the locus PE.

22 APPENDIX D Y-STR STATISTICAL INTERPRETATIONS

The ASCL will follow the recommendations in the [SWGAM Interpretation Guidelines for Y-Chromosomal STR Typing, 2014](#).

Due to the lack of recombination, the entire Y-chromosome haplotype must be treated as a single locus. Haplotype frequencies are estimated using the counting method. The counting method involves searching a given haplotype against a database to determine the number of times the haplotype was observed in that database.

The ASCL has chosen to utilize a customized version (YSTR_STATS_v4.x) of the California DOJ Y-Mix Database Filter v3.2 (entry screen shown below):

The screenshot displays the 'Y-Mix Database Filter 3.1' interface. Key sections include:

- Y-STR Profile:** A grid for entering profile data across 15 loci (DYS 387SI to DYS 643 and YGATA H4).
- Database Source:** Selections for 'Database' (African American, Asian, Caucasian, Hispanic, Native American, Combined) and 'Upper Confidence Interval' (Clopper and Pearson approach, Biometrika 1934).
- Filtering Options:** A section for 'Limit database to samples with all the loci entered above?' with 'Yes' selected, and 'Desired UCI' set to '95.0%'.
- New Variant Table:** A table with columns for 'Observed Alleles' and various DYS/ YGATA loci, showing numerical counts.
- Disclaimer:** A red-bordered box stating: 'This is a BETA version of the Y-Mix Database Filter spreadsheet. While limited testing has been performed to assess the accuracy of the results, there is no real or implied guarantee of accuracy. Prior to its use in criminal and/or civil case matters, users agree to either conduct their own validation of this spreadsheet or independently confirm the results on a case-by-case basis. The author of this spreadsheet assumes no responsibility for damages associated with this software's use or performance. Users agree to take full responsibility for its use and application. steven.myers@dcj.ca.gov'

The excel file can be found at [ForensicBiology\Excel Form\YSTR_STATS_v4.3.xltm](#). Profiles can be copied directly from the DNA-FORM-01 project and pasted into the yellow cells. Any settings may be adjusted as needed, and the **COMPARE THE PROFILE TO THE DATABASE** button pressed. This will filter the database against the entered profile and report any database profiles which have no mismatches.

Settings:

Limit database to samples with all loci entered above?: If **Yes**, only database profiles with all entered loci will be searched. Any database profiles with missing loci will be ignored. If **No**, any blank loci in either the entered profile or in the database profiles will not be compared but the rest of the profile will be compared. In general, due to the smaller database set and incomplete theta values for Yfiler Plus, any complete Yfiler Plus profiles should be searched with only the more limited original Yfiler loci with the limit set as **YES** to maximize the discrimination potential of the search in the largest possible database set. The **FILTERED LIST** tab will show all profiles found to conform to the entered profile(s). This list should be manually compared to remove any associations to database profiles which would be excluded

on the expanded Yfiler Plus loci. Be sure to press the CLEAR THE FILTERED LIST button between each search.

Treat this profile as a single source sample?: If **Yes**, the database profiles must match the entered profile exactly at each loci compared. If **No**, then the database profiles may match either allele entered for a locus in the entered profile, if more than one is entered. This should be set based on the entered profile.

Desired UCI: This changes the upper confidence interval from the standard at 95%. Only 95% has been performance checked for use in the ASCL.

Use (x+1)/(N+1)?: This modifies the number of observations to include the entered profile which alters the haplotype frequency estimate. Because a Likelihood Ratio is reported, this should remain **No**.

The results printout (Yfiler Plus and Y23 shown below) specifies the Y-STR profile searched as well as the selected settings (single-source, limited search, q, Population Substructure, CI).

Arkansas State Crime Laboratory Y-STR Statistical Tool v4.3.0										
Analyst			Question Sample				Reference Sample			2/4/2019 Date
Comments:										
Single Source:	Yes	DYS 576	DYS 389I	DYS 635	DYS 389II	DYS 627	DYS 460	DYS 458	DYS 19	
Limited to Profiles with all listed Loci:	Yes	YGATA-H4	DYS 448	DYS 391	DYS 456	DYS 390	DYS 438	DYS 392	DYS 518	
Limited to Yfiler (17):		DYS 570	DYS 437	DYS 385	DYS 449	DYS 393	DYS 439	DYS 481		
		DYF 387S1	DYS 533							
Statistics	Observations			Profile		Match Probability				
	US YSTR Database Release 4.2* (Feb. 18, 2017)			95% Upper Confidence Interval*		[Pr(A/A = $\theta + (1 - \theta)pA$)]				
				Probability	Frequency	Match Probability	Prob. of Exclusion	Likelihood Ratio		
African American	in	Profiles		1 in		#VALUE!	#VALUE!	#### times		
Asian	in	Profiles		1 in		#VALUE!	#VALUE!	#### times		
Caucasian	in	Profiles		1 in		#VALUE!	#VALUE!	#### times		
Hispanic	in	Profiles		1 in		#VALUE!	#VALUE!	#### times		
Native American	in	Profiles		1 in		#VALUE!	#VALUE!	#### times		
Combined	in	Profiles		1 in						
Is Population Substructure Noted?		Yes	θ = Est. Theta	How many loci?	0					
Results: (standard reporting format - see templates for more options)										
Results Field Empty due to No Sample Entered										
Conclusion:										
Conclusion Field Empty due to No Sample Entered										
*Note: This statistical tool follows guidelines established in Section 10: Statistical Analysis of DNA Typing Results of the SWGDAM Y-STR Interpretation Guidelines, 2014. Theta values originate from Table 1. Upper Confidence Interval calculated per Clopper and Pearson, <i>Biometrika</i> , 1934. US Y-STR Database and CADJY-MixTool available at www.usystrdatabase.org. This tool is modified from the CA DOJ Y-Mix Database Filter v3.1.										

