STATE OF CALIFORNIA
DEPARTMENT OF MOTOR VEHICLES

CALIFORNIA'S THREE-TIER DRIVING-CENTERED ASSESSMENT SYSTEM

Process Analysis

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13. ABSTRACT (Maximum 200 words)

On September 14, 2006, California Governor Arnold Schwarzenegger signed Assembly Bill 2542 (Daucher) into law, adding Section 1659.9 to the California Vehicle Code, and calling for a pilot study by the California Department of Motor Vehicles (CA DMV) of the 3-Tier Assessment System. This manuscript (the "process report") constitutes the first of two reports on the 3-Tier Assessment System. It details the planning and implementation of the pilot, the process outcomes for the 12,346 CA DMV customers who participated in the pilot as well as the 4,853 customers who constituted a baseline comparison group, and the results of the subsequent multi-component process evaluation. The process evaluation includes a description of the costs to implement the pilot, discussion of various threats to the methodological validity of the process and outcome analyses, and an estimation of the potential costs of statewide implementation. An appendix to this report (published separately) contains more detailed analyses associated with four components of the process evaluation: the results of a survey of participating staff, the results of qualitative interviews conducted with participating staff, the results of a survey of pilot customers, and the results of an analysis of customer outcomes on the Pelli-Robson contrast sensitivity assessment.

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PREFACE

This report is issued as an internal monograph of the California Department of Motor Vehicles Research and Development Branch rather than as an official report of the State of California. The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the state of California.

ACKNOWLEDGEMENTS

This project was made possible with the support of the California Office of Traffic Safety and the National Highway Traffic Safety Administration (OTS Grant #TR0703).

This study was conducted under the general direction of David DeYoung, Chief of the Research and Development Branch of the California Department of Motor Vehicles (R&D), and under the supervision of Leonard Marowitz, Manager of the Alcohol and Drug Projects Section. The bulk of the writing of this report was done by Bayliss Camp. However, certain portions of the data collection and initial analyses were performed by Len Marowitz. This includes much of the material pertaining to the estimation of the potential costs of implementation in the event of a statewide rollout.

The author would like to thank a number of people who contributed, in various ways, to the success of this project and the writing of this report. First, the management and staff of Field Operations Division (FOD) made the 3-Tier Pilot happen, and then provided critical feedback about the process of implementation; this includes, in particular, Marilee Keene, Susan Severini, and David Storzbach, at DMV Headquarters; Janis Saxon, former administrator for FOD Region III; Sue Stevens, the assistant administrator for the Region III office; the office managers for the six pilot offices (Linda Fulton, Theresa Jenkins, Glenda Lopez, Doris Stewart, B.J. Taylor, Craig Jamerson, and Terri Thiel); the 3-Tier Manager Is who oversaw the day-to-day work of customer processing and filing of data (Joy Cunanan, Gus Mendoza, Dawn Nickel, Kim Nunez, and Diane Storzbach); and all of the Licensing Registration Examiners, Senior Motor Vehicle Technicians, and Motor Vehicle Field Representatives who participated in the project. The author would most especially like to thank Laiq Syed, 3-Tier Manager I at Carmichael, who put in many hours and much effort—always with a high level of skill and an orientation toward providing outstanding customer service—at an extremely busy field office.

Second, the author would like to thank the management and staff of Driver Safety for their participation, as well as their critical feedback; this includes Mara Fujii, Anthony Mongalo, and Larry Hidalgo, at DMV Headquarters; Coleen Solomon, as manager of the Sacramento Driver Safety Office; and all of the Driver Safety Hearing Officers who worked on the project.

Third, the author would like to thank various members of the 3-Tier Task Force for their feedback and direction during the initial stages of the project. This includes, in particular, Charley Fenner, Senior Ombudsman for CA DMV; Patrick Barrett and Jenny Meaux, both of the Driver Licensing Policy Section; Keith Staten of Legal Branch; and Rosemary Wolf and Michael Stotts, both of Departmental Training Branch.

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EXECUTIVE SUMMARY

In accordance with California Vehicle Code Section 1659.9, and with funding from the California Office of Traffic Safety (OTS Grant #TR0703), this report contains a process evaluation of the 3-Tier Assessment System as piloted by the California Department of Motor Vehicles (CA DMV) in 2006-2007. This process evaluation includes a description of the 3-Tier Pilot, descriptive statistics on the 4,853 baseline and 12,346 pilot customers, an outline of the methods, the results obtained from all analyses, and a discussion of the implications of these findings for potential statewide implementation of the 3-Tier Assessment System.

Statement of the Problem

The demographics of the driving population of California are changing. Over the next 20 years, the number of seniors (those aged 65 and older) is expected to double, while their share of the population is expected to increase from 11.3% in 2010 to 17.9% in 2030. The resulting change in the driving population suggests that CA DMV explore options for how to preserve mobility for individuals who can drive safely, while at the same time identifying individuals who can no longer drive without excess risk to their own safety or that of others. The 3-Tier Assessment System constitutes one potential means by which CA DMV may further promote traffic safety through the licensing process.

Background

On the basis of prior research both at CA DMV and elsewhere, 3-Tier was developed on the basis of three key assumptions: (1) that a system for identifying driving-relevant functional limitations would apply to a broad spectrum of drivers, regardless of age; (2) that in keeping with the complexity of the driving task, a system of driving assessment would cover multiple domains including vision, cognition, and physical function; and (3) that a system for assessing drivers for limitations would include a substantial educational and/or therapeutic component, so that drivers may learn how to drive safely by compensating for identified limitations, where possible.

Description of the 3-Tier Assessment System

The 3-Tier Assessment System consists of a tiered series of assessment tools by which a licensing agency may identify renewal and referral customers potentially in need of further assessment and/or education regarding their driving.

The Tier 1 assessments included two vision tests, measuring distance acuity and contrast sensitivity. The test of contrast sensitivity assesses the ability to distinguish an object as distinct from its background. Tier 1 also included a memory recall test and a checklist of observed limitations to physical function. These assessments were administered by a front-line staff-person working in a CA DMV field office as part of a customer's renewal application processing. The Tier 1 tests were applied to all eligible customers enrolled in the pilot through the license renewal process (as opposed to Driver Safety referrals, who were assessed only at Tier 3).

The Tier 2 assessments consisted of CA DMV's 18-question written knowledge test for renewal of a Class C license, and a computer-based test of visual function, the Perceptual Response Test (PRT). The PRT constitutes an indirect measure of the processing speed of the visual system, and has been shown to be reliably associated with dementia-type cognitive disorders, as well as with crash risk. All 3-Tier eligible renewal customers enrolled in the pilot took the written knowledge test. However, only those customers flagged at Tier 1 as having one or more driving-relevant limitations were required to take the PRT. These tests were typically administered by front-line staff.

The Tier 3 assessments consisted of one of CA DMV's standardized on-road drive tests, either the Supplemental Driving Performance Evaluation (SDPE) or the Area Driving Performance Evaluation (ADPE), as well as the distribution of written- and video-based educational materials. These assessments were administered by a Licensing Registration Examiner (LRE) or a field office manager. The educational materials were tailored to a customer's needs and circumstances, depending on their Tier 1 and 2 assessment scores. The educational materials were intended to (a) prepare them for an on-road driving test and/or (b) educate them about potential means by which they might compensate for any identified limitations to their contrast sensitivity or perceptual speed. If a renewal customer was identified at Tier 1 and/or Tier 2 with multiple potential driving-relevant limitations, or with a potential limitation that was serious in nature, they were assessed at Tier 3. All Driver Safety referral customers were assessed at Tier 3.

Methods

This process report uses a variety of research design and statistical methods, depending on the specific sub-analysis.

Pilot Study Design

The observational cohort study design used in the 3-Tier Pilot was based on a non-random sampling method. Customers enrolled in the baseline cohort included renewal and referral customers conducting their transactions in one of the six specified pilot field offices and the Sacramento Driver Safety office between September 2006 and January 2007. The baseline cohort was intended to serve as a control group; no additional assessments were conducted of these customers other than what was required under current law and CA DMV policy.

Customers enrolled in the pilot cohort included renewal customers initiating applications in the six pilot field offices between June and October 2007, and Driver Safety referral customers initiating procedures between July and November 2007.

The pilot study design was determined in part by operational and policy needs. No policy changes were made to the rules governing what kinds of customers were required to renew their license in person in a field office, or who were required to take a drive test as part of a Driver Safety referral case. Only holders of class C (non-commercial) licenses, with no endorsements, were included. This ensured relatively uniform driving habits as compared to holders of other types of licenses, who were assumed to have quite different exposure and crash-risk profiles. Due to cost, drivers taking the written renewal test in a language other than English were excluded. This had no measurable effect on the report findings, but did substantially reduce the number of customers enrolled in the pilot.

Post-Pilot Sub-Analyses

A number of post-pilot sub-analyses were conducted as part of the overall process analysis. The results of these sub-analyses are intended to clarify what occurred during the pilot, to delineate the nature and scope of any potential methodological threats that might bias the main findings, and to provide information that may be useful in the event of statewide implementation of the 3-Tier Assessment System.

CALCULATION OF THE COSTS TO IMPLEMENT THE PILOT

The calculation of the costs to implement the pilot was based upon monthly reports filed with the funding agency (OTS) as part of the grant-reporting process.

ESTIMATION OF METHODOLOGICAL BIASES

The potential bias to the findings introduced by customer "migration" to non-pilot field offices was examined using four methods: (1) by calculating the gross number of customers in the pilot offices and in nearby (non-pilot) offices, to determine if there were noticeable shifts in customer flows in the months just prior to, during, and just after the pilot period; (2) by calculating the gross number of customers starting an application at one office, but completing their application elsewhere, at both the pilot and nearby offices just prior to, during, and just after the pilot period; (3) by culling the customer data collected during the pilot for specific instances of individuals enrolling in the pilot but finishing at a non-pilot office; and (4) by interviewing staff at both pilot and nearby offices regarding their impressions of the scope and severity of this potential problem.

A second form of selective non-participation subsequent to enrollment occurred in the form of customers with "lagging" applications—i.e., those who enrolled in 3-Tier but then failed to complete their renewal (or referral) process until sometime after the conclusion of the pilot. The permanent driver records of these customers were examined to estimate any potential bias to the findings.

Given the size and complexity of this pilot, it was expected that some processing and data-recording errors by staff would occur. Data-quality control and review measures were instituted within the field offices and Sacramento Driver Safety office; this resolved and corrected the vast majority of minor instances of missing data. An additional number of errors were corrected after the pilot, through review of documents by R&D. What remained after these data-quality reviews were a relatively small number of "non-correctable" errors in processing and/or data-recording. The permanent driver records of these customers were examined to estimate any potential bias to the findings in this report. These data were also used to adjust the estimates to potential changes to workload in the event of statewide implementation of 3-Tier.

SURVEY AND INTERVIEWS OF PARTICIPATING STAFF AND MANAGERS

R&D surveyed all participating staff and managers not on vacation or sick leave (n=130) within the six pilot field offices and Sacramento Driver Safety office. The survey questions included a number of closed-ended questions with Likert-type scales; these were analyzed through basic quantitative descriptive statistics. The survey also included some open-ended questions; these were analyzed through the use of qualitative open-coding procedures. The survey responses were used primarily to collect data regarding potential improvements to the 3-Tier Assessment System. The pattern of survey responses also informed the creation of the interview protocol.

In order to gather qualitative feedback on the pilot, R&D developed a flexible semi-structured interview protocol tailored to specific job categories. The author then constructed a non-probability stratified sample of all participating staff and managers who worked on the pilot (n=49). Participants were recruited through self-nomination via the survey, as well as through nomination by Driver Safety and pilot field office managers. The data collected by these interviews were analyzed through the use of qualitative open-coding procedures.

SURVEY OF CUSTOMERS

In order to gather data regarding customer acceptance of the 3-Tier Assessment System, a simple 6-question survey was distributed to a stratified random sample of pilot cohort customers. Customers undergoing enhanced assessment (Tiers 2 and 3) were over-sampled. Surveys were distributed to 5,871 customers and the response rate was 49%. Both stratification design and non-response weights were applied to the results. The results were analyzed using logistic regression to predict the odds of agreeing with six positively-phrased statements about 3-Tier.

ANALYSIS OF THE LIKELIHOOD OF FAILURE ON THE CONTRAST SENSITIVITY ASSESSMENT

A substantial number of staff raised concerns about the robustness of the Pelli-Robson charts under varying light conditions (glare, shadows, time of day, etc.). In order to examine this, the author constructed a hierarchical logistic regression predicting the likelihood of failing the contrast sensitivity assessment based on relevant independent variables including customer age, whether a customer possessed a limited-term license (usually an indicator of a progressive vision disorder), whether the technician who processed the customer's transaction was an outlier compared to other technicians in their office in passing/failing customers on all Tier 1

assessments, and the imputed location of the Pelli-Robson chart on which the customer was presumed to have been tested.

ESTIMATION OF THE POTENTIAL COSTS OF STATEWIDE IMPLEMENTATION

Finally, estimates were developed for the potential cost of statewide implementation of the 3-Tier Assessment System. These calculations were based in part upon the costs of implementing the pilot; however a number of adjustments were made on the basis of various assumptions about certain differences between 3-Tier as piloted, and any potential future adoption of the system.

It was assumed that 3-Tier, if implemented statewide, would be made available in all languages in which CA DMV conducts business, that 3-Tier would include customers holding both Class C (non-commercial) and Class M (motorcycle) licenses (referred internally at CA DMV as a Class C+M license), and that any adoption of the 3-Tier Assessment System would occur using electronic collection of assessment data. This last assumption required adjusting the estimates of pilot-associated changes to the efficiency of customer processing in the field offices and in Driver Safety. This was necessary because the pilot involved a largely paper-based data collection regimen. This assumption also required estimating the costs of re-programming CA DMV's forthcoming system of electronic data collection and record-keeping (tentatively referred to as EASE), which will likely be in place prior to any statewide implementation of 3-Tier.

It was assumed that the implementation of 3-Tier would involve substantially the same assessment equipment as was used during the pilot, and that any training associated with statewide rollout would be similar to what was used during the pilot in content, as well as the number and length of training sessions. The estimated costs of assessment equipment, training, and curriculum development were adjusted for expansion to the state as a whole.

It was generally assumed that a number of staff-initiated suggestions to changes to 3-Tier procedures would be adopted. These included suggestions for streamlining the physical observation protocol, and were used to adjust the estimates of the expected increase in the number of minutes required to process a given transaction.

It was also assumed that any expected impact of 3-Tier on the workload and processing efficiency of the field offices and Driver Safety would be balanced by the hiring of new staff. Thus, the expected increase in the number of minutes required for customer processing were

used to develop an estimate of the number of full-time equivalent positions necessary to maintain present standards of processing efficiency and wait times in CA DMV field offices.

Finally, it was assumed that 3-Tier, if adopted statewide, would be implemented in substantially the same form as was piloted. It was determined that speculation about the cost of implementing component parts of 3-Tier—as opposed to the system as an integrated whole—was outside of the scope of the present analysis.

Results

The results of the analyses undertaken in this report are broken into two major sections: findings from the pilot project (customer participation rates, basic descriptive statistics, and process outcomes for both the baseline and the pilot cohorts), and findings from the various post-pilot process analyses.

Pilot Outcomes

CUSTOMER PARTICIPATION RATES AND PROCESS OUTCOMES FOR BASELINE COHORT

During the baseline period data were collected on a total of 4,853 customers. Of these, 4,664 (96.1%) were renewal customers, while 189 (3.9%) were referred from Driver Safety to a pilot field office for a drive test. Of the renewal customers, 40 (0.9%) were required to take a drive test related to the possession of a limited-term license. A smaller number (11, or 0.2%) were required to take a drive test due to failure on the department's visual acuity standard. Because of the way in which data were collected and retained during baseline, no statistics are available regarding fail rates on the written test, except by comparison to previous CA DMV studies (e.g., Chapman & Masten, 2002).

DESCRIPTIVE STATISTICS ON BASELINE COHORT

For all baseline customers (referral and renewals combined), the mean age was 42.2 years, and the overwhelming majority (82.8%) were younger than age 70. Somewhat less than half (41.7%) were female. The mean number of negligent operator points in the 3 years prior to the date of enrollment was 0.96.

CUSTOMER PARTICIPATION RATES AND PROCESS OUTCOMES FOR PILOT COHORT

During the pilot period, a total of 10,999 customers were enrolled in 3-Tier. Of these, 10,883 (98.9%) were renewal customers, while 116 (1.1%) were referred from Driver Safety to a pilot field office for a drive test.

Tier 1: Physical observation protocol

On the physical observation protocol, 434 (4.0%) customers were observed with one or more potentially driving-relevant limitations. Of these, 395 (3.6%) were observed with one limitation only, 31 (0.3%) were observed with two limitations, and 8 (<0.1%) were observed with three or more limitations. Among those observed with physical limitations, 113 customers (1.0%) exhibited obvious shaking in the upper body, while 198 (1.8%) were unable to walk unaided. Other sorts of physical limitations were observed less often, though still generated at least ten observations each. The loss of leg or foot, or obvious shaking in the lower body, was observed quite rarely.

Tier 1: Vision assessments

On the visual acuity standard (Snellen chart), 237 customers (2.2%) failed. Of these, CA DMV had records on file for 124 individuals (1.2%), meaning that these customers had at some prior time demonstrated the ability to drive safely in an on-road test, despite their limited vision. This left 113 customers (1.0%) who, because of their failure on the acuity standard, were issued a CA DMV form DL62 and referred to a licensed optometrist or ophthalmologist for professional evaluation of their vision.