Arkansas State Crime Laboratory Y-STR Statistical Tool v4.2.1

Analyst
 Question Sample
 Reference Sample
 3/29/2018 Date

Comments:

Y23 Profile

Single Source:		DYS 576	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 481	DYS 549
Yes									
Limit Search Results to Profiles with All Entered Loci:		DYS 533	DYS 438	DYS 437	DYS 570	DYS 635	DYS 390	DYS 439	DYS 392
No									
		DYS 643	DYS 393	DYS 458	DYS 385	DYS 456	YGATA-H4		

Statistics	Observations		Profile		Match Probability		
	US YSTR Database Release 4.2* (Feb. 18, 2017)		95% Upper Confidence Interval*		[Pr(A/A = θ + (1 - θ)pA)]		
			Probability (pA)	Frequency	Match Probability	Prob. of Exclusion	Likelihood Ratio
African American	in	Profiles		1 in	#VALUE!	#VALUE!	#### times
Asian	in	Profiles		1 in	#VALUE!	#VALUE!	#### times
Caucasian	in	Profiles		1 in	#VALUE!	#VALUE!	#### times
Hispanic	in	Profiles		1 in	#VALUE!	#VALUE!	#### times
Native American	in	Profiles		1 in	#VALUE!	#VALUE!	#### times
Combined	in	Profiles		1 in			
Is Population Substructure Noted? Yes			θ = Est. Theta	How many loci? 0			

Results: (standard reporting format - see templates for more options)
Results Field Empty Due to No Sample Name

Conclusion:
Conclusion Field Empty due to No Sample Name

*Note: This statistical tool follows guidelines established in Section 10: Statistical Analysis of DNA Typing Results of the SWGDAM Y-STR Interpretation Guidelines, 2014. Theta values originate from Table 1. Upper Confidence Interval calculated per Clopper and Pearson, Biometrika, 1934. US Y-STR Database and CADUJY-MixTool available at www.usystrdatabase.org. This tool is modified from the CA DOJ Y-Mix Database Filter v3.1.

Haplotype Frequency

The US Y-STR Database v4.2 database (<http://usystrdatabase.org/>) is filtered against the entered profile. The frequency of the entered haplotype in the database is then estimated by dividing the count by the number of haplotypes searched.

95% Upper Confidence Interval-based Profile Probability

A Y-STR profile probability can be estimated from the observed haplotype frequency by attaching a confidence interval (generally 95% or greater) to the haplotype frequency estimate to capture the effect of database size. The ASCL Y23_STATS_v4.2 tool utilizes the Clopper and Pearson (Biometrika, 1934) method for estimating the 95% Confidence Interval.

Match Probability

The match probability addresses the question of a match between the evidentiary and reference samples given that the reference donor is not the source of the evidentiary sample. Match probabilities are the probabilities of observing a profile given that it has already been observed and depend on the evolutionary history of the population. It is calculated by the equation: $[Pr(A/A = \theta + (1 - \theta)pA)]$ where pA is the Profile Probability from the 95% Confidence Interval.

This match probability (or its inverse Likelihood Ratio) will be reported as recommended in section 10.3 of the SWGDAM Interpretation Guidelines for Y-Chromosomal STR Typing, 2014.

Population Substructure

Because some population substructure is expected in the Arkansas populations, a theta (θ) value is applied in the calculation of the Match Probability. Theta describes the chance of haplotypes being the same within

populations relative to the chance of them being the same between populations. The theta estimate used varies depending on the number of loci in the profile and is derived from the tables provided in the SWGDAM Interpretation Guidelines for Y-Chromosomal STR Typing, 2014. Theta values for the Yfiler Plus-specific loci have not been determined, so those loci will not be searched against.

Table 1. Theta estimates for all possible subsets of loci for each of three multiplexes

Table 1: θ estimates based on African Americans, Asians, Caucasians, Hispanics & Native Americans	Loci	Est. Theta
	1	0.06
	2	0.04
	3	0.03
	4	0.02
	5	0.008
	6	0.005
	7	0.003
	8	0.002
	9	0.002
	10	0.002
	11	0.0009
	12	0.0007
	13	0.0006
	14	0.0005
	15	0.0005
	16	0.0004
	17	0.0004
	18	0.0004
	19	0.0003
	20	0.0003
	21	0.0003
22	0.0003	

23.1 POWERPLEX 16HS STUTTER RATIOS (LEGACY)

LOCUS	-4 STUTTER RATIOS	+4 STUTTER RATIOS
D3S1358	.13	.023
TH01	.06	
D21S11	.22	.045
D18S51	.13	
Penta E	.13	
D5S818	.11	.028
D13S317	.12	.031
D7S820	.1	.042
D16S539	.13	.03
CSF1PO	.1	.021
Penta D	.06	
AMEL	0	
vWA	.14	.014
D8S1179	.11	.025
TPOX	.06	.028
FGA	.14	.031

23.2 POWERPLEX FUSION 6C STUTTER RATIOS

Locus	Reverse Stutter		Forward Stutter	
	- repeat	ratio	+ repeat	ratio
Amel	-	-	-	-
D3S1358	-4	0.136	+4	0.024
D1S1656	-2	0.056	-	-
	-4	0.174	+4	0.056
D2S441	-4	0.09	+4	0.029
D10S1248	-4	0.166	+4	0.013
D13S317	-4	0.105	+4	0.027
Penta E	-5	0.072	+5	0.026
D16S539	-4	0.12	+4	0.037
D18S51	-4	0.146	+4	0.06
D2S1338	-4	0.136	+4	0.033
CSF1PO	-4	0.117	+4	0.04
Penta D	-5	0.05	+5	0.037
TH01	-4	0.062	+4	0.028
vWA	-4	0.144	+4	0.029
D21S11	-4	0.127	+4	0.036
D7S820	-4	0.099	+4	0.018
D5S818	-4	0.11	+4	0.024
TPOX	-4	0.066	+4	0.021
D8S1179	-4	0.125	+4	0.034
D12S391	-4	0.174	+4	0.027
D19S433	-2	0.014	-	-
	-4	0.126	+4	0.042
SE33	-2	0.066	-	-
	-4	0.195	+4	0.055
D22S1045	-3	0.184	+3	0.114
DYS391	-4	0.094	+4	0.02
FGA	-2	0.012	-	-
	-4	0.165	+4	0.06
DYS576	-4	0.125	+4	0.037
DYS570	-4	0.149	+4	0.038

23.3 POWERPLEX Y23 STUTTER RATIOS (LEGACY)

Locus	-8	-3,-4,-5	-2	+2,+3,+4
DYS576	0.059	0.163		0.034
DYS389 I		0.081		
DYS448		0.047		
DYS389 II		0.163		
DYS 19		0.107	0.102	0.038
DYS391	0.014	0.124		0.027
DYS481	0.072	0.298		0.055
DYS549		0.114		0.02
DYS533		0.107		0.031
DYS438		0.05		
DYS437		0.084		
DYS570	0.029	0.159		0.018
DYS635		0.161		
DYS390		0.144		
DYS439		0.114		
DYS392	0.031	0.171		0.105
DYS643		0.039		
DYS393	0.021	0.151		0.022
DYS458	0.016	0.147		0.023
DYS385	0.025	0.16		0.017
DYS456		0.154		
YGATAH4		0.111		

23.4 YFILER PLUS STUTTER RATIOS

Locus	n-2.0	n-0.x	n-1.0	n+0.x	n+1.0	n+2.0
DYS576	0.0590		0.1515		0.0338	
DYS389I			0.0916		0.0345	
DYS635			0.1338		0.0331	
DYS389II	0.0161		0.1879		0.0373	
DYS627		0.030 (-0.2)	0.1518		0.0262	
DYS460	0.0068		0.1165		0.0427	
DYS458	0.0178		0.1531		0.0252	
DYS19		0.111 (-0.2)	0.1268	0.034 (+0.2)	0.0372	
YGATAH4			0.1153		0.0227	
DYS448			0.0468		0.0229	
DYS391			0.1000		0.0341	
DYS456	0.0144	0.010 (-0.1)	0.1536		0.0374	
DYS390		0.022 (-0.1)	0.1358		0.0351	
DYS438			0.0586		0.0276	
DYS392	0.0168		0.1694		0.1101	
DYS518	0.0384		0.2550		0.0485	
DYS570	0.0218		0.1565		0.0289	
DYS437			0.0813		0.0165	
DYS385			0.1832		0.037	
DYS449	0.0322		0.2324		0.042	
DYS393	0.0255		0.1407		0.0495	0.0364
DYS439	0.0164	0.023 (-0.1)	0.0989		0.0339	
DYS481	0.0579	0.096 (-0.2)	0.2855		0.0559	
DYF387S1			0.1571		0.1555	
DYS533	0.0188		0.1200		0.046	

note: DYS481 also demonstrated an n-1.3 stutter peak at a ratio of 0.0177

24 APPENDIX F REPORT GUIDELINES

24.1 AUTOSOMAL-STR REPORT GUIDELINES

General templates are listed below. Case situations may require additional discussion statements or even deviations from the general templates as specific assumptions and considerations are made. New statements and deviations must be approved by the Technical Leader and/or DNA supervisor. Approved statements will be stored with the more extensive templates for the most common DNA reports currently available on the FB drive.

24.1.1 SAMPLES WITH QUANTITATION VALUES \leq .0025 NG/ μ L

RESULTS

Q#, (*evidence*), did not contain a sufficient amount of DNA for further processing.

24.1.2 SEXUAL ASSAULT SAMPLE WITH MALE CONTRIBUTION \leq 5%

RESULTS

Q#, (*evidence*), did not contain a sufficient amount of a male contributor for autosomal processing.

24.1.3 SEXUAL ASSAULT SAMPLE WITH NO MALE CONTRIBUTION DETECTED

RESULTS

No male contributor to Q1# was indicated. Therefore, Q# will not be processed for autosomal testing.

24.1.4 NO DNA OBTAINED

RESULTS

No DNA profile was obtained from Q1(*evidence*).

24.1.5 SINGLE SOURCE STAINS

Condition 1: DNA profile obtained from evidence item, no reference standards are available for comparison.

RESULTS

A DNA profile was obtained from Q#.

or

The DNA profile obtained from Q#1 and Q#2 is consistent with originating from a common source.

Condition 2: Expected contributor is consistent with the item of evidence. No indications of a mixture or foreign contributor.

RESULTS

Considering the presence of K#, (*assumed contributor*), no foreign DNA profile was obtained from Q#. (*no further comparisons to this sample are needed.*)

**Note* An assumed contribution should be determined prior to comparison, and if so determined, that assumption shall be confirmed with a comparison to the known profile of the assumed. Common examples of documentation include collection in an SA Kit, description of collection directly from the person, consensual partners, or conversation with officers verifying particular items are uniquely attributable to an individual.*

Condition 3: Reference standard K2 (*suspect*) is consistent with the Q1 (*evidence*). No indication of a mixture.

RESULTS

The DNA extracted from K2 (*suspect*) is consistent with the DNA extracted from Q1 (*evidence*). The probability of selecting an individual at random from the general population having the same genetic markers as those identified in K2 and Q1 is approximately 1 in *W* in the African American population, 1 in *X* in the Asian population, 1 in *Y* in the Caucasian population and 1 in *Z* in the Hispanic population.

**Note* Statistical data that indicates uniqueness (values equal to or greater than 1 in 300 billion), will include the conclusion stated below. No further comparisons to this sample may be needed if the comparison is of no probative value.*

CONCLUSION

The DNA identified on Q1 (*evidence*) originated from K2 (*suspect*) within all scientific certainty.

24.1.6 MIXTURES

Condition 1: The results from the Q1 (*evidence*) show more than one source of DNA, however, a major or minor profile can be determined from the DNA that is consistent with the K2 (*suspect*).

RESULTS

The DNA profile obtained from Q1 (*evidence*) indicates the presence of DNA from two individuals. It is noted that the major component of DNA identified in Q1 (*evidence*) is consistent with the DNA profile obtained from K2 (*suspect*). The probability of selecting an individual at random from the general population having the same genetic markers as those

identified in Q1 and K2 is approximately 1 in *W* in the African American population, 1 in *X* in the Asian population, 1 in *Y* in the Caucasian population and 1 in *Z* in the Hispanic population.

K1 (*victim*) cannot be excluded as the minor contributor to the DNA profile obtained from Q1 (*evidence*).

**Note* If statistical data does not render uniqueness, no conclusion statement is given, only results. Statistical data that indicates uniqueness (values equal to or greater than 1 in 300 billion), will include the conclusion stated below:*

CONCLUSION

The major component of DNA identified on Q1 (*evidence*) originated from K2 (*suspect*) within all scientific certainty.

Condition 2: Persons in the case, such as K1, are expected to be present on the item for specified reasons (such as an intimate sample), and a foreign profile can be deconvoluted from the DNA that is consistent with the K2 (*suspect*).

RESULTS

A DNA mixture consistent with originating from two individuals was obtained from Q1 (*evidence*). Considering the presence of K1, (assumed), [as a partial contributor], the DNA profile foreign to K1 (assumed) matches the DNA profile from K2, (foreign). The probabilities of selecting an unrelated individual at random having a DNA profile matching the profile foreign to ASSUMED from the DNA mixture obtained from Q1 are approximately: 1 in *W* in the African American population, 1 in *X* in the Asian population, 1 in *Y* in the Caucasian population and 1 in *Z* in the Hispanic population.