Only those customers who passed the visual acuity standard were assessed for limitations in their contrast sensitivity with the Pelli-Robson chart. Of the 10,771 customers so assessed, 1,488 (13.7%) “somewhat failed” (meaning they missed one or more letters on line 5 of the chart), while 75 customers (0.8%) “extreme failed” (meaning they missed one or more letters on lines 1 or 4 of the chart). Those customers who extreme failed were issued a CA DMV form DL62 and referred for professional evaluation of their vision.

Tier 1: Memory recall assessment

On the memory recall assessment, 118 customers (1.1%) failed.

Tier 1: Cumulative assessment outcomes

A customer's Tier 1 scores were cumulated to produce an overall count of potentially driving-relevant limitations. Of the 10,857 customers with complete data on all Tier 1 assessments, 1729 (15.9%) had a total Tier 1 score of 1, while 225 (2.1%) had a total score of 2 or more.

Tier 2: Written test of the rules of the road

The fail rates for the first and second attempts on the written test were essentially identical: 20.3%. The fail rate for the third attempt was 22.3%, for the fourth attempt 29.0%, and for the fifth attempt 37.9%. Very few customers (n=11) were required to make a sixth attempt.

Tier 2: Perceptual Response Test (PRT)

A total of 2,287 customers were required, for a variety of reasons, to take the PRT. Of these, 263 customers (11.5%) extreme failed or aborted (timed out) on this test, while 12 (0.5%) somewhat failed. The contrast sensitivity assessment played a key role in routing customers to the PRT. Among those with a Tier 1 score of 1, over three-quarters had somewhat failed the contrast sensitivity assessment. Among those with a Tier 1 score of 2, over a third had extreme failed the contrast sensitivity assessment, while an additional three-fifths had somewhat failed.

Tier 3: Educational intervention

Approximately 500 customers (4.6%) were given the written educational intervention materials distributed to those required to take the on-road test; this included the *California Driver Handbook* and the "On the Right Track" pamphlet. Approximately 786 (7.2%) were shown the video-based presentation on compensating for limitations to contrast sensitivity, while approximately 10 were shown the video on perceptual speed. On the basis of inconsistencies within the patterns of the quantitative data, as well as qualitative evidence collected during the staff interviews (discussed below), it was determined that the data on the distribution of the educational intervention were unreliable and potentially biased.

Tier 3: The on-road drive test

Customers were required to take a drive test under 3-Tier for a variety of reasons. On the first attempt at the SDPE test, the fail rate was 22.6% for renewal customers, and 30.3% for Driver Safety referrals. On the second attempt at the SDPE, the fail rate was 18.2% for renewals, and 50% for referrals. On the third attempt at the SDPE, the fail rate for renewals was 23.8%. Only five referral customers were required to make a third attempt on the SDPE; of these, one failed. There was no statistically significant relationship between customer self-report of having taken behind-the-wheel training prior to testing and their likelihood of passing the SDPE, regardless of attempt. This lack of significance may be due, in part, to a lack of statistical power. As a general matter, those who had a Tier 1 score of 1 and who failed the written test three or more times were most likely to fail the SDPE on their first attempt; customers who had a Tier 1 score of 2 and who extreme failed/aborted on the PRT were also somewhat more likely than other types of customers to fail their first attempt at the SDPE.

Very few ADPEs were administered: a total of 16 first attempts on this drive test were recorded during the pilot period. The fail rate was 12.5%. Two customers requested an SDPE after passing the ADPE.

Mobility options in case of a drive-test fail

Special Instruction Permits (SIPs) and Special Restricted Licenses (SRLs) were issued quite rarely. Among the 706 customers who were required to take an on-road drive test, a total of 11 (1.6%) were given a SIP or SRL after a drive-test failure.

Revocations and suspensions were also quite rare. Out of all drive-test customers, 29 (4.1%) exited the pilot with a suspended or revoked license. Of these, a majority (20) were Driver Safety referral customers. Of those Driver Safety referral customers who exited the pilot with a suspended or revoked license, approximately half (11) already possessed a suspended license.

DESCRIPTIVE STATISTICS ON PILOT COHORT

The various 3-Tier assessment tests were designed to identify driving-relevant limitations in physical function, cognition, and vision. As a general matter, while many of the assessment outcomes are associated with age, it remains true that the there exists a great deal of variation

within age cohorts. Furthermore, the majority of customers—even among the most advanced age groups—passed the various assessment tests.

Characteristics of pilot cohort by Tier 1 assessment outcome

On the physical observation protocol, those identified with physical limitations were, on average, between 10 and 20 years older than those free of such limitations. In general these differences were statistically significant. The number of observed potential physical limitations was also associated with advancing age; those with one or more observed limitations were 18-20 years older than customers observed with no limitations. However, physical limitations are observed only rarely even at the most advanced age stratum, and there is no clear age cutoff point at which they appear, or below which they do not appear. Not only were some younger customers (those younger than 45) observed with physical limitations, but over 90% of the oldest stratum (those 75 or older) were observed by staff to be free of such limitations.

Similarly, the likelihood of failure on the memory recall, visual acuity, and contrast sensitivity assessments was significantly associated with advanced age; those who failed these assessments were, on average, 16-20 years older than those who passed. Also, the Tier 1 total score was significantly associated with advanced age; those who were identified with one or more limitations in physical function, vision, or memory were, on average, 20-25 years older than those identified with no limitations.

Characteristics of pilot customers by Tier 2 assessment outcome

The likelihood of passing the written renewal test bears no consistent relationship with age. While those who fail the second and third attempts are slightly older (by, on average, 5-6 years), the mean ages of those failing or passing on the first and fourth attempts are statistically indistinguishable.

The likelihood of passing the PRT was associated with age. Those who somewhat or extreme failed were, on average, 6-9 years older than those who passed. However, there was no statistically significant difference in age between those who extreme failed and those who aborted (i.e., timed out) on this assessment.

Characteristics of pilot customers by Tier 3 assessment outcome

The relationship between age and outcome on the first attempt at the SDPE depends, in part, upon the reason why a drive test was required. For customers whose drive test was the result of a previously-identified progressive vision disorder or the result of a Driver Safety investigation, the likelihood of passing was statistically associated with age. In both cases, older drivers are significantly more likely than younger drivers to fail their first attempt at the SDPE. For customers whose drive test was the result of failure on one or more 3-Tier assessment tests, there is no statistical relationship between age and likelihood of failing the first attempt at the SDPE. There is no statistical relationship between age and likelihood of failing the second or third attempt at an SDPE, or at failing the first or second attempt at an ADPE.

Process Analyses

THE COSTS TO IMPLEMENT THE 3-TIER PILOT

The costs to implement the pilot were calculated using quarterly reports to the grant-funding agency. These costs totaled $1,033,704, the bulk of which ($989,935) came in the form of salaries and benefits for the additional staff necessary for successful implementation.

CUSTOMER MIGRATION

No discernable shift in gross customer volumes at pilot and nearby non-pilot offices was seen in the months just prior to, during, and just after the pilot period; neither was there any discernable shift in the gross number of senior customers (those aged 65 and older) in those periods. No discernable rise was observed in the gross number of customers starting transactions at pilot offices and completing them at non-pilot offices in those periods; perhaps more to the point, the rate of customers migrating from pilot to non-pilot offices was essentially identical to the rate of customers migrating from non-pilot to pilot offices. In qualitative interviews on this matter, staff at both pilot and non-pilot offices did report isolated instances of customers making remarks about the presence (or absence) of pilot-related assessment materials (especially the Pelli-Robson contrast sensitivity chart). However, staff noted that these comments did not appear to be connected to the avoidance of pilot-associated assessment.

A small group (n=71) of customers enrolled in the pilot but completed their applications at a non-pilot office. These customers were significantly younger (by, on average, 6 years), and

substantially and significantly more likely to have accumulated negligent operator points in the prior 3 years. These customers' data will be analyzed separately in the outcome analysis, to estimate any potential bias to the main findings of the pilot.

PROCESSING ERRORS IN PILOT PERIOD

A relatively small number of customers (n=118) were erroneously enrolled in the pilot. These were excluded from the analysis, and present no threats to the validity of the main findings.

A somewhat larger number of customers (n=332) had missing documents and/or data that could not be reliably reconstructed or imputed from other sources. In addition, 107 customers were not given the PRT even though it was required, and 225 customers were licensed without taking an on-road test of driving skill, as required under 3-Tier procedures. The existence of these erroneously-processed customers presents the possibility of a serious undercount of the number of drive tests that would normally be generated by the 3-Tier Assessment System; this was taken into account in the estimation of the potential costs of statewide implementation (see below). These customers' data will be analyzed separately in the outcome analysis, to estimate any potential bias to the main findings of the pilot.

CUSTOMERS WITH LAGGING APPLICATIONS

A substantial number of customers (n=683) did not complete their renewal application or Driver Safety referral process by the end of the pilot. While some (about half) were customers who started applications towards the end of the pilot (September or October), over one quarter were customers who started applications at the beginning of the pilot (June or July). Approximately half (362, or 53%) did not renew their license by the end of the calendar year 2008 (i.e., 12 months after the end of the pilot). In addition, a substantial number of these customers (n=63) had suspended or revoked licenses. These customers' data will be analyzed separately in the outcome analysis, to estimate any potential bias to the main findings of the pilot.

COMPARISON OF BASELINE AND PILOT COHORTS (EFFECT OF SHIFT IN LICENSE TERM)

The baseline period coincides with a periodic decline in the number of customers seen in CA DMV field offices. This decline—which appears as a trough every fifth year (starting in 2002) in trend lines of field office customer volumes—stems from a policy decision made in the late

1990s to shift the normal term of driver licenses from 4 years to 5. This affected the number of customers enrolled into the baseline cohort. It is also associated with substantial differences in the demographic characteristics of the two cohorts. Among regular 5-year renewal applications, baseline cohort customers are substantially and significantly younger than pilot cohort customers, by approximately 14 years. Baseline customers renewing regular-term licenses are also significantly more likely to be male, and to have accumulated substantially and significantly more negligent operator points in the prior 3 years, as compared to similar pilot cohort customers. Among limited-term renewals and Driver Safety referrals—the policies governing which were not affected by the change to the normal license term—the two cohorts are statistically indistinguishable when it comes to age, gender, and prior violation record.

RESULTS OF THE MANAGEMENT AND STAFF SURVEY AND INTERVIEWS

The main findings of the survey were as follows:

- Suggested improvements to the 3-Tier process included:
  - The elimination of excess paperwork (ideally, through incorporation of data collection into the DMVA).
  - Streamlining the physical observation protocol to make customer processing more efficient.
- There exist staff concerns regarding the robustness of the Pelli-Robson contrast sensitivity chart under varying light conditions (glare and shadows).
- Substantial variation occurred in the administration of the memory recall assessment.
- There exist staff concerns regarding the purpose, and traffic safety relevance, of the PRT.
- Staff are committed to fulfilling CA DMV's organizational mission, and in particular are committed to providing excellent customer service. However, the definition of what constitutes good customer service varies somewhat among staff, and includes at least three possible components:
  - Efficient processing and low wait times in the field offices.
  - A knowledgeable, cheerful demeanor combined with personalized attention to the customer.
  - Treating all customers in a non-discriminatory manner with regard to characteristics irrelevant to safe driving.
- Staff views of 3-Tier's impact on customer service depended, at least in part, on the particular definition of good customer service most salient to their job category:
  - Field office managers were most likely to stress the importance of efficient processing, and so therefore to conclude that 3-Tier had a negative impact on customer service.

- LREs and 3-Tier Manager Is were most likely to stress the importance of personalized attention, and so therefore to conclude that 3-Tier had a positive impact on customer service.
- Respondents from a number of job categories were concerned about potential discrimination against older customers, as well as customers speaking different languages. More generally, the tiered nature of the 3-Tier Assessment System was seen as singling out individuals for special treatment, and so therefore as discriminatory.

The main findings of the interviews include:

- There exists broad understanding among staff regarding the overall goals of the 3-Tier Assessment System. Staff were particularly excited to be participating in a project that may result in reducing crashes, saving lives, and producing a safer driving environment.
- The 3-Tier Assessment System increased the amount of communication that occurred among employees. This increase in communication occurred among frontline staff in the field offices, between frontline staff and LREs as well as between frontline staff and Manager Is, and across branches and divisions. This increase in communication was largely seen as a positive outcome of the pilot. The efforts of the staff who worked as liaisons between R&D and the field offices was especially appreciated by those interviewed.
- The suggested improvements to 3-Tier reiterated findings from the survey regarding the paramount importance of eliminating excess paperwork, ideally by incorporating the collection of 3-Tier associated data into the DMVA system.
- Substantial variation occurred in the implementation of the memory recall assessment.
- No substantial variation occurred in the implementation of either the physical observation protocol or the visual acuity (Snellen Chart) assessment.
- In keeping with protocols developed for the administration of the visual acuity (Snellen) charts, customers may have been assessed on a Pelli-Robson chart other than the one associated with the terminal at which their application was processed.
- Some customers may have taken the PRT multiple times.
- There was substantial variation in the administration of the educational intervention. In particular, respondents reported instances where they distributed video-based materials on how to compensate for potential limitations to contrast sensitivity to all customers required to take a drive test, not just those customers who somewhat failed the contrast sensitivity assessment.
- Staff were skeptical of the validity and usefulness of the memory recall test for assessing skills relevant to safe driving.

- Staff understood, and were comfortable with, the stated purpose and driving-safety relevance of the physical observation protocol, the visual acuity assessment, and the contrast sensitivity assessment.
- Staff were skeptical of the validity and usefulness of the PRT for assessing skills relevant to safe driving. In addition, there was widespread misunderstanding of what the PRT actually tested (perceptual speed, as opposed to reaction time).
- Staff saw the usefulness of the educational intervention materials at least partly in terms of the delivery of personalized, attentive, customer service. Distribution of these materials was therefore seen in the first instance as calming customer anxiety about an upcoming road test.
- Staff expressed a variety of views regarding the utility of the ADPE.
- Staff views of the impact of 3-Tier on customer service reiterated the findings of the survey, namely that the definition of what constitutes good customer service differs somewhat according to job duties. This in turn influences the expressed views of staff regarding whether 3-Tier had a positive, negative, mixed, or neutral impact on customer service.
- Some of the variation in the implementation of various assessment tests may be attributed to differences in the materials offered during training.
- Some of the variation in the implementation of various assessment tests may be attributed to inherent tension between two of the organizational goals that DMV staff and managers are expected to fulfill: enhancing customer service (defined as speedy, efficient processing), and improving traffic safety through the licensing process.
- Staff expressed two views of the purpose of assessment testing. For those tests the purpose of which was not clearly understood—and this occurred most frequently with assessments of cognitive function—assessments were regarded as bothersome hurdles that all customers should (theoretically) be able to clear. For those tests whose purpose was more clearly understood, assessments were described as appropriate gauges of driving competency and skill, and therefore as justifiable instruments of discrimination between potentially safe, and potentially unsafe, drivers.

PILOT EFFECTS ON STAFF WORKLOAD

The implementation of 3-Tier had the following effects on staff workload in the participating field offices and Sacramento DSO:

- An effect on the efficiency of customer processing and wait times in the field offices. This effect is difficult to estimate, however.
- An increase in the number of SDPE and ADPE drive tests administered by the field offices.

- The addition of a new job category (3-Tier Manager I).
- Some qualitative changes to the duties of staff in various positions, but especially of front-line staff in the field offices.
- Certain changes to inter-division communication that were likely temporary and confined to the pilot period.

PILOT-PRODUCED LEARNING OUTCOMES FOR MANAGEMENT AND STAFF

There were three main ways in which staff and managers learned from participating in the 3-Tier Pilot:

- New methods for the assessment of driving-relevant limitations to physical function, vision, and cognition.
- An enhanced commitment to improving the safety of California's drivers through the licensing process.
- Participation in the planning and evaluation of a large, complex pilot project.

ROBUSTNESS OF THE PELLI-ROBSON CHARTS

The two variables that exert the strongest effect on customer outcomes on the Pelli-Robson contrast sensitivity assessment were (i) customer age, and (ii) whether or not the customer possessed a limited-term license, or had a "long-standing vision condition" on record with CA DMV. These results were interpreted as demonstrating that the Pelli-Robson chart operates substantially as it was intended to, and as found by prior research in the clinical and research literature.

Once these effects are accounted for, there remains some variation in customer outcomes that may be associated with chart location. However, this effect is difficult to disentangle from variation associated with a second, constructed variable ("technician orthodoxy"), that measured whether a technician was an outlier in passing/failing customers on all Tier 1 assessments (including contrast sensitivity). "Technician orthodoxy" showed a more robust and generally stronger effect on customer outcomes than chart location. However, this latter effect was not as strong as the effects associated with customer age and a formal indication of a serious vision condition.