**Note* Statistical data that indicates uniqueness (values equal to or greater than 1 in 300 billion), will include the conclusion stated below:*

Conclusion:

The DNA profile foreign to K1, (assumed), identified on Q1 originated from K2, (foreign), within all scientific certainty.

**Note* Prior to making a comparison, if the underlying understanding is that a contributor's DNA is expected to be present on the evidence (Q) and reasons are documented, then the following reporting will be followed.*

- *The assumed contributor(s) will be designated in the results by "Considering the presence of..."*
- *The degree to which an assumed contributor is present may be indicated, such as "...as a partial contributor"*
- *Additional considerations may be included in the results to explain an assumption of contribution, such as consensual partner or mother-child relationship.*

If the evidence contains a semen stain, then the following reporting will be followed. (Male victim/female suspect and same-sex victim/suspect cases may need approval of the Technical leader and/or DNA supervisor):

- *The epithelial (non-sperm, or 'epi') fraction will be run and analyzed along with the probative sperm fraction to ensure sample integrity. The epithelial fraction will be compared to other samples in the case and on the run plates for quality assurance, but will not be separately reported unless it is determined to have a probative value not found in the sperm fraction.*
- *If the female victim's profile is in the epi fraction and the sperm fraction contains a male profile with no indication of mixture or only the male major contributor of a mixture is useable (minor is inconclusive), then the victim does not need to be addressed in the comparison to the sperm fraction profile. A separate comparison to the epi fraction may be necessary depending on the probative value of the item.*
- *If the female victim's profile is in the epi fraction and the semen fraction contains a mixture, then the victim needs to be addressed (considered, included, or excluded) from the mixture unless the victim's contribution is inconclusive.*
- *If the female victim's profile is not on the epi or sperm fraction, the victim can be excluded from reported profiles.*
- *If additional female profiles are present in the sample, then the victim may need to be addressed (considered, included, or excluded).*
- *If a consensual partner's known has been tested and documentation exists that intercourse between the victim and the consensual partner occurred in the 96 hours prior to the sample collection, the partner's profile may also be assumed and applied to the mixture. No statistics are needed.*

If the sample is an intimate sample from the female victim, a differential extraction was not performed, and the sample contains a male profile with no indication of mixture or only the male major contributor of a mixture is useable (minor is inconclusive), then the victim does not need to be addressed in the comparison to the reported profile.

The assumption of a contributor should be determined prior to mixture analysis, not based on whether a mixture interpretation is bettered by an assumption. All assumed contributors should be verified as a contributor prior to further mixture interpretation steps. If an assumed contributor (such as a consensual partner) is excluded from a sample, that exclusion may be reported if probative. It is noted that not all exclusions of assumed contributors need to be reported, such as from intimate samples from the assumed. The objective in assuming a known contributor to a mixture is to clarify the other possible contributors in a manner that is both reasonable and helpful to an investigator and a trier of facts.

Condition 3: More than one reference standard could have contributed to a mixed stain result and the major and minor components of the DNA profile *cannot* be separated. Neither reference sample can exclude as being contributors to the DNA profile.

RESULTS (Restricted/Modified Random Match Prob.)

A DNA mixture consistent with originating from two individuals was obtained from Q1 (evidence). K1 (victim) and K2 (suspect) cannot be excluded as contributors to the DNA mixture. The probabilities of selecting an unrelated individual at random that cannot be excluded as a contributor to the DNA mixture obtained from Q1 are approximately: 1 in W in the African American population, 1 in X in the Asian population, 1 in Y in the Caucasian population and 1 in Z in the Hispanic population.

**Note* Mixtures in which each allele can be assigned to either reference may include the conclusion stated below:*

CONCLUSION

The DNA mixture obtained on Q1, *Evidence*, is consistent with originating from K1, *Known*, and K2, *Known*.

**Note* In sexual assault cases, if the race of the perpetrator is known, the statistical data may be limited to that race only. If the origin of the sample is unknown then all statistical data will be given.*

RESULTS (Likelihood Ratio)

The DNA extracted from Q1 (*evidence*) indicates a mixture from more than one individual. This mixture is consistent with a mixture of DNA from K1 (*victim*) and K2 (*suspect*). The mixture profile from Q1 (*evidence*) is 100 billion times more likely if it came from a mixture of DNA from K1 (*victim*) and K2 (*suspect*) than if it came from two random African American individuals, 1 trillion times more likely if it came from two random Asian individuals, 1 trillion times more likely if it came from two random Caucasian individuals and 2 trillion times more likely if it came from two random Hispanic individuals.

24.1.7 KINSHIP CASES

Kinship statistics may be performed any time there is a question of paternity or familial relations. These cases include but are not limited to: criminal paternity, body identification, and missing persons.

1) Criminal Paternity

a) Known reference samples from Mother, Child, and Alleged Father submitted:

**Note* The three profiles associated with the reference samples from the Mother, Child, and Alleged Father will be entered into Popstats Parentage Trio. Please be aware that 2 mismatches (per parent) are allowed with a paternity match due to the possibility of mutation(s)* occurring.*

- i. Enter the appropriate profiles into the target profiles for Biological Mother; Child; and Alleged Father. (see Parentage Trio Data Entry Tab below)
- ii. Select the Calculate button. (Explanation of Popstats calculations as listed in CODIS 7.0 Help files can be seen in Appendix C, reformatted to fit page).
- iii. Check to ensure "Consistency Status" is "Yes" at all loci. (see Parentage Trio Report Tab below)

- iv. Print Parentage Trio Calculations for reporting. (see Parentage Trio Statistics below)
- v. Refer to the Normal Paternity report template.