CUSTOMER ACCEPTANCE OF THE 3-TIER ASSESSMENT SYSTEM

Customers participating in the pilot had, on the whole, positive attitudes toward the 3-Tier Assessment System. The proportion agreeing or strongly agreeing with six positively-phrased comments were as follows:

- #1: "The time I spent during my office visit was reasonable": 92%.
- #2: "I found the new assessment system easy to follow": 89.2%.
- #3: "I found the instructions for each test easy to understand": 88.4%.
- #4: "The DMV office staff treated me with courtesy and respect": 94.3%.
- #5: "In my opinion, this new assessment system is fair to all customers": 83.6%.
- #6: "I am confident that this new assessment system will improve driver safety": 78.2%

In a logistic regression predicting the odds of viewing 3-Tier negatively (i.e., of disagreeing with one or more of the above statements), the following patterns were seen:

- Customers who experienced enhanced assessment, at Tiers 2 or 3, were more likely to view 3-Tier negatively, as compared to those assessed at Tier 1.
- Customers with poor driving records were more likely view 3-Tier negatively, as compared to those with good driving records.
- Senior drivers (those aged 65+) held positive views of DMV staff courtesy and respect, other effects held constant.
- On all other questions, age had no statistically significant relationship with attitudes towards 3-Tier.
- On no question did gender, or the field office in which a customer processed their transaction, have a statistically significant relationship with attitudes towards 3-Tier.

ESTIMATION OF THE POTENTIAL COSTS OF STATEWIDE IMPLEMENTATION

In calculating the estimated costs of statewide implementation of the 3-Tier Assessment System, it was determined that:

- Approximately 19% of all non-commercial license renewal transactions in CA DMV field offices are expected to involve 3-Tier procedures, if customers are enrolled regardless of language and regardless of whether they hold a motorcycle license.
- The Tier 1 components of 3-Tier processing will add approximately 5 minutes to a basic Class C license renewal transaction.
- The Tier 2 and Tier 3 components of 3-Tier processing will apply to only a small minority of customers, but will nevertheless add to staff workload in both the field offices and Driver Safety.

- Given the increased workload associated with 3-Tier, the following number of full-time equivalent positions would be necessary to maintain current standards of processing efficiency:
  - 50-57 MVFR level positions.
  - 22-25 LRE positions.
  - 16-18 Manager I positions.
  - The expected increase in workload to Driver Safety is minimal: <1 full-time equivalent position (FTE).
- The estimation of the potential costs of statewide implementation of the 3-Tier Assessment System includes the following components:
  - Start-up (one-time) costs:
    - Development of training materials: $18,224.
    - Implementation of training at rollout: $294,976.
    - Purchase of Pelli-Robson charts: $298,494.
    - Purchase of PRT equipment and software: $882,389.
    - Reprogramming of DMVA/EASE: $160,500.
  - On-going costs:
    - PRT annual license fee: $84,500/year.
    - New FOD personnel: $4.2-$4.8 million/year.
    - New Driver Safety personnel: $9,408/year.

Discussion and Conclusions

Process Concerns

CONSEQUENCES OF DIFFERENCES BETWEEN PLANNING AND IMPLEMENTATION

In all essential respects, 3-Tier was implemented as planned. There were three major areas of failure in the consistency of implementation: (a) variation in the implementation of the contrast sensitivity and memory recall assessments, (b) maladministration of the educational intervention, and (c) misprocessing of a substantial number of customers, especially as regards the issuance of a license without a required drive test.

The variation in implementation of the contrast sensitivity and memory recall assessments may be addressed with changes to the training offered to staff in this assessment; in particular it is

suggested that training incorporate additional material regarding how to respond to customer complaints and questions about these new assessments.

The maladministration of the educational intervention materials appears to have derived from a commitment on the part of CA DMV staff to abide by the highest standards of customer service, especially when answering customer questions and calming anxieties in a drive-test situation. In the event of statewide implementation, it will likely be necessary to provide written drive-test preparation materials to customers assessed at Tier 3.

The misprocessing of substantial numbers of customers during the pilot appears to derive from the disjuncture between pilot-specific procedures (e.g., requiring a road test in the event of failing the written knowledge test three or more times) and "standard" (non 3-Tier) procedures (where drive tests are normally waived in the event of a three-time failure on the written test). This form of misprocessing is expected to be infrequent in the event of a permanent switch from current policies and procedures to 3-Tier procedures. There may, however, be a transition period between procedural regimes, during which time staff are trained in the new requirements.

PROGRAM EFFECTIVENESS

Regardless of these differences between planning and implementation, the implementation of the pilot resulted in some unanticipated benefits. This included highlighting the connection between the 3-Tier Assessment System and CA DMV's organizational goal of improving traffic safety through the licensing process. In regards to CA DMV's goal of adhering to consistently high standards of customer service, 3-Tier has different effects depending on the definition of customer service adopted: efficient customer processing and low wait times, a knowledgeable and cheerful demeanor on the part of staff, or consistent and homogenous treatment of all customers.

Most importantly, the pilot succeeded as a demonstration project. The 3-Tier Pilot has shown that the 3-Tier Assessment System can be implemented in an agency context, for the assessment of a wide population of license renewal applicants for driving-relevant limitations to physical function, vision, and cognition.

Recommendations for Potential Future Implementation

This process analysis finds that the 3-Tier Assessment System can be successfully implemented; however, a final recommendation as to whether it should be implemented on a statewide basis must wait until the results of the outcome evaluation become available. The outcome report (due to be published in late 2011) will include an analysis of the impact of 3-Tier on driver mobility and traffic safety.

MINIMIZING IMPACT ON PROCESSING EFFICIENCY AND WAIT TIMES IN THE FIELD OFFICES

Based upon suggestions made by staff, as well as upon findings from this report, it is recommended that four substantive changes by made to 3-Tier in the interests of improving processing efficiency:

- Elimination of the driving habits survey.
- Consolidation of the physical observation protocol to 7 items (from 11).
- Observation for potential physical limitations at two or even three points in the application process (the Start Here station, the initial counter, and the Video Capture Station). This would eliminate the necessity of "walk time." It would also ensure that as few instances as practicable were overlooked of customers in need of further assessment.
- Reprogramming the DMVA (or EASE) system for the collection and storage of 3-Tier data. This would eliminate excess paperwork while at the same time producing an individual record of past assessment outcomes.

PREVENTION AND MINIMIZATION OF PROCESSING ERRORS

There are three primary methods for reducing potential processing errors: reprogramming of the DMVA (or EASE) system, improvements to training, and ongoing quality control monitoring. The reprogramming of the electronic system of data collection and storage is primarily useful for speeding up processing; however, it may also allow for a mechanism of forced-logic decision trees that would require the inputting of additional assessment data on the basis of prior entries. This might reduce instances of processing errors where 3-Tier conflicts with previous procedures (such as waiving the drive test requirement in the event of failing the written test three times). Improvements to training may be most useful for providing background information on the purpose of specific assessment tests and their connection to safe driving. Ongoing monitoring

and refresher training should encourage consistency of implementation, both across regions and within offices.

CHANGES TO STAFF DUTIES

The primary changes to staff duties that result from 3-Tier involve frontline staff positions responsible for the administration of Tier 1 assessment tests. These changes will likely involve an expansion in the provision of knowledgeable, personalized customer service. These changes may also involve a greater degree of shared responsibility among staff for the observation and assessment of customers for potential driving-relevant limitations. All other changes to staff duties are expected to be minimal, and in line with current scopes of work.

The Link Between the 3-Tier Assessment System and Traffic Safety

On the basis of feedback from staff as well as on the basis of findings from the customer survey, it is recommended that any adoption of the 3-Tier Assessment System on a statewide basis be accompanied by a public information campaign on the part of CA DMV emphasizing the potential for improvements to traffic safety. Depending on the results of the outcome analysis, it may also be appropriate to emphasize the effect of 3-Tier on the extension of safe driving years for drivers of all ages.

The Link Between the 3-Tier Assessment System and Customer Service

On the basis of feedback from staff as well as on the basis of findings from the customer survey, it is also recommended that any adoption of the 3-Tier Assessment System on a statewide basis be accompanied by a public information campaign on the part of CA DMV emphasizing improvements to customer service.

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INTRODUCTION

On September 14, 2006, California Governor Arnold Schwarzenegger signed Assembly Bill 2542 (Daucher) into law, adding Section 1659.9 to the California Vehicle Code, and calling for a pilot study by the California Department of Motor Vehicles (CA DMV) of the 3-Tier Assessment System (3TAS). This manuscript (the "process report") constitutes the first of two reports on 3TAS. It details the planning and implementation of the pilot, the process outcomes for the 12,346 CA DMV customers who participated, and the results of the subsequent process evaluation conducted by CA DMV Research and Development Branch (R&D). A second set of analyses (the "outcome report"), detailing the predictive validity of 3TAS as a means for extending safe driving years for California drivers of all ages, and as a means for reducing crashes and traffic violations, will be based on two years of elapsed driving history measured from the conclusion of the pilot intervention. Both the process report and the outcome report will be submitted to the California state legislature on or before December 31, 2011, in accordance with the original authorizing legislation.

Statement of the Problem

In California, as well as elsewhere, the demographic composition of the driving population is changing. The California Department of Finance (2007) estimates that the number of seniors (age 65 and older) is expected to double over the next twenty years, rising from 4.4 million to 8.8 million, while their share of the total population will increase by nearly 60% over that period, increasing from 11.3% in 2010 to 17.9% in 2030. The increase in the number of seniors, and the related increase in their proportion of the driving population, has many implications in a number of areas of traffic safety. These include exploring options for preserving mobility for individuals who can drive safely, and identifying appropriate means of determining when individuals cannot drive safely. 3TAS constitutes one potential means by which CA DMV may promote traffic safety through the licensing process. This process report and the outcome report to follow together constitute critical sources of information by which policy-makers, traffic-safety researchers, administrators of licensing agencies in other jurisdictions, and community stakeholders may judge the utility and cost-effectiveness of 3TAS for preventing crashes, reducing violation rates, and extending safe driving years for all drivers.

Background

3TAS builds upon prior analytic work at CA DMV and elsewhere. Indeed, research on the assessment of age-related functional limitations in driving is a growing field made richer by the multi-disciplinary nature of the object of study. Scholars and practitioners outside CA DMV have looked at a number of research questions related to the assessment of driving competency. Taken together, this body of research findings raises three key points that have shaped the development of 3TAS: (1) that an assessment system designed to identify driving-relevant functional limitations should apply to a broad spectrum of drivers, regardless of age, (2) that such a system must involve multiple domains of assessment, including vision, cognition, and physical function, and (3) that such a system should incorporate a substantial educational and/or therapeutic component, so that drivers may retain the driving privilege as long as they can safely do so.

Research by Scholars and Practitioners Outside CA DMV

Any assessment of driving competency cannot be based solely upon age. This is true for empirical as much as for conceptual or political reasons. Empirically speaking, the elderly are among the safest drivers on the road, especially when measured in terms of per driver crash rates (Evans, 1988a; US Department of Transportation, 1993). However, there exists a good deal of variation within age groups, and crash rates as measured on a per driver (or a per able driver) basis are higher among the oldest seniors (those aged 80+) than they are among younger seniors (e.g., those aged 65-74) (Lyman, Ferguson, Braver, & Williams, 2002; US Department of Transportation, 2003; Eberhard & Mitchell, 2009). When measured on a per mile basis, crash rates are generally higher for older drivers than for all others except novice younger drivers (McKenzie & Peck, 1998; Williams & Carsten, 1989; National Highway Traffic Safety Administration, 2000). That said, when it comes to traffic citations, violation rates decline with age. Seniors are always among the most law-abiding drivers on the road, whether measured on a per driver or per mile basis; this is especially true for violations involving alcohol (Janke, Masten, McKenzie, Gebers, & Kelsey, 2003; National Highway Traffic Safety Administration, 2005).

To the degree that (some) seniors are at risk for crashing, they are also at elevated risk for crashes that result in injuries and fatalities (Barancik, Chatterjee, Greene-Cradden, Michenzi, Kramer, Thode, & Fife, 1986; Retchin, Cox, Fox, & Irwin, 1988; Reuben, Siliman, & Traines,

1988; McCoy, Johnston, & Duthie, 1989; Barr, 1991; Evans, 1991; Massie & Campbell, 1993; Ryan, Legge, & Rosman, 1998; Bédard, Guyatt, Stones, & Hirdes, 2002; Newgard, 2008; Hanrahan, Layde, Zhu, Guse, & Hargarten, 2009). Fatalities and injuries among senior drivers are largely a product of the physical frailty typically associated with age (Evans, 1988b; Viano, Culver, Evans, Frick, & Scott, 1990; Li, Braver, & Chen, 2003; Meuleners, Harding, Lee, & Legge, 2006). Thus, while crashes among seniors are not frequent, when they happen they tend to have serious consequences. However, this is really only true for senior drivers themselves (and perhaps their passengers), and not for other road users (Dulisse, 1997; Evans, 2000; Braver & Trempel, 2004; Dellinger, Kresnow, White, & Sehgal, 2004; Langford, Bohensky, Koppel, & Newstead, 2008). Furthermore, crash rates for all age groups, including seniors, have been on the decline over the past decade (Eberhard, 2008), likely due to improvements to road safety, vehicle crashworthiness, and increased use of safety devices such as seat belts and airbags.

Crash risk among older drivers is directly related to the frequency and type of driving done by individual seniors and this in turn complicates the way in which this category of crash risk ought to be conceptualized (Hakamies-Blomqvist, Raitanen, & O'Neil, 2002; Langford, Methorst, & Hakamies-Blomqvist, 2006). Many seniors reduce their amount of driving by, for instance, making fewer and shorter trips (Marottoli, Ostfeld, Merril, Perlman, Foley, & Cooney, 1993; Benekohal, Michaels, Shim, & Resende, 1994; Stutts, 1998; Gallo, Rebok, & Lesiker, 1999; Kostyniuk, Shope, & Molnar, 2000; Klavora, & Heslegrave, 2002; Adler & Kuskowski, 2003; Raitanen, Tormakangas, Mollenkopf, & Marcellini, 2003; Ruechel & Mann, 2005; Charlton, Oxley, Fildes, Oxley, Newstead, Koppel, & O'Hare, 2006). This self-restricting behavior limits their exposure. In other words, the less often a person drives, the fewer opportunities they have of crashing. Many seniors also alter their driving behavior in particular ways to limit the incidence of risky or demanding traffic situations; this may include restricting their driving to routes with lower speed limits, to routes that involve fewer turns (especially unprotected left turns), to certain times of day (i.e., avoiding driving at night or during rush hour), to days when the weather is clear, etc. (Hakamies-Blomqvist & Wohlstrom, 1998; Preusser, Williams, Ferguson, Ulmer, & Weinstein, 1998; Adler, Rottunda, & Kuskowski, 1999; Stalvey & Owsley, 2000; Baldock, Mathias, McLean, & Berndt, 2006; Kostyniuk & Molnar, 2006). It should be noted, however, that self-restricting behavior occurs at such widely varying rates across studies (Molnar & Eby, 2008) as to invite some skepticism as to the reliability of self-reported self-restricting driving behavior. Furthermore, as seniors adopt restrictions to their driving, this generally involves reducing the proportion of driving done on freeways, and consequently increasing the proportion of driving on city streets, where crashes are more likely on a per-mile basis regardless of the age of the person doing the driving (Janke, 1991; Eberhard, 2008).

Self-restriction, in turn, derives in large part from drivers' knowledge of their own limitations in vision, cognitive health, or physical frailty (Kington, Reuben, Rogowski, & Lillard, 1994; Ball, Owsley, Stalvey, Roenker, Sloane, & Graves, 1998; Johnson, 1998; Foley, Masaki, Ross, & White, 2000; Stalvey & Owsley, 2000; Dellinger, Sehgal, Sleet, & Barrett-Connor, 2001; Owsley, Stalvey, & Phillips, 2003; Dobbs & Carr, 2005; Freund, Colgrove, Burke, & McLeod, 2005; Vance, Roenker, Cissell, Edwards, Wadley, & Ball, 2006; Alvarez & Fierro, 2008; Marshall, 2008). Of course, drivers who are unaware of their limitations (or deny the relationship between a particular limitation and safe driving) are unlikely to take precautions when driving (Holland & Rabbitt, 1990). This lack of self-awareness is especially troubling for patients with dementia or other cognitive limitations (Friedland, Koss, Kumar, Gaine, Metzler, Haxby, & Moore, 1988; Kazniak, Keyl, & Albert, 1991). Self-regulation of driving is also tied to household composition (i.e., living alone versus with a spouse or other family member) and psychological factors such as feelings of independence and self-worth (Johnson, 2002; Donorfio, D'Ambrosio, Coughlin, & Mohyde, 2009). Functional limitations in vision, cognition, and physical strength or coordination are, of course, related to safe driving. The literature on this last point is quite large (but see Janke, 1994; Marottoli, Cooney, Wagner, Doucette, & Tinetti, 1994; Charlton, Koppel, O'Hare, Andrea, Smith, Khodr, Langford, Odell, & Fildes, 2004; Vaa, 2004; and Dobbs, 2005 for recent reviews of the literature and synthetic meta-analyses). In sum, crash risk among seniors is a product of the combination of at least two factors: (a) functional limitations in physical frailty, visual health, and cognitive capacity that may impair driving skill but also (b) the degree to which drivers are aware of these limitations and compensate for them by changing where, when, and how they drive.

It is undeniably the case that the frequency of driving-related impairments in physical function, vision, and cognitive health increases with age (Stelmach & Nahom, 1992; Hakamies-Blomqvist, 1993; Marottoli & Drickamer, 1993; Attebo, Mitchell, & Smith, 1996; Stutts, Stewart, & Martell, 1998; Lyman, McGwin, & Sims, 2001; Molnar & Eby, 2008). However, it does not follow that assessment of driving skill ought to be based upon age (Organization for Economic Cooperation and Development, 2001). Leaving aside variation between younger and older drivers, there is simply too much variation even *within* age groups (by gender as well as by health status) for a strictly age-based assessment system to be of any real utility (Waller, 1992; Rabbitt, 1993; Hu, Trumble, Foley, Eberhard, & Wallace, 1998; Hu, Jones, Reuscher, Schmoyer, & Truett, 2000; Baker, Falb, Voas, & Lacey, 2003; Oxley et al., 2005). Stated more plainly: some younger drivers have functional limitations that impair driving, while many older drivers do not possess substantial functional limitations that impair their driving. Even among those older drivers who

do possess driving-relevant functional limitations there is a good deal of evidence that many drivers can compensate (by, for instance, self-restricting) for their limitations (Ball et al., 1998; Owsley, Stalvey, Wells, & Sloane, 1999; Charlton, Oxley, Fildes, Oxley, & Newstead, 2003). Thus, an age-based system of assessment would likely miss some drivers who ought to be assessed, and subject substantial numbers of drivers to potentially fruitless scrutiny, while at the same time using limited resources inefficiently. Furthermore, where jurisdictions have imposed age-based assessment of driving skill, there is little evidence that such policies have produced significant reductions of motor vehicle crashes (Torpey, 1986; Levy, Vernick, & Howard, 1995; Lange & McKnight, 1996; Hakamies-Blomqvist, Johansson, & Lundberg, 1996; Rock, 1998; Grabowski, Campbell, & Morrisey, 2004; Langford, Fitzharris, Koppel, & Newstead, 2004; Langford, Fitzharris, Newstead, & Koppel, 2004). The only age-based licensing policy that shows specific results in reducing crashes and deaths among older drivers is a requirement to renew a license in a DMV office in person, rather than by mail (Grabowski, Campbell, & Morrisey, 2004).

This then argues for exploring the utility of a function-based system of driving assessment that would identify those with limitations that may affect their driving, regardless of age (Janke & Eberhard, 1998; Fildes, Pronk, Langford, Hull, Frith, & Anderson, 2000). Driving involves a multitude of competencies, however, and no single functional domain—not even vision—exerts a predominant effect on overall driving skill (Simms, 1985; Galski, Bruno, & Ehle, 1992; George & Smiley, 1999; Antsey, Wood, Lord, & Walker, 2005; Bédard, Weaver, Dārzinš, & Porter, 2008; Stav, Justiss, McCarthy, Mann, & Lanford, 2008). Thus, where jurisdictions have adopted systems of post-licensing driving competency assessment, this often involves assessment batteries that cover several domains (Diller, Cook, Leonard, Reading, Deon, & Vernon, 2001; Vernon, Diller, Cook, Reading, Suruda, & Dean, 2002; Staplin, Gish, & Wagner, 2003; Staplin, Lococo, Gish, & Decina, 2003; Kantor, Mauger, Richardson, & Tschantz-Unroe, 2004; Ball, Roenker, Wadley, Edwards, Roth, McGwin, Raleigh, Joyce, Cissell, & Dube, 2006; Fildes, Charlton, Pronk, Langford, Oxley, & Koppel, 2008; Langford, 2008; Wheatley & Di Stefano, 2008). Usually, these assessment systems incorporate some form of an on-road drive test, which has been shown both to have utility for demonstrating one's overall driving competency, as well as one's ability to compensate for a given limitation (Brook, Qustad, Patterson, & Valois, 1992; Hunt, Murphy, Carr, Duchek, Buckles, & Morris, 1997; Fox, Bowden, & Smith, 1998; Withaar, Brouwer, & Van Zomeren, 2000; Wood & Mallon, 2001; Di Stefano & McDonald, 2003; Justiss, Mann, Stav, & Velozo, 2006; Molnar, Patel, Marshall, Man-Son-Hing, & Wilson, 2006).

Furthermore, research suggests that any system of driving assessment can usefully incorporate therapeutic and educational components (Korner-Bitensky, Kua, von Zweck, & Van Benthem, 2009). These are expected to result in positive safety and mobility outcomes by (a) potentially reducing an individual's risk of crashing, and (b) potentially extending an individual's safe driving years and so preserving their options regarding personal mobility. Referral to a health professional is, in California and some other jurisdictions, sometimes called for in those cases where conditions known to affect driving are medically indicated (Lococo & Staplin, 2005; Adler & Silverstein, 2008; Fildes et al., 2008; Soderstrom & Joyce, 2008; Wheatley & Di Stefano, 2008). In many instances conditions that affect driving may be treatable, or at least to some extent managed, though medical means (Dobbs, Carr, & Morris, 2002; Marottoli, Allore, Araujo, Iannone, Acampora, Gottschaulk, Charpentier, Kasl, & Peduzzi, 2007). Alternatively, driving skill can in some cases be corrected or improved through driving rehabilitation and training—as, for instance, under the care of an occupational therapist or licensed driving instructor, or even in consultation with family members (Ranney & Hunt, 1997; Lyman, McGwin, & Sims, 2001; Eby, Molnar, Shope, Vivoda, & Fordyce, 2003; Bédard, Isherwood, Moore, Gibbons, & Lindstrom, 2004; Sommer, Falkmer, Bekiaris, & Panou, 2004; Kua, Korner-Bitensky, Desrosiers, Man-Son-Hing, & Marshall, 2007; Man-Son-Hing, Marshall, Molnar, & Wilson, 2007; Wheatley & Di Stefano, 2008). Certainly referrals to health professionals and other kinds of community resources may be necessary in situations where a driver is required to cease driving and transition to other transportation options (Carr, Schmader, Bergman, Simon, Jackson, Haviland, & O'Brien, 1991; Gilley, Wilson, Bennett, Stebbins, Bernard, Whalen, & Fox, 1991; O'Neill, 1997; Adler & Silverstein, 2008). This last point cannot be overstated; as noted by many, many authors, access to personal transportation (usually in the form of a vehicle owned and operated by a member of the household) is an important factor in the maintenance of overall health and well-being (Eisenhandler, 1993; Persson, 1993; Marottoli, Mendes de Leon, Glass, Williams, Cooney, Berkman, & Tinetti, 1997; Yasuda, Wilson, & von Mering, 1997; Harper & Schatz, 1998; Johnson, 1998; Kostiniuk & Shope, 1998; Harris, 2000; Marottoli, Mendes de Leon, Glass, Williams, Cooney, & Berkman, 2000; Fonda, Wallace, & Herzog, 2001; Stutts, Wilkins, Reinfurt, Rodgman, & Van Heusen-Causey, 2001; Taylor & Tripodes, 2001; Rabbitt, Carmichael, Shilling, & Sutcliffe, 2002; Harrison & Ragland, 2003; Banister & Bowling, 2004; Ragland, Satariano, & MacLeon, 2005; Freeman, Gange, Muñoz, & West, 2006; Windsor, Antsey, Butterworth, Luszcz, & Andrews, 2007; Oxley & Whelan, 2008).

Prior research at CA DMV

At CA DMV the research that led to 3TAS began as part of a cooperative agreement between the Department and the National Highway Traffic Safety Administration (NHTSA) starting in 1993. This arrangement led to the publication of literature reviews (Janke, 1994; Janke, 2001a) and the development of several pilot studies (Hennessy, 1995; Janke & Hersch, 1997; Janke, 2001b). These latter studies resulted in the development of an assessment battery consisting of a relatively small set of tests covering a range of functions, suitable for use in an agency setting (Janke & Eberhard, 1998; Hennessy & Janke, 2005), which also incorporated a substantial educational component (Kelsey & Janke, 2005). It was also through these studies that the concept of a "tiered" system was developed, whereby only those customers demonstrating some evidence of limitation on an initial (simple and efficient) battery of assessments would be subjected to further, more complex, assessment in concert with education and possible referral. This "tiered" aspect was deemed particular useful in an agency context, where it would be inefficient to subject all drivers to extended assessment. For further details on the technical background and theoretical concepts which undergird 3TAS, see Hennessy & Janke (2009).[1]

Description of the 3-Tier Pilot as Implemented

Organizational Preparation for the Pilot

THE 3-TIER TASK FORCE

On December 1, 2005, R&D convened the first meeting of the 3-Tier Task Force. The purpose of the Task Force was to plan the baseline and pilot phases of the 3-Tier Pilot, to negotiate and coordinate any changes to policies and procedures affected by the implementation of the pilot, to schedule the installation of new resources and the training of personnel, and to inform affected branches within DMV of the project and what it would require. This first meeting was itself a product of six months of planning after an initial "kick-off" program meeting in late May 2005. Participants in the 3-Tier Task Force, which met for 10 months, included representatives from a number of branches and divisions within DMV: R&D, Field Operations Division (FOD),

[1] This last manuscript was not published at the time of the drafting of the present report. In making use of the department's own research findings, the author has drawn upon those analyses and arguments found in, especially, Janke (1994, 2001), Janke & Hersch (1997), Janke & Eberhard (1998), Kelsey & Janke (2005), and Hennessy & Janke (2005). The author has also benefitted from personal communication with David Hennessy on certain technical questions regarding specific assessment tests, as well as the general theoretical background of 3TAS.

Licensing Operations Division (LOD), Driver Safety Branch, Departmental Training Branch (DTB), and Legal Affairs Division.

Because of certain then-anticipated changes to DMV license renewal procedures associated with non-3-Tier programs and policies, several meetings of the task force were dedicated to discussion of how 3-Tier procedures would (or would not) intersect with these changes. This included potential automation/computerization of the written test of the rules of the road (which ultimately did not occur during the pilot period). Most critically, however, the task force spent a number of sessions discussing those procedures associated with implementation of DMV's on-road tests of driving skill. These discussions were deemed necessary in part because 3TAS was expected to increase the number of drive tests administered to license renewal customers. In particular, it was expected that the 3-Tier Pilot would involve the administration of two types of drive tests: the Supplemental Driving Performance Evaluation (SDPE), and the Area Driving Performance Evaluation (ADPE). The ADPE, in particular, is administered somewhat rarely under current FOD and Driver Safety procedures. Because of the rarity of the ADPE, Task Force members dedicated a great deal of effort to discussing the potential necessity of additional staff time and positions, additional training for the Licensing Registration Examiners (LREs) who administer the on-road drive tests, the specific procedures to be followed in case of test failure, and the brokering of communication between different branches for those Driver Safety referral customers enrolled in 3-Tier and given an on-road test in a field office.

ORGANIZATIONAL COORDINATION DURING THE PRE-PILOT PERIOD

In addition to convening the 3-Tier Task Force, R&D met with internal stakeholder groups for the purposes of planning and coordinating of the pilot. Because of the complexity of the project, R&D communicated with a number of other DMV branches and divisions that were not included in the 3-Tier Task Force. This included FOD Facilities Coordination (regarding the installation of new tools and equipment), FOD PC/LAN Support (regarding electronic data storage and retrieval), LOD PC/Automation Support (also regarding electronic data storage and retrieval), and DMV's Senior Ombudsman Office (regarding potential questions and concerns from members of the community during the pilot itself).

R&D and other members of the 3-Tier Task Force visited potential 3-Tier Pilot office sites within FOD Region III. This included two offices (Stockton and Lodi) that were considered for

inclusion in the pilot but ultimately not used; Folsom and Sacramento-South were substituted in their place on the basis of input from FOD Region III management.

R&D also met with external stakeholder groups potentially affected by the pilot. In conjunction with DMV's Labor Relations Branch, R&D met with representatives of SEIU Local #1000, the union that represents rank-and-file DMV staff, to discuss the program's potential impact on staff working conditions and workload. In conjunction with DMV's Senior Ombudsman Office, R&D met with representatives of the California chapter of the American Association of Retired Persons (AARP), to discuss any potential concerns from seniors about the impact of the program on individual mobility.

IDENTIFYING POTENTIAL USERS OF THE 3-TIER PROCESS

In addition to those directly involved in either the planning or the coordination of the 3-Tier Pilot, there exist a number of additional stakeholder groups. Per the principles of utilization-focused evaluation (Patton, 2008), during the planning and implementation phases of the 3-Tier Pilot R&D communicated with these groups. This included: those with decision authority over the program, those with direct responsibility for the program, those who are the intended potential beneficiaries of the program, and those who might be potentially disadvantaged by the program.

Those with decision authority over the program include executive management of CA DMV, policy makers, and funders. In the specific case of the 3-Tier Pilot program, these parties included the sponsor of the authoring legislation for the 3-Tier Pilot, former Assemblywoman Lynn Daucher, currently (2010) Director of the California Department of Aging; also, the California Office of Traffic Safety (CA OTS), which provided the funding grant and received quarterly reports of the progress of the 3-Tier Pilot. Within the DMV these parties included the Director of the Department, the Chief Deputy Director, the Deputy Directors of Field Operations Division (FOD) and LOD, the Assistant Deputy Director of FOD, and the Chief of the Driver Safety Branch of LOD. All of these parties were kept informed of the progress of the 3-Tier Pilot through memorandums as well as periodic meetings throughout the planning, implementation, and analysis stages of the project.

Those with direct responsibility for the program included the developers of the pilot, administrators, managers, and direct service staff. For 3-Tier, this consisted of all members of the Task Force, the Administrator of Region III of FOD and her administrative assistant, the

Manager of the Sacramento Driver Safety Office (DSO), the Office and Administrative Managers of all six pilot field offices, and all of the Field Office and Driver Safety staff who participated in the pilot. All of these parties had intimate knowledge of the progress of the pilot precisely because of their responsibility for implementation. In addition, R&D has conducted presentations of the findings from this process analysis to some of these groups, at their invitation.

Those who comprise the intended beneficiaries of 3-Tier include all those customers who participated in the pilot program, their families, and other road users. To the degree that 3TAS results in fewer traffic crashes and violations, all licensed California drivers will benefit from improvements to the safety of California's driving population.

Utilization-focused evaluation also requires the identification of those parties potentially disadvantaged by the program being evaluated. There exist no groups that were directly and negatively impacted by the pilot. However, part of the evaluation analysis estimates any potential impacts, in the event of implementation, on the mobility of individual drivers. These potential impacts might include delays in renewal due to extra assessment, restrictions to the driving privilege placed on the license, or suspensions and revocations of the driving privilege.

This process analysis serves as one of the primary methods of communication of the evaluation findings to those stakeholders with direct participation in the program. In addition to the publication of this document, certain sub-components of the process evaluation incorporated specific feedback from directly involved parties. This includes the interviews and surveys conducted with Field Office and Driver Safety staff and management, as well as the survey conducted of customers participating in the 3-Tier Pilot.

WRITING GRANT REQUEST TO CALIFORNIA OFFICE OF TRAFFIC SAFETY (OTS)

R&D applied for, and was awarded, two grants from CA OTS with regard to 3-Tier: OTS Grant #TR0703 and OTS Grant #TR1015. The first grant, for $1,432,046, provided the funding for the implementation of the 3-Tier Pilot and the analysis associated with this process evaluation. The second grant, for $252,419, will provide funding for the analysis of the outcome data.

BASELINE PERIOD DATA COLLECTION

In order to establish a control group, data were collected for five months on customers renewing their licenses in the six offices that were later to serve as pilot offices. Baseline customers included anyone renewing a basic class C (non-commercial) license in a pilot field office on or after 9/1/06 but before 1/31/07, who were required to take the written renewal test and chose to do so in English, and who completed that application before 3/31/07. This time period was the same length as that of the pilot. Data were also collected for any customer referred from DSO to any of the six pilot field offices for an on-road drive test during this period. The purpose of the baseline data collection was to sample a group of drivers for comparison with the 3-Tier Pilot customers, who possessed similar demographic characteristics and driving environments. These drivers could then be used to estimate the effects, if any, of 3TAS on crashes, violations, and licensing outcomes.

To accomplish this data collection, FOD directed the managers of the six pilot offices to collect certain information on renewal applicants and referrals from Driver Safety. This included, for renewal customers:

- The applicant's DL44 or DL1RN, which constitute the physical application form for license renewal, and
- A copy of the applicant's "test results," a computer-generated printout of the customer's application status, generated for every customer taking a written renewal test.

For referral customers, the documents included:

- The applicant's DL11D, a form used by Driver Safety to indicate to the drive-test examiner the type of drive test to be conducted as part of a customer's referral process, as well as the reason for the referral. The latter information may be used in conjunction with specific drive test elements related to a customer's identified condition, disease, or referral circumstances. The second page of the form contains space for the examiner to provide a qualitative summary of the results of the drive test.
- The DL11D generated for any customer referred from Field to Driver Safety for (for instance) potential physical limitations or self-reported medical issues.

For any customer that took a drive test (renewal or referral), the documents collected included a copy of the score sheet used by the examiner to rate their driving skill. Also, for any drive test customer who possessed the 3-Tier criteria listed above, field office staff were asked to fill out a cover sheet created by R&D. This form, titled "Drive Test Information Form" included the following information:

- What type of drive test was conducted (DPE, SDPE, or ADPE),

- Whether the drive test was the first, second, or third such test,
- The reason for the drive test (on a limited-term license, failed the department's visual acuity standard, or was a Driver Safety referral), and
- The outcome of the drive test, including various licensing options in the case of passing (or satisfactory) results: restricted versus unrestricted license, full versus limited term license. Also listed were the various options available in the case of failure (or unsatisfactory results): scheduling of a subsequent test, suspension or revocation, referral to Driver Safety, etc.

All of these forms were then sent to R&D, on a weekly basis. All data collected from the field offices were then converted to electronic format, first in a series of MS Access databases, then to SPSS format suitable for basic and advanced quantitative analysis.