Example of Paternity:

Parentage Trio Data Entry Tab

Parentage Trio Report Tab

Parentage Trio Statistics

Parentage Trio Calculations

Database: \AR060035YS70\CODIS\Popstats\IPOPDATA\FBI\Expanded FBI STR 2015
 Prior Probability: 0.5

Lab ID: AR060035Y Child AR060035Y Alleged Parent
 Specimen ID: Mother (Keyboard) Child (Keyboard) Alleged Father (Keyboard)

Comment:

Population Group: **Caucasian**

Locus	Probability Of Exclusion (%)	Parentage Index	Probability Of Parentage (%)	Match?	Mutation Rate	Mean Power Of Exclusion
D3S1358	97.5354	40.323	97.5800	Yes		
TH01	48.372	1.6420	62.150	Yes		
D21S11	62.742	4.8100	82.788	Yes		
D18S51	75.048	7.4794	88.207	Yes		
Penta E	84.787	6.3131	86.326	Yes		
D5S818	90.3450	20.202	95.2835	Yes		
D13S317	84.327	6.1200	85.955	Yes		
D7S820	97.5354	40.323	97.5800	Yes		
D16S539	35.284	1.2315	55.188	Yes		
CSF1PO	97.5354	40.323	97.5800	Yes		
Penta D	62.742	2.4050	70.631	Yes		
Amelogenin				Inconclusive		
vWA	78.517	4.3898	81.446	Yes		
D8S1179	73.771	7.0872	87.635	Yes		
TPOX	76.773	4.0388	80.154	Yes		
FGA	94.1482	16.835	94.3931	Yes		
Total	>99.999999999	1.8940E+13	>99.999999999	Yes		

b) Known reference samples from Child and only one Alleged Parent submitted.

**Note* In the instance that only known samples from one alleged parent are received, kinship statistics may be performed, except in cases of possible incest or additional relatedness. If known samples from the mother are received at a later time additional Parentage Trio statistics can be performed.*

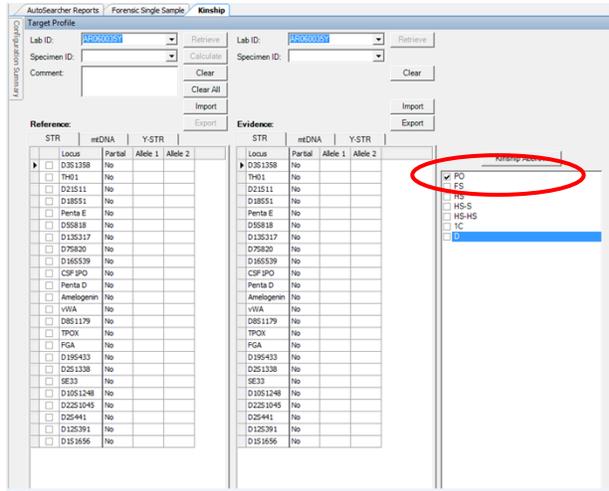
- i. The Reference sample is the known from the alleged parent; the Evidence sample is the child.
- ii. Select only "PO" (parent/offspring) in the kinship box in the Kinship Data Entry Tab. (see example below)
- iii. Print the Popstats Single Parentage Statistics for reporting. (see example below)

iv. Refer to the Single Parentage Reporting template.

Example of Single Parentage:

Kinship Data Entry Tab

Single Parentage Statistics



**Popstats Single Parentage Statistics
DNA Testing Results**

Database: \\AR060035Y70\CODIS\Popstats\POPDATA\FB\Expanded FBI STR 2015

Lab ID: Reference AR060035Y Evidence AR060035Y
Specimen ID: alleged father (Keyboard) child (Keyboard)

Comment:

Population Group: Caucasian (Continued)					
Locus	Allele Frequency	Probability Of Exclusion (%)	Parentage Index	Mutation Rate	Mean Power Of Exclusion
vWA		40.158	2.5253		
Allele 1: 12	1.2400E-02(M)				
Allele 2: 14	9.9000E-02				
Allele 3: 17	2.6730E-01				
D8S1179		44.329	2.9922		
Allele 1: 13	3.3420E-01				
TPOX		10.837	0.45704		
Allele 1: 8	5.4700E-01				
Allele 2: 9	1.2380E-01				
Allele 3: 10	3.7100E-02				
FGA		61.953	4.5872		
Allele 1: 18	2.9700E-02				
Allele 2: 19	5.4500E-02				
Allele 3: 23	1.5840E-01				
Single Parentage Probability of Exclusion for Population Group, Caucasian				:99.98826%	
Single Parentage Index for Population Group, Caucasian				:46.030	

**Mutations* – if there is a mutation between the child and alleged father or the biological mother the analyst may remove that locus from the target profile window and perform the statistics without that data, but the possibility of a mutation will be noted in the case report.*

c) Fetal Mixtures

Fetal mixes that indicate a Y chromosome will have Y-STR analysis performed in addition to the autosomal STR testing. If a mother’s reference sample has been submitted, these mixtures will be deconvoluted with ArmedXpert, if possible, and paternity statistics will be performed with the fully-resolved loci in the resulting fetal profile.

2) Body Identification

a) Known reference samples from Mother and Father submitted (reverse paternity)

- i. Follows the same guidelines as normal paternity testing.
- ii. Select the “Reverse” Button on the Parentage Trio Data Entry Tab. (see example below)
- iii. Enter the appropriate profiles for target profiles of “Biological Mother”; “Biological Father”; and “Alleged Child”.
- iv. Print Reverse Parentage Statistics for reporting.

Example of Reverse Parentage:

Target Profile

Lab ID: Retrieve Lab ID: Retrieve Lab ID: Retrieve

Specimen ID: Calculate Specimen ID: Specimen ID: Clear

Comment: Clear All Clear Clear

Subtype: Trio Reverse Import Import Import

Biological Mother: Export Biological Father: Export Alleged Child: Export

STR	mtDNA	Y-STR
Locus	Partial	Allele 1 Allele 2

Reverse Parentage Statistics

Database: \\\AR060035YS70\CODIS\Popstats\POPDATA\FBI\Expanded FBI STR 2015

Lab ID: Biological Mother Biological Father Evidence
 AR060035Y AR060035Y AR060035Y

Specimen ID: Mother (Keyboard) Father (Keyboard) Alleged Child (Keyboard)

Comment:

Population Group: Caucasian (Continued)