In addition to these data from the field offices, R&D requested from DMV Audits office certain records relating to the transactions conducted in the six pilot field offices for any 3-Tier eligible customer renewing their license during the baseline period. These data were delivered to R&D in secure electronic form, for the purposes of cross-checking the hard copy data received weekly from the field offices. R&D retained only those records for which we possessed both (a) a hard copy of the customer's application form and/or their test results screen printout, and (b) a record of their transaction in the data delivered by CA DMV Audits. Because of the nature of the data generated by Audits, these records were only used to cross-check what was generated for renewal customers from the field offices. Cross-checking and data-cleaning for referral customers occurred primarily by hand, to ensure that only those customers who qualified as 3-Tier eligible were retained for analysis. The primary data for exclusion included the following: any customer who possessed a license other than class C (non-commercial), any customer with an endorsement (i.e., for driving an ambulance, paratransit vehicle, or motorcycle) any customer who took a DPE drive test, any customer referred for a drive test as a result of a "Brandi Mitlock" lapse of consciousness case, any customer referred by law enforcement for a priority re-examination, and any customer whose referral case appeared to date from prior to the beginning of the baseline period.

In the original design of the project, it was anticipated that the authors would conduct a customer service satisfaction survey of pilot participants. This survey was done, and the results are presented in brief in the results section of this process report (pp. 137-138) and at more length in the Module 3 of the Appendix to this report. It was also anticipated that we would compare the results of the survey of pilot participants with the department's normal periodic survey of all

driver license and vehicle registration customers. Given the low response rate for the latter, as well as certain related issues regarding sample comparability, it was decided not to pursue this second analysis.

After the specific dates for the baseline period were settled upon, it was determined that the customer load in the field offices during the baseline period was substantially different from other times, and specifically quite a bit lower as compared to the pilot period. Starting in 1997, CA DMV lengthened the renewal period for basic Class C (non-commercial) licenses from a four-year cycle to a five-year cycle as part of a larger set of cost-saving measures. No effect was anticipated on traffic safety. However, this policy shift had the unintended effect of producing a dramatic decline in the number of customers seen in the field offices every fifth year starting in mid-2001. This decline appears as a distinct "trough" in the trend-line of customers processed on an annual basis in the field offices (these troughs do not coincide with the calendar year, but rather with the fiscal year, and so run from approximately July through June). The baseline period (September 2006 through January 2007) fell precisely into one of these troughs in the license renewal cycle, while the pilot period (June through October 2007) did not. Not only did this result in a substantial difference in customer load between the two periods, but there is strong evidence that the type of customer processed during baseline was quite different from that processed during the pilot. On the basis of evidence presented later in this report (pp.106-107 it appears that regular-term customers renewing their license during baseline were substantially younger, somewhat more likely to be male, and substantially more prone to violations, as compared to customers renewing during the 3-Tier Pilot period. Limited-term renewal customers and Driver Safety referral cases, however, do not appear to be statistically different from each other across the two cohorts.

ORGANIZATIONAL COORDINATION DURING THE BASELINE PERIOD

During the baseline period, R&D worked with several internal stakeholder groups to ensure both quality data collection and adequate preparation for implementation of the pilot. This meant meeting with FOD management (including the Region III administrator), LOD management (particularly Driver Safety Branch management), and the manager of the Sacramento office of Driver Safety. To assist with the day-to-day details of organizational coordination and project implementation, three liaison staff were hired around this time. All three liaison staff were hired as full-time for R&D, though "on-loan" from their respective home divisions (FOD and the Training Branch of Administrative Services Division). These staff took primary responsibility for distribution and installation of new equipment, as well as the coordination and actual conduct

of the training required in new 3-Tier processes and procedures. In addition, one of the liaison staff took responsibility for monitoring local and state media for stories regarding 3-Tier, and the construction of a database of newspaper articles and television coverage on the project.

Distribution and installation of new equipment, educational materials, and forms

A great deal of new equipment associated with the various assessment tests was distributed to the pilot offices during the months just after the baseline data-collection period, in preparation for pilot implementation. This included:

- The installation of Pelli-Robson charts at each of the offices, as well as some subsequent adjustment of chart locations based on staff input regarding variation in ambient light.
- The installation of computer hardware (computers and touch-screen monitors) necessary for the Perceptual Response Test (PRT). The software for this test was provided on contract by Transanalytics, LLC and installed on-site.
- The distribution of electronic scanning machines to each office, for use in the storage of all personally sensitive customer data on a secure central server.

In addition to hardware and computer software, the pilot required a raft of new educational materials and data-collection forms for use during implementation. Each office was supplied with the forms used to collect assessment outcome data (the Tier 1 Score Sheet and 3-Tier Tracking Sheet); DVDs of the experimental educational intervention component of Tier 3, as well as paper handouts containing the same information (these materials were developed by R&D and DMV Audiovisual Services); copies of "On The Right Track," a pamphlet developed by R&D specifically to advise 3-Tier customers about how to prepare for an on-road drive test, and DVDs about 3TAS for use in refresher training of pilot office staff. As a general matter, the liaison staff handled the distribution of these materials to the pilot field offices.

Training of 3-Tier Pilot office staff and managers

In the three months leading up to pilot implementation (March-May 2007), training was conducted for all managers and staff involved in the 3-Tier Pilot. The majority of training was conducted by R&D, with the lead participation of the three liaison staff, at CA DMV headquarters in Sacramento. Additional individuals participated as necessary, depending on the subject matter; this included representatives of FOD Staff Services Branch and Driver Safety Procedures Unit. DTB also participated in the development and delivery of certain portions of the training classes. This training covered all aspects of 3TAS: from background and overview of the project, to the changes to current processes and procedures required by the project, as well as the new processes and procedures that 3-Tier entailed. Training was conducted in sessions of

varying length, depending on the staff being training and the subjects covered; sessions lasted from a minimum of 2 hours to a maximum of 16 hours (conducted over 2 work days). The topics covered, participating staff, and hours required are detailed in Table 1.

Table 1

Training Classes Conducted for the 3-Tier Pilot

Class	Dates (hrs.)	Participant titles/position (*N*)
Field Office Manager overview	March 20 (2 hrs.)	FOD Region III Regional Manager (1), FOD Region III Assistant Manager (1), Field Office Managers (6), DTB Trainers (3)
Administrative Manager overview	March 20 (4 hrs.)	Field Office Administrative Managers (6), FOD Staff Services Manager (1), DTB Trainers (3)
Driver Safety Manager and Hearing Officer overview	March 28 (3 hrs.)	DSO Manager (1), Driver Safety Manager I (2), Hearing Officers (17)
Hearing Officer procedures	March 28 (3.5 hrs.)	Driver Safety Manager I (2), Hearing Officers (17)
Field office counter procedures	April 3-5, 10-11, 26, and May 7 (4 hrs.)	Office Manager (1), Manager I/II (15), Administrative Manager (2), Manager Trainees (4), LRE (16), Senior Motor Vehicle Technicians (5), Motor Vehicle Field Representatives (77), Control Cashiers (5), DTB Trainers (2)
Drive Test Examiner procedures	April 16-17 and April 23-24 (16 hrs.)	Manager I (1), LRE (13)
3-Tier Manager 1 procedures	April 19-20 (16 hrs.)	Manager I (8), Manager II (4), Manager III (2)
PRT procedures	April 30 (2 hrs.)	Manager I (6), Administrative Manager (6)
Use of scanners, secure data storage	April 23-24 (1.5 hrs.)	Manager I (8), Administrative Manager (6)

R&D, in consultation with DMV DTB, also developed materials for “refresher” training to be delivered during implementation. This included orientation of new employees hired into the field offices while 3-Tier was occurring, as well as enhanced/follow-up training of current employees for the purposes of quality control. The topics covered, and hours required for the following-up

training are detailed in Table 2. As a general matter, these follow-up training sessions were conducted in the field offices or, in the case of Driver Safety, at DSO.

Table 2

Follow-Up Training Classes Conducted for the 3-Tier Pilot

Class	Dates (hrs.)	Participant titles/position (*N*)
Counter procedures for employees new to DMV or to a 3-Tier office	May 9th, July 24th and August 22nd (3 hrs)	Motor Vehicle Field Representatives (11)
Orientation for managers new to a 3-Tier office	July 26th (2 hrs.)	Manager I (2)
Refresher training for field office employees	July 18th and 25th, and August 1st (1 hr.)	All 3-Tier field office employees
Use of Optec 1000 for visual acuity assessment	May 23rd (1 hr.)	Senior Motor Vehicle Technicians (3), Hearing Officers (12)
Refresher training for Driver Safety	May 16th (1 hr.)	All 3-Tier Driver Safety employees

Mailing to potential 3-Tier customers prior to their field office visits

The final step in preparing for the implementation of the 3-Tier Pilot involved informing potential customers. All potential 3-Tier customers received an announcement (DL83 insert) in their renewal notice. The DL83 came with the wording shown on the opposite page.

Those customers who received this notice included anyone living within certain specified zip codes surrounding the six pilot field offices, whose license was up for renewal during or just prior to the pilot period (May through September, 2007), who (i) was required to renew their license via an office visit (as opposed to renewing by mail), and (ii) possessed a Class C license with no endorsements, and (iii) was required to take both the written knowledge test and the visual acuity assessment. Limited-term license holders who were required to pay a fee at this renewal cycle were also notified of the pilot via this method.

NEW DMV ASSESSMENT TOOLS

In keeping with a new law, CA DMV is piloting some new assessment tools (described below). They will be used in making licensing decisions during a pilot program that runs in selected Northern California field offices from May through September, 2007. The new assessment tools include:

1. Observation for any physical limitations that could affect safe driving.
2. A cognitive exercise that will require you to recall in writing your Social Security Number (SSN), or your zip code if you have never been issued a SSN.
3. A vision test that measures contrast sensitivity. Contrast sensitivity refers to the ability to see objects as distinct from their background, such as a dark car parked in the shade or a light car in the fog. You will be referred to a vision specialist for further evaluation if your test results indicate a severe reduction in contrast sensitivity.
4. PRT. This is a computer-based test that measures how well you process visual information, by identifying silhouettes as belonging to either a truck or a car. The PRT test is reserved for applicants who do not perform well on the standard tests and/or the new assessment tools.

Failure on any of the standard tests and/or the new assessment tools listed above may require a behind-the-wheel road test.

Description of 3TAS

3TAS consisted of a series of nested, or tiered, screening tests. Potential participants in the pilot were first identified as "3-Tier eligible" at the Start Here Station—the initial counter where CA DMV customers first take their queue ticket upon entering a field office. Depending on what a customer communicated to the DMV staff person working the Start Here Station, as well as what was contained in their renewal notice, staff identified as 3-Tier customers all those who were (a) required to renew their license in a field office (as opposed to having the option to renew by mail), and who were (b) required to re-take the written knowledge test as part of their renewal, who were (c) renewing a basic Class-C (non-commercial) license, and who were (d) conducting their transactions in English. All of these customers then experienced Tier 1 of the 3-Tier process, and took the written knowledge test as part of Tier 2. If on any of these first assessment screens a customer showed evidence of any potential cognitive, physical, or visual driving-relevant limitations, they might then be asked to participate in additional screening as part of Tiers 2 or 3.

THE TIER 1 ASSESSMENT TESTS

The Start Here Station procedure

Upon entering a field office, customers typically "take a number" at the Start Here Station at the front of the office. Tickets are issued by the staff attending the Start Here Station on the basis of transaction type: basic, or non-commercial license original, renewal, or duplicate applications; commercial license original and renewal applications; individual (non-commercial) vehicle registration; commercial/dealer transactions, etc. These different transaction types are grouped under different alphanumeric codes.[2] Almost all 3-Tier customers were conducting basic Class C (non-commercial) license renewals, with the exception of Driver Safety referral customers, who made their field office visit through a different process (see below). If identified as a 3-Tier customer by the staff at Start Here (i.e., because of the presence of the DL83 form with their DL1RN renewal notice), or as a potential 3-Tier customer (i.e., because they had completed a DL44 form indicating that they were applying for a basic Class C license renewal) staff would remind customers verbally that they might be asked to participate in additional assessment screening as part of the 3-Tier Pilot. In particular, the staff who worked on the 3-Tier Pilot were trained to inform customers that they might be asked to write down their SSN from memory.

As their ticket number was called on the overhead monitor, customers would then find the terminal to which their ticket had been assigned. Once at the terminal, their license renewal transaction would begin, including the various elements of Tier 1 of 3TAS.

The memory recall assessment screen

To start, staff would first determine if the customer was eligible to participate in the 3-Tier Pilot. If so, the staff would then administer the memory recall assessment by asking the customer to write down their Social Security number from memory. They would usually ask the customer to do this on the reverse side of the customer's license renewal paperwork; this was later shredded to protect customer privacy. If a customer could not remember this number without prompting (i.e., if they had to look it up in their personal effects), the technician would assign a "1" in the

[2] The precise combination of codes and transaction types are subject to some degree of managerial discretion at the office level. In general, non-commercial license renewals were grouped under "F" and "G" tickets, unless the customer required additional assistance (e.g., for a physical disability), in which case they might be issued a "J" ticket. Non-commercial original and duplicate applications are typically grouped together with non-commercial renewal applications under the same alphanumeric code.

appropriate box in the customer's Tier 1 Score Sheet. If the customer performed this task correctly, the technician would enter a "0."[3]

Observation of the upper body for physical limitations

Second, the customer would complete any paperwork needed for their renewal (such as the remainder of their DL44 application), and fill out the Driving Information Survey. The latter survey was optional; customers only rarely declined to fill this out, and the non-response rate was approximately 3%. During these portions of the transaction the technician would observe the customer for potential upper-body physical limitations that might relate to driving. These included:

- The loss of the use of an arm or a hand
- Any obvious shaking
- Any obvious stiffness
- Other obvious physical limitations in the arms, hands, neck, or trunk.

The presence of any one of these—or combination, if more than one existed—would be noted with a "1" in the appropriate box on the Tier 1 Score Sheet. Staff were trained to mark the presence of these limitations separately—so, for example, difficulty moving one's neck (an example of "obvious stiffness") would be marked separately from a non-functioning arm.

Visual acuity screen on the Snellen chart

Third, the technician would administer the department's visual acuity screening standard. This assessment (which occurs as part of the regular, non 3-Tier renewal process as well) consists of a Snellen chart modified to fit the distance from the technician's terminal. Every Snellen chart in a CA DMV field office is designed to assess visual acuity at approximately 20/40 (or better). Customers are asked to correctly identify the letters on the chart first with both eyes, then with each eye singly. If a customer fails this screen they may be given the opportunity to pass it on a different chart, or to attempt it on an Optec 1000 Vision Tester—a small, desk-mounted binocular device.

[3] In some cases, customers may have been ineligible for, or simply not possess, a Social Security number. In these cases the technician was trained to ask the customer to write down their ZIP code. If a customer refused to perform the task—an eventuality that in fact almost never occurred in practice—the technician was instructed to assign the customer a score of "1" (failing).

If a customer was wearing visual correction devices (e.g., contact lenses or glasses), and could not pass the visual acuity screen without them, their license was amended to include a vision restriction. This states simply that the license holder "must wear corrective lenses while driving."

If a customer could not pass the visual acuity screening standard in the field office despite correction, in most cases they were given a DL62 referral form. This requires that the customer undergo professional evaluation by a vision specialist. These forms are quite detailed, including not simply the measurement of visual acuity but also the diagnosis and prognosis of a range of visual conditions. The customer's chosen doctor (ophthalmologist, optometrist, etc.) completes this paperwork, which the customer brings with them upon their next visit to the DMV.

In many cases, this referral for professional evaluation resulted in a new prescription for visual correction. If, however, even after professional evaluation and correction a customer could not achieve the department's minimum standard for visual acuity (20/40 in both eyes, or 20/70 in one eye alone), they were marked as failing the visual acuity assessment. [4] Failing the visual acuity screen generally results in a customer being asked to demonstrate their ability to drive safely despite this vision limitation; or in other words, to take an on-road drive test. As a general matter, if a customer's visual limitation is the result of a stable condition, they are only required to take an on-road drive test *once* to demonstrate their ability to compensate for this limitation. After that, the presence of a stable "long-standing vision condition" is noted on their driver record. Customers with long-standing vision conditions are not normally required to fill out a DL62 at each renewal; neither are those customers with vision restrictions on the licenses. Those who failed the visual acuity assessment were not generally given the contrast sensitivity assessment screen.

Contrast sensitivity screen using the Pelli-Robson "fog chart"

Fourth, assuming a customer passed the visual acuity screening standard, they were assessed for potential contrast sensitivity limitations on a Pelli-Robson chart (Pelli, Robson & Wilkins, 1988). If a customer could not identify all the letters on Line 1 (the topmost line) or Line 4, the technician marked the appropriate box on their Tier 1 Score Sheet with a "2." If the customer could not identify all the letters on Line 5 (out of six), the technician marked the appropriate box

[4] The department also has an absolute minimum standard. If a customer cannot achieve 20/200 acuity in at least one eye despite correction, the department will not issue a driver license.

on their Tier 1 Score Sheet with a "1." If a customer could identify all letters on Lines 1, 4, and 5, the technician marked each of the appropriate boxes with a "0."[5]

If a customer scored a 2—an "extreme" (or frank) fail—on the contrast sensitivity assessment, they were given a DL62 referral form and asked to undergo professional evaluation by a vision specialist. They were also given a DL960 form, which informed the ophthalmologist or optometrist that this customer might have a condition that affected their contrast sensitivity.