Locus	Allele Frequency	Probability Of Exclusion (%)	Parentage Index
Penta D		97.1471	30.733
Allele 1: 8	1.7300E-02		
Allele 2: 9	2.3510E-01		
Allele 3: 13	2.0790E-01		
Allele 4: 15	1.4900E-02		
Amelogenin			
Allele 1: X	L		
Allele 2: Y	L		
vWA		98.1832	101.82
Allele 1: 12	1.2400E-02 M		
Allele 2: 13	1.2400E-02 M		
Allele 3: 14	9.9000E-02		
Allele 4: 17	2.6730E-01		
D8S1179		79.159	3.6419
Allele 1: 13	3.3420E-01		
Allele 2: 14	2.0540E-01		
Allele 3: 15	1.0640E-01		
TPQX		90.0453	6.1595
Allele 1: 8	5.4700E-01		
Allele 2: 9	1.2380E-01		
Allele 3: 10	3.7100E-02		
Allele 4: 12	3.7100E-02		
FGA		92.0748	84.168
Allele 1: 19	5.4500E-02		
Allele 2: 23	1.5840E-01		
Allele 3: 24	1.3860E-01		

Reverse Parentage Probability of Exclusion for Pop Group Caucasian: >99.999999999999%
 Reverse Parentage Index for Pop Group Caucasian: 3.4890E+17

b) Known reference sample from Mother or Father only*

- i. The Reference sample is the known from the family member; the Evidence sample is the unidentified remains.
- ii. Select only "PO" (parent/offspring) in the kinship box.
- iii. Print the Popstats Single Parentage Statistics.
- iv. Refer to the Offspring (Parent Reference) report template.

**Note* This process is also the same for when a biological child's known sample is submitted to compare to the unidentified remains - refer to the Offspring report template. Care should be used when looking at relationships outside of parentage and full-siblings. These can be addressed on a case-by-case basis to ensure accurate reporting of statistics if there is a familial match.*

c) Known reference sample from Full Sibling

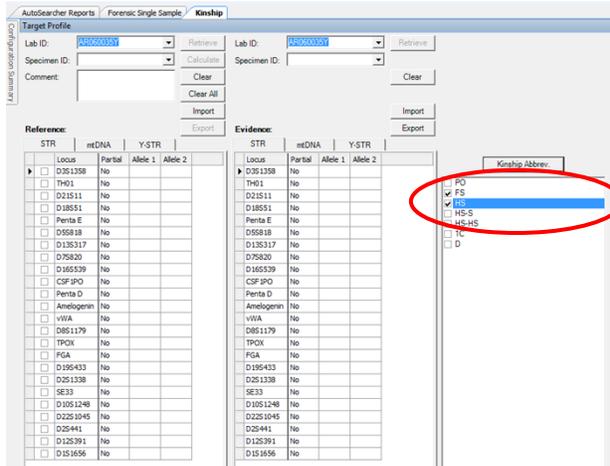
- i. The Reference sample is from the known family member.
- ii. The Evidence sample is the unidentified remains.
- iii. Select "FS" (full siblings) in the kinship box of the Kinship Data Entry Tab. (see example below)
- iv. Print the Popstats Kinship Statistics Summary. (see example below)

- v. There is no probability of exclusion associated with this statistic.
- vi. Refer to the Sibling report template.

Example of Full Sibling Kinship:

Kinship Data Entry Tab

Full Sibling Statistics



Popstats Kinship Statistics Summary

Database: \\\AR060035YS70\CODIS\Popstats\POPDATA\FBIExpanded FBI STR 2015
 Lab ID: Reference AR060035Y Evidence AR060035Y
 Specimen ID: Sibling (Keyboard) unidentified remains (Keyboard)
 Comment:

Population Group: Caucasian			
Kinship	Kinship Conditional Probability	Unrelated Conditional Probability	Likelihood Ratio
Full Sib (FS)	5.813E-23	1.183E-26	4.916
Population Group: AfricanAmerican			
Kinship	Kinship Conditional Probability	Unrelated Conditional Probability	Likelihood Ratio
Full Sib (FS)	6.456E-24	2.280E-28	28.320
Population Group: SoutheastHispanic			
Kinship	Kinship Conditional Probability	Unrelated Conditional Probability	Likelihood Ratio
Full Sib (FS)	2.751E-23	2.542E-27	10.820
Population Group: SouthwestHispanic			
Kinship	Kinship Conditional Probability	Unrelated Conditional Probability	Likelihood Ratio
Full Sib (FS)	1.786E-24	8.860E-29	20.150

24.1.8 CODIS-ELIGIBLE PROFILE SEARCH AND ENTRY

Sample profiles deemed eligible for searching against or for entry into the CODIS database(s) will be denoted in the report body. These notes will follow the templates available on the FB shared drive. Additional information regarding the reporting of CODIS-eligible sample profile searches, associations, entries, and removals will be included in the standard report footer to ensure compliance with ISO17025:2017/ANAB AR3125 standards 7.1.9.

This single communication is sufficient to meet the requirement to report the extent of the search or entry of a profile as the CODIS Procedures and the CODIS software are configured to automatically advance a profile to the most extensive level for which it is eligible. If an entered sample is determined to be ineligible, it shall be removed per the *CODIS DOC-01 QM* and an additional communication with the investigating agency explaining the removal will be made. Documentation of this communication will be included in the casefile for future reference.

24.2 Y-STR REPORT GUIDELINES

24.2.1 NO PROFILE REPORT

Condition 1: No Y-Chromosomal DNA profile obtained from Q1.

Results:

No Y-STR profile was obtained from Q1.

24.2.2 PROFILE-ONLY REPORT

Condition 1: The Y-Chromosomal DNA profile obtained from Q1 is useable but no known reference standard is available for comparison.

Results:

A Y-STR profile was obtained from Q1.

If further testing is needed, two oral swabs are required from any developed suspect(s).

24.2.3 INCONCLUSIVE REPORTS

These basic report templates include profiles too limited for comparisons, mixtures too complex for comparison, and data which is not interpretable due to other factors such as artifacts.

Condition 1: The single source Y-Chromosomal DNA profile obtained from Q1 is too limited for comparison, or is low quality data.

Results:

The partial Y-STR profile obtained from Q1 is inconclusive for comparative purposes due to the limited amount of DNA (or, due to insufficient quality of data).

Condition 2: The Y-Chromosomal DNA mixture obtained from Q1 has indications of more than 2 contributors, is too limited for comparison, or is low quality data (confounding artifacts, unable to determine # of contributors, etc.)

Results:

The Y-STR mixture obtained from Q1 is inconclusive for comparative purposes due to the complexity of the mixture (or, due to insufficient quality of data, or, due to the limited amount of DNA).

24.2.4 EXCLUSION REPORT

Condition 1: The Y-Chromosomal DNA profile obtained from Q1 does not match the Y-Chromosomal DNA profile obtained from the known reference standard, K1.

Results:

K1, Known 1, is excluded as a contributor to the Y-STR profile obtained from Q1.

24.2.5 INCLUSION REPORTS

These basic report templates include comparisons to both single-source and isolated contributors. It will typically be most reasonable to report the likelihood of exclusion for a randomly selected individual from the a given population, and the likelihood that a Y-STR DNA profile obtained from evidence occurred due to an origin within the K1 patrilineage than if the source of the evidence is a randomly selected individual from the a given population. It may be necessary to report Observations within the Database or the resultant Frequency estimates (based on 95% CI) and reports may be altered to suit.

Condition 1: The Y-STR profile obtained from Q1 matches the Y-STR profile obtained from K1.

Results:

The Y-STR profile obtained from Q1 matches the Y-STR profile obtained from K1, Known 1. Therefore, neither K1, nor any of his paternally related male relatives can be excluded as the contributor of this DNA. The Y-STR profile obtained from K1 and Q1 has been observed in xxx of xxx African American individuals, xxx of xxx Asian individuals, xxx of xxx Caucasian individuals, xxx of xxx Hispanic individuals, and xxx of xxx Native American individuals within the database.

Conclusion:

The DNA profile obtained from Q1 is xxx times more likely to occur if Known 1 or his paternally related male relatives are the contributor than if the source of the evidence is a randomly selected individual from the African American population, xxx times more likely than a randomly selected individual from the Asian population, xxx times more likely than a randomly selected individual from the Caucasian population, xxx times more likely than a randomly selected individual from the Hispanic population, and xxx times more likely than a randomly selected individual from the Native American population. Conversely, xxxx% of unrelated African American individuals, xxxx% of unrelated Asian individuals, xxxx% of unrelated Caucasian individuals, xxxx% of unrelated Hispanic individuals, and xxxx% of unrelated Native American individuals would be expected to be excluded from the observed DNA profile.

Condition 2: The Y-STR profile obtained from Q1 indicates the presence of DNA from two males. K1, Known 1, can be assumed. K2, Known 2, is consistent with the foreign contributor. (see Autosomal-STR Report Guidelines 6.3.2.6 for directives on assuming contributors.)

Results:

The Y-STR profile obtained from Q01 indicates the presence of DNA from two males. Considering the presence of K1, Known 1, the DNA profile foreign to Known 1 matches the DNA profile from K2, Known 2. Therefore, neither K2, nor any of his paternally related male relatives can be excluded as the contributor of this DNA. The Y-STR profile foreign to Known 1 has been observed in xxx of xxx African American individuals, xxx of xxx Asian

individuals, xxx of xxx Caucasian individuals, xxx of xxx Hispanic individuals, and xxx of xxx Native American individuals within the database.

Conclusion:

The DNA profile foreign to K1 obtained from Q01 is xxx times more likely to occur if Known 2 or his paternally related male relatives are the contributor than if the source of the evidence is a randomly selected individual from the African American population, xxx times more likely than a randomly selected individual from the Asian population, xxx times more likely than a randomly selected individual from the Caucasian population, xxx times more likely than a randomly selected individual from the Hispanic population, and xxx times more likely than a randomly selected individual from the Native American population. Conversely, xxxx% of unrelated African American individuals, xxxx% of unrelated Asian individuals, xxxx% of unrelated Caucasian individuals, xxxx% of unrelated Hispanic individuals, and xxxx% of unrelated Native American individuals would be expected to be excluded from the observed DNA profile.

Condition 3: The Y-STR profile obtained from Q1 indicates the presence of DNA from two males. This mixture can be deconvoluted into a major and a minor contributor. K1, Known 1, is consistent with a contributor.

Results:

The Y-STR profile obtained from Q1 indicates the presence of DNA from two males (at # of # loci). It is noted that the major component of the Y-STR mixture obtained from Q1 matches the Y-STR profile obtained from K1, Known 1. Therefore, neither K1 nor any of his paternally related male relatives can be excluded as the contributor of the major component of DNA. The Y-STR profile obtained from K1 and the major component of Q1 has been observed in xxx of xxx African American individuals, xxx of xxx Asian individuals, xxx of xxx Caucasian individuals, xxx of xxx Hispanic individuals, and xxx of xxx Native American individuals within the database.

Conclusion:

The major component of the DNA profile obtained from Q01 is xxx times more likely to occur if Known 1 or his paternally related male relatives are the contributor than if the source of the evidence is a randomly selected individual from the African American population, xxx times more likely than a randomly selected individual from the Asian population, xxx times more likely than a randomly selected individual from the Caucasian population, xxx times more likely than a randomly selected individual from the Hispanic population, and xxx times more likely than a randomly selected individual from the Native American population. Conversely, xxxx% of unrelated African American individuals, xxxx% of unrelated Asian individuals, xxxx% of unrelated Caucasian individuals, xxxx% of unrelated Hispanic individuals, and xxxx% of unrelated Native American individuals would be expected to be excluded from the major component of the observed DNA profile.

24.2.6 MIXTURE REPORTS

These basic report templates include comparisons to mixtures which cannot be fully deconvoluted. It will typically be most reasonable to report the likelihood of exclusion and the match probability for a randomly selected individual from a given population. It may be necessary to report Observations within the Database or the resultant Frequency estimates (based on 95% CI) and reports may be altered to suit. Note

Condition 1: The Y-STR profile obtained from Q1 indicates the presence of DNA from two males. This mixture is consistent with a mixture of DNA from K1, Known 1, and an unknown male.

Results:

The Y-STR profile obtained from Q1 indicates the presence of DNA from two males. K1, Known 1, cannot be excluded as a contributor to the observed Y-STR mixture. Therefore, neither K1, nor any of his paternally related male relatives can be excluded as contributors of this DNA. The profiles consistent with having been a possible contributor to the Y-STR mixture obtained from Q1 have been observed in xxx of xxx African American individuals, xxx of xxx Asian individuals, xxx of xxx Caucasian individuals, xxx of xxx Hispanic individuals, and xxx of xxx Native American individuals within the database.

Conclusion:

Based on the results from the mixture obtained on Q1, 1 in xx randomly chosen African American individuals, 1 in xxx randomly chosen Asian individuals, 1 in xxx randomly chosen Caucasian individuals, 1 in xxx randomly chosen Hispanic individuals, and 1 in xxx randomly chosen Native American individuals would be expected to be included as contributors to the DNA mixture obtained from Q1. Conversely, xxxx% of unrelated African American individuals, xxxx% of unrelated Asian individuals, xxxx% of unrelated Caucasian individuals, xxxx% of unrelated Hispanic individuals, and xxxx% of unrelated Native American individuals would be expected to be excluded from the observed DNA mixture.