Observation of the lower body for physical limitations

The fifth and final component of the Tier 1 assessment tests consisted of the technician observing the customer for potential physical limitations in their lower body. These included:

- Being unable to walk unaided
- The loss of the use of a leg or a foot
- Obvious shaking
- Obvious stiffness
- Other limitations in the legs or feet.

A technician might observe these at any time during the transaction; in most cases they watched a customer's gait and carriage while walking to the video capture station for the purposes of taking the photo image of the customer for their license. The presence of any one of these potential driving-relevant limitations—or combination, if more than one existed—would be noted with a "1" in the appropriate box on the Tier 1 Score Sheet.

At the conclusion of the renewal transaction process, the technician would then sum the scores contained on the Tier 1 Score Sheet. These scores were summed both within the three functional domains (Memory, Physical, and Contrast Sensitivity) and across domains, for a combined score. These four scores were then transferred by the attending DMV staff person to a "3-Tier Tracking Sheet."

[5] As with the memory recall test, if a customer refused to perform this task—an eventuality that in fact almost never occurred in practice—the technician was instructed to assign the customer a score of "2" (extreme fail).

THE TIER 2 ASSESSMENT TESTS

The written test of the rules of the road

All customers would then advance to Tier 2 and take the written knowledge test.[6] According to standard CA DMV Field Office procedures, applicants who must take the written test as part of their renewal process are required to take the shortened (18-question) test, rather than the full (36-question) version (Masten, 1998a; Reiner & Hagge, 2006). On this test, customers may miss up to three questions. If a customer passed on the first or second attempt, and had no identified limitations at Tier 1—i.e., their summed score from the Tier 1 Score Sheet was 0—their license was renewed and their participation in 3TAS was terminated.

In most cases, customers took the written test on the same day of their initial visit to the field office. Customers were encouraged to study the *California Driver Handbook* in preparation for taking the written test. If a customer failed the test, they were encouraged to study the *Handbook* and the questions they missed on their corrected test. In practice, many customers who failed their first attempt then made a second attempt on the same day. In cases where a customer failed twice, they were encouraged to come back to the field office on another day, after additional studying. In cases where a customer failed three times, they were required to submit a new application for license renewal and re-pay their renewal fee.

The PRT

Any customer that failed the written test at least twice, as well as any customer with a total score of 1 or more on their Tier 1 Score Sheet, was asked to take the PRT, a computer-based screening test of visual function. This test is part of a larger battery of screens for visual and cognitive function (the Useful Field of View, or UFOV).

The PRT required that a customer use a computer touch-screen to correctly identify schematic images of cars and trucks. These images were "flashed" on the screen, alone, with no other distracting information. This image was then followed by a screen of randomized white and black visual noise, the purpose of which was to remove any after-image on the test-taker's retina. After this "snow" screen, the customer had to select which of the two images—car or truck—had

[6] All 3-Tier customers, by definition, took the written renewal test in English. If a customer elected at any point along the assessment process to take the written renewal test in some other language, they were excluded from the pilot. For a discussion of the methodological and process implications of this exclusion, see the results section (pp. 180-182).

previously appeared on the screen. The test program varied the amount of time the images appeared on the screen, from a minimum of 17 milliseconds to a maximum of 500 milliseconds. By doing so, the computer algorithm would establish the minimum amount of time the test-taker required to reliably identify the flashed images. This minimum time was measured as the interval at which a customer could correctly identify the images at least 75% of the time. A customer's score on this test thus varied from 17 to 500 (milliseconds). This score constituted an indirect measure of the processing speed of the visual system (Janke & Hersch, 1997). In other words, the score on this test measured the amount of time someone needed to identify something of which they had only a brief glance. The amount of time a customer took to make their choice and press the screen—in other words their reaction time—had no bearing on their final score. However, in cases where a customer took longer than 2 minutes to complete the test, the program was preset to abort and the customer was assigned a failing score. In the traffic safety and public health literature, this test has been found in multiple studies to be reliably associated with the early stages of dementia-type cognitive disorders (Owsley, Ball, Sloane, Roenker, and Bruni, 1991). More specifically, performance on this test has also been found to predict crash risk (Clay, Wadley, Edwards, Roth, Roenker, & Ball, 2005; Hennessy, 1995).

Customers could achieve one of three outcomes on this test. A "pass" included scores of between 17 and 23 (milliseconds). A "somewhat fail" included scores between 24 and 40. An "extreme" (or frank) fail included any score above 41. The program was also designed to time out (i.e., abort) after a certain period (2 minutes); any customer that could not complete the test within that period was assigned a failing score. During the actual pilot, it appears that customers often took the PRT multiple times, especially in cases where they were not satisfied with their initial scores.[7]

Once a customer had passed their written test and (if called for) taken the PRT, the attending staff person consulted a rubric on the 3-Tier Tracking Sheet to determine if the customer would

[7] The computer program did include a practice module, which every customer had to complete before taking the test. In some cases customers appear to have regarded their first test attempt at the PRT as their "practice" session, with a second (or later) session counting as their "final" score. In all cases, only one score was recorded for each customer—this being whichever score was recorded by the attending staff person. Anecdotally on report from staff interviewed for this evaluation (see Appendix Module 3), it appears that staff would allow customers to take the PRT as many times as they (the customer) felt necessary, with the last and final score typically being the one that "counted" for the purposes of the pilot. As an additional matter, staff reported that it was usually older customers who requested the opportunity to re-take the PRT multiple times, either because they were unused to working with computers (and so wanted to "practice"), or because they misunderstood the instructions for the test the first time they attempted it.

advance to Tier 3, or be issued their license immediately. The various scores from Tiers 1 and 2 resulted in the following combinations of outcomes:

- If a customer had a score of 1 that resulted from a potential physical limitation identified at Tier 1 through the upper and lower body observation, AND they had passed the PRT, they were issued their license and their participation in the pilot was terminated.
- If a customer had a score of 1 that resulted from a potential cognitive limitation identified at Tier 1 through the memory recall test, AND they had passed the PRT, they were issued their license and their participation in the pilot was terminated.
- If a customer had a score of 1 that resulted from a "somewhat fail" on the contrast sensitivity assessment, AND they had passed the PRT, AND their driver license ended in an even digit, staff were trained to issue the customer their license immediately and terminate their participation in the pilot.
- If a customer had failed the visual acuity test, and CA DMV did not have record of a long-standing stable vision condition, they were assessed at Tier 3.
- If a customer had a combined score at Tier 1 of 2 or more—meaning they had been identified as possessing multiple potential physical, visual, or cognitive limitations, or they had scored an "extreme fail" on the contrast sensitivity assessment—they were assessed at Tier 3.
- If a customer "somewhat failed" either the Pelli-Robson contrast sensitivity assessment or the PRT AND their driver license number ended in an odd digit, they were assessed at Tier 3.
- If a customer scored an "extreme fail" on the PRT, they were assessed at Tier 3.
- If a customer failed the written test three or more times, they were assessed at Tier 3.

THE TIER 3 ASSESSMENT TESTS AND INTERVENTIONS

Educational intervention

Two components of 3TAS were strikingly new to most participants: the Pelli-Robson contrast sensitivity chart (Tier 1) and the PRT (Tier 2). Both of these assessment screens test for visual abilities about which many customers may be unfamiliar—particularly in respect to their importance for driving. Furthermore, as a result of indications from earlier research (Hennessy & Janke, 2005), a hypothesis was developed that persons in the early, or mild, stages of progressive vision disorders might be unaware of their limitations. This might lead, in turn, to an elevated

risk for crashes (Hennessy, 1995; West et al., 2003) due to the lack of compensating self-regulation.

Following the idea that some customers might be unaware of their own limitations, and so unaware of the kinds of strategies they might adopt to make their own driving more safe, two short (four-minute) educational videos were developed. These videos discussed the nature of the underlying limitation (either contrast sensitivity or perceptual speed) and the kinds of driving strategies appropriate to compensating for such a limitation. A customer would watch these videos with a designated member of the office managing staff (the 3-Tier Manager I for each office, or their back-up if they were not present). The attending staff person was trained to answer questions and provide verbal explanations for the materials presented in the videos.

In order to more rigorously assess the impact of watching the videos on subsequent driving behavior, an experimental protocol was developed to govern the distribution of this educational intervention. Specifically, staff were trained to distribute the video (and the associated printed matter) only to those customers who somewhat failed the contrast sensitivity assessment, or who somewhat failed the PRT, and who also had a driver license that ended in an odd digit. Customers who somewhat failed on either test, but had a driver license that ended in an even digit were intended to serve as a control group, and were not supposed to be shown the videos. In addition, the videos were not supposed to be distributed to customers having any other combination of physical, cognitive, or visual assessment flags. Through this randomizing experimental protocol, it was hoped that other variables might be controlled for, so that the potential traffic safety benefit of this educational intervention might be more rigorously estimated.

As it happens, staff found the educational intervention materials to be quite useful as customer service tools (i.e., for answering questions, calming potential anxiety, etc.), especially for those customers who were required to take a drive test. This revealed a previously-unforeseen use for these materials, though it also had serious implications for the rigor with which the randomizing experimental protocol was followed (see below, pp. 121-122, for more details).

Once a customer had seen the video, and assuming they had no other identified driving-relevant limitations and had passed their written test of the rules of the road, they were issued their license and their participation in the pilot was terminated. If, however, the customer had failed other portions of the Tier 1 or Tier 2 assessment screens, their participation in the program continued.

Pre-drive test counseling

If a customer, for whatever reason, was required to take an on-road drive test as part of their participation in 3TAS, they first met with a member of the field office managing staff (the 3-Tier Manager I or their designated backup). If the customer was enrolled in 3TAS as a result of a referral to the Driver Safety Office, this meeting occurred as part of their contact with a Driver Safety Hearing Officer. Regardless of which staff person (3-Tier Manager I or Hearing Officer) conducted the meeting, it included a number of components.

First, the driver was presented with drive test education and study materials. These included the *California Driver Handbook*, the standard brochure distributed to all DMV customers to help them prepare for any of the tests (written or on-road) which the department requires of non-commercial Class-C drivers.[8] Customers were also given certain drive-test specific materials that CA DMV Field Office and the CA DMV Driver Safety Branch provide to those who are asked to take an on-road drive test. Customers also received a brochure entitled "On the Right Track;" this was developed specifically for the 3-Tier Pilot program, to cover various pilot-specific questions and concerns (such as why customers were being asked to take an on-road test).

Secondly, the 3-Tier Manager I (or Driver Safety Hearing Officer) would query the customer about their normal driving habits, in order to determine what type of drive test was most appropriate for them. These "Pre-Drive Scope of Driving Questions" included:

- Do you ever drive 15 miles or more from your residence?
- Do you drive on longer trips, for 45 minutes or more at a time?
- Do you ever drive on the freeway or on highways with speed limits of 55 mph or more?
- Do you ever drive during heavy traffic?
- Do you ever drive to unfamiliar areas?

If a customer answered "yes" to at least one of these questions, they were scheduled for an SDPE. If they answered "no" to all questions, the 3-Tier Manager I was trained to ask additional questions of the customer, to determine the appropriateness for the individual of taking the ADPE drive test. In either case, the initial appointment for the drive test was then made. There was typically some interval between this pre-drive test counseling session and the actual date of the drive test; customers were encouraged to spend the interval preparing for the test, practicing

[8] For drivers seeking licensure for other classes of vehicles, the DMV has a separate set of test preparation materials.

their driving, and perhaps taking formal or informal training (e.g., with a drive test instructor or a family member).

First drive test: the SDPE

There were several routes by which a customer might be asked to take an on-road drive test. A customer might have been required to take a drive test because of a combination of physical, visual, or cognitive limitations that had been identified as part of 3TAS. In addition, some DMV customers are regularly required (according to current, non-3-Tier procedures) to demonstrate their ability to drive safely despite a progressive or unstable physical, mental, or vision condition. This latter group—referred to as "limited term" renewals—have a shortened term between license expiration dates. While the normal term in California for a non-commercial license is five years, a DMV licensing examiner may assign a shorter license term (e.g., a two-year renewal period, a one-year renewal period). The assignment of a shorter license term is based upon the results of a drive test and the information provided in a DL62 or Confidential Medical Report (CMR) form. In general, these customers are required to take an on-road drive test at every license renewal period.[9] A third group of drive-test customers consisted of referrals from the Driver Safety Branch.

Upon arrival at the DMV for their drive-test appointment, the customer would first meet with the LRE. As part of the preparation for the actual test itself, the LRE would ask the customer whether they had taken additional behind-the-wheel training in order to prepare for their drive test. This training could have been with a driving instructor, an occupational therapist/rehabilitation specialist, or a friend/relative. These data were collected in order to determine whether there exists any correlation between formal or informal training and passage rates on the drive test.

The customer and the LRE would then proceed to conduct the SDPE drive test (for details on the general procedures for conducting CA DMV on-road drive tests, see: Hagge, 1994, Hagge, 1995, Romanowicz & Hagge, 1995, Masten, 1998b). The SDPE is substantially similar to the standard Driving Performance Evaluation (DPE) test given to original/novice non-commercial driver license applicants, with five (5) additional test elements designed to evaluate a customer's ability

[9] In some cases, a customer may have their limited term license ended, and converted to a regular renewal period. Ending a limited term requires an on-road test, and typically occurs because of a change in the nature of the underlying condition.

to compensate for any potential limitations in vision, cognition, or physical function. These additional test elements include:

- A multiple directions task, where a customer is given a combination of instructions to perform (e.g., "at the next intersection make a right turn, then make a lane change to the left"). This occurs in at least three locations during the SDPE test. This is intended to gauge the customer's short-term memory.
- A destination trip, where a customer is directed a short distance—approximately two blocks—from the field office where the drive test began. The customer is then asked to find their way back to the field office along the same route, without asking for directions from the examiner. This occurs at the end of the SDPE test; the customer is briefed before this destination trip begins as to what will be expected of them.
- Two additional lane changes (one left and one right).
- A concentration task. This essentially involves engaging the customer in topics of everyday interest (the weather, hobbies, etc.) during the drive test; the purpose is to determine if the customer has difficulty maintaining divided attention while driving. This concentration task occurs twice, but only under normal driving conditions and only when the driver is not performing other drive-test maneuvers.
- Freeway driving. For the purposes of the drive test, roads with a speed limit of 45 mph may be considered freeways/highways if a freeway is not readily accessible.[10]

If a customer committed 20 or fewer errors during the course of their test, and committed no "critical driving errors"—dangerous driving maneuvers that imperil the health or safety of the driver, the examiner, or other road users—they passed their driving test. For the purposes of the pilot, the sheet used to score the customer's drive test (DL32 S/A) was then copied and scanned to their 3-Tier file, to record the number and type of errors committed (if any), as well as any license restrictions imposed by the examiner.

If a customer failed their first SDPE drive test, there were a number of options available to the examiner and the customer. In the first instance, it is possible for an examiner to suspend or revoke a customer's license. This occurs rarely, but may happen in (for instance) cases where a customer commits a critical driving error stemming from a non-correctable limitation to their perception, judgment, or motor function. If a customer whose license had been suspended or revoked was taking a drive test as part of the license reinstatement process—a circumstance which occurred during the pilot with some Driver Safety referrals—the examiner or Hearing

[10] In cases where a customer declines to take the freeway portion of the drive test, they are issued a license with a restriction reading "no freeway driving."

Officer may issue a Special Instruction Permit (SIP). This allows a customer to practice their driving under the supervision of a professional driving instructor, occupational therapist, or licensed driver over the age of 25. Similarly, for customers failing their drive test the first or second time (but who had not been previously suspended or revoked), examiners and Hearing Officers may issue a Special Restricted License (SRL). This constitutes a temporary restriction to a currently valid license, and requires a driver to be accompanied by a professional driving instructor, occupational therapist, or licensed driver over the age of 25. In both of these cases—SIPs and SRLs—the customer's mobility is preserved while encouraging them to improve their skills in preparation for the next drive test. In the event of a satisfactory test result on a subsequent drive test, the SIP or SRL is removed, and the customer's license is valid for unaccompanied driving (though other restrictions may apply, depending on the circumstances). That said, the most common outcome involved scheduling a second (or third) drive test for a later period—during the interim for which a customer whose license had not been suspended or revoked was issued a temporary extension of their previous license (e.g., for 60 or 90 days) and verbally encouraged to practice their driving skills.

First drive test: the ADPE

In some cases a customer elected, on the basis of the initial drive test scheduling interview, not to take an SDPE, but rather an ADPE. This determination was made on the basis of a set of questions asked in addition to the pre-drive scope of driving questions discussed above. These additional questions included the following:

- Do you drive at least once a month?
- Do you limit your driving to certain locations, routes and destinations?
- When you are driving normally, are you able to avoid heavy traffic conditions?
- Do you drive only in familiar areas?
- Are the speed limits on the roads you use less than 55 mph?
- Is most of your driving within 15 miles of your residence?
- Do you take shorter trips whenever possible (30 minutes or less one-way)?

If a customer answered "Yes" to all of these questions, the 3-Tier Manager I discussed the differences between the ADPE and the SDPE with them, to see which type of drive test (SDPE or ADPE) was most appropriate to their circumstances.

While the test elements and maneuvers of the ADPE are largely consistent with those covered by the DPE and SDPE, the focus of the ADPE consists of testing a customer on the routes and in the areas with which they are most familiar. The LRE and the customer determine these routes in

advance of the test. These routes typically consist of traveling from a customer's home to places where they conduct instrumental activities of daily living, such as the doctor, church, the grocery story, or a community center. As a result of the individually tailored nature of the test, the ADPE is necessarily less consistent (across customers) than the SDPE; it is also less structured in the sense that a given customer's chosen routes may not contain the full range of maneuvers required for passing an SDPE.