Condition 2: The Y-STR profile obtained from Q1 indicates the presence of DNA from two males. This mixture is consistent with a mixture of DNA from K1, Known 1, and K2, Known 2. Neither can be assumed.

Results:

The Y-STR profile obtained from Q1 indicates the presence of DNA from two males. This mixture is consistent with a mixture of DNA from K1, Known 1, and K2, Known 2. Therefore, neither Known 1 nor Known 2, nor any of their paternally related male relatives can be excluded as contributors of this DNA. The profiles consistent with having been a possible contributor to the Y-STR mixture obtained from Q1 have been observed in xxx of xxx African American individuals, xxx of xxx Asian individuals, xxx of xxx Caucasian individuals, xxx of xxx Hispanic individuals, and xxx of xxx Native American individuals within the database.

Conclusion:

Based on the results from the mixture obtained on Q1, 1 in xx randomly chosen African American individuals, 1 in xxx randomly chosen Asian individuals, 1 in xxx randomly chosen Caucasian individuals, 1 in xxx randomly chosen Hispanic individuals, and 1 in xxx randomly chosen Native American individuals would be expected to be included as contributors to the DNA mixture obtained from Q1. Conversely, xxxx% of unrelated African American individuals, xxxx% of unrelated Asian individuals, xxxx% of unrelated Caucasian individuals, xxxx% of unrelated Hispanic individuals, and xxxx% of unrelated Native American individuals would be expected to be excluded from the observed DNA mixture.

24.2.7 TESTIMONY AND UNIFORM LANGUAGE FOR Y-STRS

Forensic DNA analysts may be called to testify to their conclusions in a court of law. When testifying to Y-STRs, the following guidelines from the Department of Justice Uniform Language for Testimony and Reports for Forensic Y-STR DNA examinations will be adhered to:

Conclusions Regarding Forensic Y-STR DNA Examinations

- An examiner may offer any of the following conclusions regarding forensic Y-STR DNA examinations:
 - 1) Inclusion (i.e., included, or cannot be excluded)
 - 2) Exclusion (i.e., excluded)
 - 3) Inconclusive
- ‘Inclusion’ is an examiner’s conclusion that 1) a known male is included as a possible contributor to the Y-STR typing results obtained from an evidentiary sample; or 2) two known males, or a known male and the source of an evidentiary sample, may share the same paternal lineage. The basis for an ‘inclusion’ conclusion is an examiner’s interpretation that the Y-STR haplotype of a known male is consistent with 1) the Y-STR typing results obtained from a single-source evidentiary sample; or 2) the Y-STR typing results obtained from a contributor to a distinguishable mixed evidentiary sample; or 3) the Y-STR haplotype of a putative male relative from the same paternal lineage. All male relatives from the same paternal lineage are expected to have the same Y-STR haplotype and would also be included as potential contributors. In addition, unrelated males may also exhibit the same Y-STR haplotype.
- ‘Exclusion’ is an examiner’s conclusion that 1) a known male is eliminated as a possible contributor to the Y-STR typing results obtained from an evidentiary sample; or 2) two known males, or a known male and the source of an evidentiary sample, do not share the same paternal lineage. The basis for an ‘exclusion’ conclusion is an examiner’s interpretation that the Y-STR haplotype of a known male is not consistent with 1) the Y-STR typing results obtained from a single source or mixed evidentiary sample at one or more loci; or 2) the Y-STR haplotype of a putative male relative from the same paternal lineage at two or more loci.

All male relatives from the same paternal lineage are expected to have the same Y-STR haplotype and would also be expected to be excluded as potential contributors.

- ‘Inconclusive’ is an examiner’s conclusion that no determination can be made whether 1) a known male can be included or excluded as a possible contributor to the Y-STR typing results obtained from an evidentiary sample; or 2) two known males, or a known male and the source of an evidentiary sample, share the same paternal lineage. The basis for an ‘inconclusive’ conclusion is an examiner’s interpretation that 1) an evidentiary sample contains an indistinguishable mixture or 2) the Y-STR haplotype of a known male is not consistent with the haplotype of a putative male relative from the same paternal line at two or more loci interpreted to be the result of a single mutational event.

Qualifications and Limitations of Forensic Y-STR DNA Examinations

- An analyst shall not assert that forensic Y-STR examinations are infallible or have a zero error rate
- An analyst shall not assert that a Y-STR profile is unique to a particular male or is the basis for personal identification
- An analyst shall provide a quantitative statement describing the weight of the evidence for all comparisons in which a known male is included as a possible contributor to the Y-STR typing results obtained from a probative evidentiary sample.
- An analyst shall not assert that a Y-STR DNA profile can be used to predict the specific population, racial, or ethnic group to which a person belongs.
- An analyst shall not cite the number of forensic Y-STR DNA examinations performed in their career as a direct measure for the accuracy of a proffered conclusion. An analyst may cite the number of forensic Y-STR DNA examinations performed in his or her career for the purpose of establishing, defending, or describing their qualifications or experience.
- An analyst shall not use the expression ‘reasonable scientific certainty’ or similar assertions of reasonable certainty in either reports or testimony.

24.2.8 CODIS–ELIGIBLE PROFILE SEARCH AND ENTRY

Sample profiles deemed eligible for searching against or for entry into the CODIS database(s) will be denoted in the report body. These notes will follow the templates available on the FB shared drive. Additional information regarding the reporting of CODIS-eligible sample profile searches, associations, entries, and removals will be included in the standard report footer to ensure compliance with ISO17025:2017/ANAB AR3125 standards 7.1.9. Due to the nature of the CODIS Software Search configurations, it is preferable to include Y-STRs with the most complete autosomal profile available in the case rather than the sample with the most forensic value. Therefore, it may be regularly determined that the YSTR profile common to multiple samples in a case shall be added to the reference standard in CODIS.

This single communication is sufficient to meet the requirement to report the extent of the search or entry of a profile as the CODIS Procedures and the CODIS software are configured to

automatically advance a profile to the most extensive level for which it is eligible. If an entered sample is determined to be ineligible, it shall be removed per the *CODIS QM* and an additional communication with the investigating agency explaining the removal will be made. Documentation of this communication will be included in the casefile for future reference.