If a customer passed the ADPE, they were then restricted to driving those routes (or within a specified boundary, depending on the nature of the test). In addition, a "no freeway driving" restriction is automatically added to the license in cases where a customer passes an ADPE. The requirements for passage are similar to the SDPE: no more than 20 errors, and no driving critical errors at all. The outcomes in the event of failing an ADPE are also similar to an SDPE: revocation, a SIP, an SRL, or a temporary extension of their existing license.

Second (and third) drive tests

A customer had up to three opportunities to demonstrate their ability to drive safely.[11] In most cases a customer continued to take the same type of drive test (SDPE or ADPE) which they had chosen the first time—with each test occurring under essentially identical circumstances to the first. When scheduling the second (and third) tests, the LRE would continue to encourage the customer to practice their skills before the next test—which was often scheduled at least two weeks later, to allow time for such practice. Depending on the outcome of the previous test(s), their current license status, and the circumstances of their referral for a drive test (if they were a Driver Safety customer), an examiner or Hearing Officer may also issue a SIP or SRL. If a customer could not pass either the SDPE or the ADPE after a total of three attempts, their license would be revoked.

Driver Safety referrals

Some 3-Tier customers were enrolled in the program as a result of a referral through CA DMV's Driver Safety Branch. As a general matter, the Driver Safety Branch handles administrative hearings and processing of cases of drivers convicted of driving under the influence of alcohol (DUI/APS); drivers reported to CA DMV by law officers for driving unsafely (accidents, near accidents, recklessness, confusion, etc.); drivers reported to CA DMV by physicians and vision

[11] This involved a slight change from current (non-3-Tier) procedures. Currently, customers have up to three opportunities to pass the SDPE. However, they only have one opportunity to pass an ADPE. For 3-Tier, this was extended to two opportunities to pass the ADPE.

specialists for certain medical conditions that may affect driving; and drivers reported to CA DMV by members of the community (family, friends, neighbors, etc.) concerned about their ability to drive safely.

Depending on the circumstances of the referral, the Driver Safety Hearing Officer handling a particular case may determine that a driver must take an on-road drive test to establish that they can drive safely. This occurs for many law enforcement referrals (i.e., drivers reported for unsafe driving), as well as in certain categories of referrals for physical and mental (P&M) conditions. In the latter case (P&M conditions), Hearing Officers typically require a substantial medical report from a driver's own physician, detailing the diagnosis and prognosis of the specific condition for which the driver has been reported. Depending on the physician's diagnosis and recommendations, the Hearing Officer processing the case may then require that a driver take an on-road test, to establish their ability to compensate for any potential physical, cognitive, or visual limitations associated with their disease or condition.

If a Driver Safety Hearing Officer required that a customer take an SDPE or ADPE on-road test as a result of a referral, this customer was enrolled in the 3-Tier Pilot. This occurred primarily for drivers referred by law enforcement officers for confusion and reckless driving, drivers referred by physicians for a range of unstable or progressive medical conditions, and drivers referred by community members (family, neighbors, etc.) because of potentially unsafe driving. Customers with commercial licenses were excluded from enrollment, as were customers conducting their hearings with Driver Safety and/or their drive tests in languages other than English.

The precise sequence of tests required of the customer depended upon the circumstances of their referral, as governed by the procedures in use by the Driver Safety Office. In some cases customers were required to take the written test of the rules of the road as well as a drive test. In a few cases customers were required to pass the visual acuity screen as well as take a drive test. In general, however, Driver Safety referrals were not assessed using the Tier 1 screening tests, nor were they given the PRT (Tier 2). They were, however, provided with the same written drive-test preparation materials given to other Tier 3 customers. They were also given the opportunity to complete the driving habits survey.

In all cases, any customer enrolled in the 3-Tier Pilot as a result of a Driver Safety referral had an additional set of data recorded in their file, detailing the nature of their referral and the outcome of their drive test. These data were taken from the DL11 and DL11D forms, which are used to convey information between the Driver Safety Office and field offices.

Quality Control Measures Implemented During the Pilot

During the pilot, R&D took certain measures to improve the uniformity of implementation and to ensure data quality. This occurred in a number of ways.

LIAISON STAFF

First, R&D hired three staff to serve as liaisons between R&D and those branches responsible for implementing the 3-Tier Pilot: Field Operations Division (FOD), and Driver Safety Branch. These staff had flexible roles that, to some degree, changed over the course of the pilot. In broad terms, however, they were responsible for brokering communication between R&D, Field Operations, and Driver Safety. Their specific duties included:

- During the pre-pilot period, ensuring that the field offices and Driver Safety were properly supplied with new equipment and supplies of forms used for data collection.
- During the pilot, ensuring that pilot equipment was in proper working order and that each of the offices were supplied with appropriate forms for the collection of pilot data.
- Communicating requests for clarifications of procedures, as well as measures to be taken for data quality management, to and from the three branches involved in the pilot (R&D, Field Operations, and Driver Safety).
- Monitoring the storage of the electronically scanned PDF documents (on a secure computer server) that recorded the pilot-specific 3-Tier customer data collected in the field offices and at Driver Safety.

Problem log

Second, as part of the monitoring of the storage of pilot data, these liaison staff maintained a "problem log." This problem log tracked various kinds of errors—including missing forms, incomplete entries, and procedural mistakes. These findings were then communicated to each of the field-office and Driver Safety Branch managers on a weekly basis, to improve the quality of data collection and to ensure greater uniformity of procedures.

Informal monitoring

Third, these staff, along with the author, engaged in informal monitoring of practices in the pilot field offices. This informal monitoring occurred primarily when liaison staff accompanied the author on site visits to all the pilot offices as part of the latter's orientation and training.[12]

ADDITIONAL TRAINING OF BACK-UP/REPLACEMENT STAFF, REFRESHER TRAINING

In addition to these measures, the managers of the pilot field offices and the DSO each independently took action to ensure effective implementation of the pilot; these actions included the training of back-up/replacement staff who provided coverage of essential tasks during periods when pilot staff were ill, on vacation, or had been promoted to other positions. In particular, this included:

- The training of an LRE to serve as the 3-Tier Manager I at the Sacramento-Broadway office, and
- The training of a relief manager to serve as the back-up to the 3-Tier Manager I at the Folsom office, and
- The training of 11 Motor Vehicle Field Representatives (MVFRs) who were either hired after the initial training classes, or who transferred to pilot offices from non 3-Tier offices.

This training was accomplished at the field office level, and overseen by the managers of the affected offices.

During the final month of the project, one of the liaison staff with prior experience as a field office manager took on the duties of the 3-Tier Manager I at the Carmichael field office and (subsequently) the Sacramento-South field office. This was done to ensure coverage of these positions while the formal incumbents took scheduled vacation time.

Finally, R&D distributed refresher training materials (prepared by R&D) to the pilot field offices mid-way through the project (July and August, 2007). These refresher training sessions were led by the field office managers and (in the case of Driver Safety) the liaison staff during the normal weekly Wednesday morning staff meetings. This method paralleled CA DMV's practice of periodic training updates on changes to any policies, processes, or procedures affecting field office (or Driver Safety) operations.

[12] Note: the author was hired by CA DMV in August of 2007, mid-way through the pilot period. The liaison staff also conducted informal monitoring during the months of June and July.

Description of the Database, and Associated Data-Quality Measures

There were two principal sources of data used in the current process analysis. The first source involved extracting certain variables from DMV's internal Audits files. These were used mainly for analysis of the robustness of the Pelli-Robson contrast sensitivity charts (see Module 4 of the Appendix to this report), as well as for estimating any potential methodological biases produced by customer migration (see below, pp. 43-44). As these data are collected originally in an automated manner, as a subset of data produced by the electronic processing of all customer transactions in the field offices, there is little possibility for the introduction of human error. The only real limitation to these data lies in the possibility of data extraction for past periods; DMV Audits maintains an archive for a relatively limited period of time. This limitation had no impact on the current analysis.

The second database originated in the paper forms used for data collection in the field offices and Driver Safety. The collection of these forms, and their subsequent conversion to a spreadsheet-type database, involved a number of steps. Each of these steps introduced the possibility of data loss or corruption, which in turn were dealt with through various means. The first round of data-cleaning occurred at the field office level. The 3-Tier Manager I in each office held primary responsibility for the collection of all forms (including any forms generated by Driver Safety, which are typically faxed to the field offices when a drive test is scheduled), as well as for making sure that all forms were properly filled out. These forms were then scanned to electronic PDF format on a secure electronic server (to protect customer identity). As each customer's renewal process (or Driver Safety case) was completed, these files were then double-checked by the liaison staff at R&D. Towards the end of the pilot period, the 3-Tier Manager Is were asked to wrap up any still-open cases or incomplete files. In many cases this involved renewal applications that were still pending; these customers were contacted and encouraged to complete their application. In some cases the incomplete data derived from a form that had not been scanned, for whatever reason. Where possible, copies of these forms were located from CA DMV's own internal archives and scanned to the appropriate customer's file; this was most commonly the case for customers enrolled in the pilot through Driver Safety (which maintains its own archive), or who had a referral to a vision health professional (a DL62 form, copies of which are maintained on file at DMV headquarters in most cases).

The second round of data-cleaning involved those customers with still-missing data (or forms) after collation and scanning by the 3-Tier Manager Is at the pilot field offices. Where possible

and prudent, certain data values were imputed from known, reliable sources. This included, most commonly, the following:

- Line-date stamps for the completion of the Driving Information Survey and Tier 1 Score Sheet. These documents were almost always completed in conjunction with each other; where a date stamp was missing on one, it was generally imputed from the other.
- Passage or failure of the visual acuity standard on the Tier 1 Score Sheet. Because failure on the Snellen chart generates a referral to a vision specialist, the "final" status of a customer's outcome on this assessment was often not recorded until sometime later. This led in some cases to missing data values. These were generally imputable from (a) the information contained on a DL62 form, or (b) the final status as recorded on the 3-Tier Tracking Sheet.
- Total scores on the Tier 1 memory, contrast sensitivity, and physical observation assessments. In a number of cases, values recorded on the Tier 1 Score Sheet were not transferred (or were transferred in error) to the 3-Tier Tracking Sheet. There existed a variety of ways in which values might have been missing or were recorded incorrectly; R&D created a set of formal decision rules covering the imputation of data where missing. Because the data were recorded on two different forms, it was generally possible to reconstruct the data when it was missing, and even (in most cases) when the values recorded on the two different forms appeared to disagree. The only exception lay in cases where a Tier 1 Score Sheet was missing and the total score for the physical observation protocol as recorded on the 3-Tier Tracking Sheet was greater than zero; however, this happened quite rarely.
- Date of passage of the written renewal test, and the number of written tests taken. In a number of cases, there was no data entered on the 3-Tier Tracking Sheet recording the date on which a customer passed their written renewal test. In these cases, the CA DMV driver record database was queried to find the date on which the customer was issued their license. If a customer was issued a license on the same day that they enrolled in the program (as testified by the line-date stamp on their Tier 1 Score Sheet and/or Driving Information Survey), they were assumed to have passed on their first or second attempt and the date of passage was imputed. If, however, they were issued a license on some other day (i.e., after the date recorded on the Tier 1 Score Sheet or Driving Information Survey), these data were <u>not</u> imputed. It was assumed that they had taken the test more than once, but that the number was unknown. In this case the customer's file was regarded as containing a non-correctable processing error.
- PRT outcomes. Where a customer was recorded as having taken the PRT, their results were generally recorded in two places: on the 3-Tier Tracking Sheet, and on a printout

generated by the computer on which the customer took the test. This meant that it was generally possible to reconstruct missing (or erroneously recorded) data-values on this assessment.

- Drive test outcomes. In a few cases, the passage or failure of a customer on a drive test (as recorded on their drive test score sheet); or the type of drive test taken (SDPE vs. ADPE) was not transferred to their 3-Tier Tracking Sheet. Where possible, these data were imputed. In a very few cases, a customer's file included drive test information on their 3-Tier Tracking Sheet, but did not include their Drive Test Score Sheet; where possible, these data were imputed as well.

In order to convert the data contained on the pdf files into a format capable of statistical analysis, an MS Access database was created that had a user-friendly interface suitable for data-entry by non-specialized key data operators. The database was structured so that the data from each type of form was entered into a separate screen, but with the screens linked in sequence so that a customer's complete data file was entered in one session. All data entered were linked by an individual's driver license number, though stored electronically in a relational database partitioned according to the type of form from which the data came.

After testing, the database was then turned over to a team of key data operators working in LOD's Issuance Unit. These staff entered data using a dual monitor system whereby they could access the electronic files on one screen and enter data into the MS Access database on the other screen. This method had two major advantages. First, it eliminated the need to print out physical copies of the PDF documents (which totaled over 50,000 pages), thus saving printing and disposal costs. Second, it ensured that personally sensitive customer data always resided in a secure electronic format. Staff was trained and supervised by R&D in data-entry procedures. The staff in Issuance worked remarkably quickly; the data entry portion of the project ultimately took three months for two staff members working full-time.

Upon completion of the conversion of the electronic PDF files to MS Access, the author then converted the data to SPSS/PASW (ver. 17). This allowed for a final round of data-cleaning, which consisted first of ensuring the consistency of data recorded at multiple points (such as physical, memory, and contrast sensitivity assessment scores, PRT scores, and drive test results). Secondly the data were cleaned for any errors generated by the data-entry process itself (e.g., incorrect dates or driver license numbers). Third, the data were cleaned for the purposes of identifying customers who had been incorrectly processed, but who had not been earlier

identified (note: customers whose applications were incomplete or non-correctable were not keyed by the staff in Issuance; instead they are held in separate database constructed by the author). Fourth, any customer who appeared in both the baseline and pilot cohort (of which there were nine cases) was flagged. Because these customers were correctly processed, they were retained for the bulk of the process analyses (with certain noted exceptions). However, they will be removed prior to the outcome report to ensure independence of observations in the analysis of any effects of participation in the 3-Tier Pilot. Finally, the data were cleaned of all customers holding motorcycle licenses (Class C&M), as well as those holding commercial licenses (Class A or Class B). This included all those who changed their license class within 18 months of pilot participation.

METHODS

This section describes the methodologies used in the main pilot study, as well as each of the associated post-pilot sub-analyses.

Research design of the 3-Tier Pilot

Description of Pilot Study Design

The 3-Tier Pilot used an observational prospective cohort study design (Gordis, 1996). The designation of participating cohorts (baseline period versus pilot period) was based upon a non-random sampling method. Both cohorts (baseline and pilot) included all drivers required to renew their licenses in a California Department of Motor Vehicles (CA DMV) field office during the following time periods: September 2006 through January 2007 for the baseline cohort, June through October 2007 for the pilot cohort of renewal customers, July through December 2007 for the pilot cohort of Driver Safety referral customers. The renewal customer cohorts included anyone whose renewal process required them to take the written test of the rules of the road (and who chose to take this test in English), whose license was solely Class C (non-commercial) with no endorsements (i.e., for driving an ambulance, paratransit vehicle, or motorcycle), and who chose to renew their licenses in one of six participating CA DMV field offices (Carmichael, Fairfield, Folsom, Sacramento-Broadway, Sacramento-South, and Vacaville). For Driver Safety referral customers, the cohorts included any customer referred to the Sacramento Driver Safety Office (DSO) for one of a range of physical or mental (P&M) conditions reported to CA DMV, who was scheduled for an Supplemental Driving Performance Evaluation (SDPE) drive test as a result of the P&M condition for which they were referred to CA DMV, whose drive test was scheduled at one of the six participating field offices, who possessed solely a Class C license, and who conducted their transaction with their Hearing Officer in English. The period of observation for each cohort was two years (24 months) from the end of each cohort period: February 1, 2007 through January 31, 2009 for the baseline cohort, and January 1, 2007 through December 31, 2009 for all pilot cohort customers. These periods thus include 11 months where each cohort was observed separately, and 13 overlapping months where both cohorts were exposed to the same temporally-defined driving conditions.

Many of these specific sampling constraints on the cohort populations were chosen because of pre-existing CA DMV policy regarding who is required to renew their license in a field office; this reduced the amount of disruption to standard operating procedures in the participating field offices. For methodological reasons, it was decided to exclude Class C license holders who also possessed a motorcycle license, special certificate, or endorsement. Although this type of DMV customer is normally subject to renewal processes essentially identical to those experienced by regular Class C license holders, their driving habits (and risk profiles) are likely quite different in ways that could not be easily measured and controlled for in this study.

Choice of Statistical Methods for this Report

For this process report both descriptive and inferential statistics are used. This includes simple proportions, arithmetic means, and associated standard deviations. Where comparisons are drawn between different categories of customers, χ^2 tests of cross-tabulations, gamma tests, or two-tailed *t*-tests (with unequal variances) of compared means are used.

Limitations of Research Design and Potential Methodological Issues

There are several limitations inherent to an observational cohort study. Where possible, study design characteristics were incorporated that reduced or controlled some of these limitations. In addition, several post-pilot sub-analyses (see below) were adopted to measure and control for known methodological biases.

In the first instance, the observation periods for the baseline and pilot cohorts only partially overlap. This introduces two problems. First, it is possible to collect more prospective data on the baseline cohort simply because they renewed their licenses earlier (in some cases as much as a year earlier) than participants in the pilot cohort. This would have the effect of allowing for more exposure time, and thus potentially for higher rates of accumulation of the dependent variables of interest (i.e., crashes and violations). For this reason, the end dates for the observation period were chosen with reference to the ending date of each cohort's period of enrollment in the program, to make the periods of observed post-participation driving equivalent. Secondly, however, this partial overlap between cohort periods means that for only a portion of the observed data are both cohorts driving at the same time, and so (presumably) under identical conditions. In the outcome analysis, sensitivity tests will be conducted to determine whether

there appears to be substantial differences in crashes and violation rates *within* cohorts but *across* time that would interact with the partial overlap of observation periods.[13]

A less important study design problem involved the potential for participation by customers in both the baseline and pilot cohorts. There were nine such cases. All nine were involved in Driver Safety referrals: four during the baseline period (who were then later enrolled as renewal customers during the pilot period), four during the pilot period (who had previously been enrolled as renewal customers during the baseline period), and one during both periods. Because these customers were correctly processed within each cohort, they were retained for this process analysis. However, due to the necessity of independent observations, they are excluded from any analyses that involve direct comparisons of pilot and baseline cohorts (on, e.g., demographic and prior violation characteristics). They were also flagged for later exclusion from analysis of any outcomes measures.

An additional problem with observational cohort studies involves various forms of the Hawthorne effect, which refers to the pure effect of participation in a research study quite apart from any effect of the content of the intervention. There are at least two ways in which this affected the pilot cohort in particular. First, it was anticipated that some potential pilot cohort customers might decline to participate in the pilot by either renewing their license at a non-pilot office (the so-called "migrating" customers), or by delaying the completion of their renewal application until after the program had ended (the so-called "lagging" customers). If those customers who declined to participate were significantly different from participants on any of the dependent or independent variables of interest, this would potentially bias the findings. This would be especially problematic if it were not possible to estimate the number of declining participants or their characteristics. Because it was unknown at the outset whether (and to what degree) deliberate non-participation in the pilot might occur, several sub-analyses (see below) were conducted to estimate the number and characteristics of the customers who declined to participate by either migrating to another office or delaying the completion of their application. There should have been no parallel effect on the baseline cohort. Data collection on these participants was entirely passive, included no information other than what CA DMV is required to collect according to law and departmental policy, and customers were not made aware of their participation in the pilot.

[13] Although unlikely, it is possible that differences would occur within cohorts but across time in driving exposure, as influenced by (for instance) the time of year, the price of gas, or significant changes to the driving environment.

In a secondary manner, however, participation in the 3-Tier Pilot was expected to have a salutary effect on crash risk and violation rates. To the degree that participants in the pilot were subjected to additional assessment (even at Tier 1) compared to normal CA DMV renewal procedures, it is possible that this assessment might have some effect on post-pilot driving behavior. Where appropriate, the analyses incorporated into the outcome report will attempt to tease out the effects of participation in various tiers of the 3-Tier process from participation in the program *per se*. This is important from a methodological perspective insofar as participation in a new safety program may have a declining effect over time (as the assessments become part of the routine process of license renewal), while any differences across assessment tiers may have a more stable effect over time (if such differences indeed exist).

The final problem with the observational cohort study design of the 3-Tier Pilot lies in the non-random nature of the sampling. This has several possible effects on the findings. It was not possible, largely for organizational and procedural reasons, to construct a randomization process for participation in the pilot, though a randomizing element was built into the treatment of customers at Tier 3 (specifically, in the distribution of the educational intervention materials). Because participation in the 3-Tier Pilot was not based upon a random sample of the driving population, it is not possible to generalize in a straightforward manner from the patterns found among the baseline and pilot cohorts to the driving population of California as a whole.

Secondly, baseline and pilot cohorts were drawn from a specific region of the state: the greater Sacramento metropolitan area. This region has marginally different characteristics from other areas of the state in terms of the demographics of the population. It also has different characteristics as regards its driving environment. To some degree these population differences can be controlled for by comparing the demographic characteristics of the pilot and baseline cohorts with known population parameters (age, gender, crash rates, violation rates) of California drivers. It is not really possible, however, to control for characteristics of the driving environment, and this must remain an essentially unknown source of potential bias to the findings.

Baseline and pilot cohorts were also limited to a specific segment of the driving population: those who are required by law and CA DMV policy to renew their licenses in person in a DMV field office and to take the written renewal test when doing so. This had the effect of directly constraining the variation among participants in terms of violation risk, crash risk, and age. It likely also had an indirect effect on the gender distribution of participants. A driver's recent violation record (number of negligent operator points, DUIs, Failures To Appear/ Failures To

Pay, and at-fault crashes) constitutes a trigger for the requirement to renew in person and re-take the written renewal test. Age (being 70 or older) also constitutes a trigger for the requirement to renew in person. Less directly, gender is a known correlate of violation and crash risk (Gebers & Roberts, 2004). For all of these reasons, pilot and baseline cohorts are more likely to have violations and crashes on their record, more likely to be older, and more likely to be male than the general population of California drivers. From an analytical perspective, this means that the author will focus on differences among the various study groups, to highlight any therapeutic or preventive effect of participation in the pilot. From a process perspective, this suggests caution when considering whether or how to implement any elements of the 3-Tier Assessment System (3TAS), either in California or in other jurisdictions.

Participation in the pilot was also limited to those customers electing to take the written renewal test in English or (for referrals) conducting their Driver Safety hearing in English. A sub-analysis was conducted to estimate any potential bias introduced by this limitation to the process analysis and outcome data. Furthermore, this limitation was controlled for in the calculation of the estimated cost of statewide implementation. In the event of statewide implementation, the 3-Tier Assessment Process will, by law and CA DMV departmental policy, include customers conducting their business with the state of California regardless of language.

Finally, participation in the pilot was limited to those customers who did not possess licenses for operating a motorcycle (Class C&M). This limitation was controlled for in the calculation of the estimated cost of statewide implementation, as it is likely that a statewide rollout would include customers holding Class C&M licenses.

Research Design of Post-Pilot Sub-Analyses

Calculation of the Costs of Implementing the 3-Tier Pilot

Because the funding of the 3-Tier Pilot derived from a grant from the California Office of Traffic Safety and NHTSA, the costs of implementing the project are documented through quarterly reports to the funding agency. These costs include: the funding of new staff positions to provide coverage for the expected increase in staff workload resulting from the pilot, the training of staff in 3TAS procedures, the development of the training materials, the development of new forms for the collection of data during the pilot, the development of the educational materials distributed during the pilot, the purchase of new equipment necessary for certain assessment tests

(including Pelli-Robson contrast sensitivity charts and the computers on which customers took the PRT), the purchase of new equipment necessary for the secure storage of customer data during the pilot, and the purchase of certain programming services associated with the delivery of the PRT on stand-alone computer terminals. The calculation of the costs to implement the 3-Tier Pilot served as one among several sources of data for the estimation of the potential costs of statewide implementation (discussed in further detail below).

Estimation of Customer Migration

In part because of rather intense media coverage at the beginning of the pilot (approximately two dozen articles and television news reports appeared in local media in the eight months leading up to implementation), it was anticipated that the pilot offices might experience "customer migration." By this term was meant that some unknown number of customers who would have otherwise participated in the pilot might, because of fear or anxiety about undergoing increased assessment of their driving skill, have avoided renewing at their normal field office. Instead, they may have "shopped around" for an office that was not participating in the 3-Tier Pilot. In particular, it was anticipated that such migrating customers—if indeed they existed in substantial numbers—were likely to have included precisely those types of drivers most in need of additional assessment and education regarding how to compensate for conditions and limitations that may affect driving. In other words, it was anticipated that if migrating customers existed in any substantial numbers, this would have potentially affected the estimates of the proportion of the study population subject to Tiers 2 and 3 of the 3-Tier Assessment System. Furthermore, the existence of migrating customers might have altered the size, direction, or statistical significance of any correlations found between participation in the 3-Tier Pilot and subsequent driving behavior or licensing outcomes. In technical terms, it was anticipated that non-response (in this case in the form of potential participants opting not to enroll in the program) might correlate with various dependent variables, and so therefore constitute a source of potential bias to the findings.

This potential source of bias was estimated in four ways. First, the author calculated (via the DMV Audits database) the gross number of customers in pilot and nearby offices in the months just prior, during, and just after the pilot. This was used to determine whether nearby offices processed a measurable number of excess customers during the pilot period. Secondly, the author calculated (again via the DMV Audits database) the gross number of customers who switched from one office to another in the months just prior, during, and just after the pilot. This was used to determine whether the number of customers switching from one office to another was measurably greater during the pilot period. Third, the author specifically tracked those 3-Tier

identified customers who began their applications at a 3-Tier office but then completed their renewal elsewhere. In tracking those 3-Tier identified customers who completed their renewal applications at a non-pilot office, it was possible to calculate descriptive statistics regarding age, gender, and violation rates for comparison to the overall pilot cohort. Finally, some of the staff at pilot and nearby offices were interviewed regarding their qualitative impressions of the scope of this potential problem. The author also tracked those 3-Tier identified customers who began their applications at a 3-Tier office but then failed to complete their renewal process until sometime after the pilot period. These so-called "lagging customers" are discussed in the next sub-section.

Estimation of Processing Errors and Lagging Application Data

As might be expected in a project of the size and complexity of 3-Tier, various kinds of data collection errors were committed. This includes instances where data fields were left blank on the paper forms used to collect data on individual customers, where false or otherwise erroneous data were recorded, and where paper files were not scanned into electronic format for storage in the secure computer server created for the pilot. In many cases these data collection and processing errors were correctable through imputation and cross-referencing from other data sources. In some cases these errors were uncorrectable; this was especially true for specific kinds of deviations from 3-Tier procedures. This was also true in some instances where paper files were not scanned to electronic format.

The most common form of error involved missing data in specific data fields: boxes not checked, choices left uncircled, and data values not transferred from one document to another (e.g., from the Tier 1 Score Sheet to the 3-Tier Tracking Sheet, or from the PRT printout to the 3-Tier Tracking Sheet). During the pilot period, quality assurance protocols were instituted to reduce the incidence of data errors. This included two layers of document review before customer files were considered complete. The first review occurred at each field office by the 3-Tier Manager I as they scanned documents to electronic format. The second review, of the scanned electronic documents housed on a secure computer server, occurred at California DMV Research and Development Branch (R&D) by one of the liaison staff. Where erroneous or missing data-values were discovered during these two reviews, if correctable the documents were amended for accuracy and completeness. Often the missing data values were easily corrected by cross-referencing from other 3-Tier documents—as for instance in the transfer of data values from the Tier 1 Score Sheet to the 3-Tier Tracking Sheet.

In some cases entire documents were missing from customer files. This might occur for any number of reasons; for instance, customers may have lost their paperwork between multiple visits to a field office. In some cases paper documents may not have been scanned to electronic format before being filed with other divisions within CA DMV. Or they may simply have been disposed of before scanning, in accordance with DMV field office procedures for destroying documents with sensitive personal information. Where documents were kept on file with other divisions within CA DMV, copies were obtained to ensure the completeness and accuracy of the data files. These alternative sources of data were especially helpful in two instances. First, for those customers who had referrals to professional vision specialists, a copy of a customer's DMV form DL62 is often kept on permanent record at CA DMV headquarters. This is typically the case, for example, where a customer has a limited-term license due to a progressive vision condition. Second, for those customers who had referrals to the Driver Safety Branch, copies of all relevant materials associated with their referral are kept within that branch. Where data were missing on Driver Safety customers, these latter resources were particularly useful.

Not all files were correctable, however. In some instances the type and amount of lost data made it impossible to reconstruct a customer's documents accurately. In other instances the error lay not in missing paperwork but rather in deviations from 3-Tier procedures. In those instances where data losses were unimputable, or where customers were processed erroneously, their files were housed separately from the main database. Very little process-specific data was retained for these customers except for the following information: driver license number (which was then used to extract demographic information, crash incidents, and violation history from the driver record) and the category of error committed. Error categories included: enrollment of a non 3-Tier customer, missing documents or data, Tier 2 (PRT) not administered, Tier 3 (drive test) not administered, and Tier 3 (drive test) administered in error. These data were retained in order to analyze 3TAS as a process, to determine process flows and outcomes. These data also provide a method of determining if there exist threats of bias in the findings introduced by the exclusion from the main analysis of customers with missing data and/or erroneous procedures.

As a result of data collected during the staff interviews, the author concluded that a substantial number of errors were committed in the administration of the educational intervention portion of Tier 3. This was confirmed quantitatively in subsequent examination of the data collected on the 3-Tier Tracking Sheet, which show that 30-40% of customers were either given these materials in error, or were not given the materials according to pilot protocols. However, there exists additional evidence from the staff interviews that (a) these errors occurred in a non-random manner, and (b) that the data recording which customers did and did not receive the educational

intervention are unreliable. Because of these doubts as to the reliability of the data, as well as the substantial evidence of bias in the administration of this element of the 3-Tier Process, these data are reported only in regards to the implications of these errors for the process analysis. No attempt will be made in the outcome report to examine the potential effects of the educational intervention on crashes, violation rates, or licensing.

In some instances, missing data do not appear to be a product of erroneous processing on the part of staff, but rather from non-compliance and withdrawal of participation in the program on the part of customers. Those customers who started their renewal applications (or their referral process) during the baseline period, but did not complete their application/referral by January 31, 2007, were not retained in the database. Data on those customers who started their renewal/referral process during the pilot period, but did not complete their application/referral by December 31, 2007, were kept in a separate database. These data were retained in order to analyze 3TAS as a process, to determine process flows and outcomes. These data also provide a method to determine if there are threats of bias in the results introduced by the exclusion of customers with missing data. For these customers, the following data were retained: driver license number (for use in extracting demographic data, crash incidents, and violation history from the driver record); the date on which they enrolled in the pilot; the date on which they were eventually licensed (if this occurred during the 2008 calendar year); and the pending application reason on file in the driver record, if they did not complete their application during the 2008 calendar year.

Survey of Staff and Management

In order to gather staff feedback on 3TAS, two methods were used: surveys and interviews. The surveys were distributed among those field office and Driver Safety staff and managers who participated in the pilot. The survey was administered by the author and the liaison staff immediately upon conclusion of the field office portion of the pilot, during the regular Wednesday morning training and staff meetings at each pilot office. Although the sampling procedure was technically of a convenience nature, essentially the entire population of participating field office and Driver Safety staff and managers was surveyed. Almost no respondents declined to participate; missing respondents were either on vacation or sick leave. The final *N* of respondents was 130.

The survey instrument included a number of closed-ended questions with Likert-type scales. These data were easily quantized, especially as many of these questions involved ordinal answer choices. These were analyzed using descriptive statistics including means and cross-tabulations. However, given the size and nature of the sample, statistical tests of significance were deemed to be of only marginal utility. The survey also included a number of open-ended questions, many of which were follow-ups to the closed-ended Likert-type queries. Answers to these questions were analyzed through the use of qualitative open-coding procedures. On most of the open-ended questions there was substantial fall-off in response rate between the quantitative and qualitative halves of the questions. Almost all respondents answered nearly all of the closed-ended questions; the open-ended questions had response rates ranging from 50-65%. Given the size of the sample and the nature of the data it was not possible to weight answers for potential non-response bias. Because respondents varied substantially in the depth and nature of their participation in the pilot, the data are analyzed with controls for job category or self-reported daily customer load (depending on the question). For further details on the staff survey, see Module 1 of the Appendix to this report.

Interviews of Staff and Management

To collect qualitative feedback from participating staff and managers, the author constructed a purposive (non-probability) stratified sample of all DMV staff and managers who worked on the 3-Tier Pilot. Potential respondents were identified first through the staff survey, which included a cover sheet asking for interview volunteers (this sheet was immediately detached to assure anonymity of the survey responses). In order to ensure the participation of multiple respondents from every pilot site, the author recruited additional participants via nomination by the six pilot field office managers and the manager of the Sacramento Driver Safety Office (DSO). The author also recruited key informants who participated in the planning and implementation of the pilot. These key informants came from FOD Region III office, FOD Staff Services, and the Training and Procedures Unit of Driver Safety Branch. The final sample included 49 respondents.

Because the study design of the staff interviews incorporated a non-probability sampling frame, no claims can be made that the findings were strictly generalizable to the universe of staff and managers that worked on the pilot. To partly compensate for this, the sample includes multiple representatives from all job categories with direct participation in the pilot. In some cases the sample incorporated all possible representatives of a particular job category: this was the case for

all of the office managers, the 3-Tier Manager Is, and the key informant coordinating personnel working at either FOD Region III or CA DMV Headquarters.

In consultation with other members of California DMV Research and Development Branch (R&D), as well as with the liaison staff, the author developed a flexible interview protocol. This protocol included some questions common across multiple job categories—such as the query regarding the project's overall purpose—and some questions that were unique to specific positions. See Module #2 of the Appendix to this report for the full interview protocol. Each interview lasted between 20 and 60 minutes, and was conducted at the respondent's office, typically in a break room, a meeting room, or an unused manager's office. In general the interviews with front-line staff took 20 minutes. Interviews with managers typically took 30-45 minutes. Only one or two interviews—all with upper management/Headquarters coordinating personnel—took longer than 45 minutes. Each interview was tape-recorded, then transcribed either by the author or a staff member of the Driver Safety Branch at CA DMV Headquarters with experience in transcription. The vast majority of the interviews were conducted by the author; a small number were conducted by two members of the liaison staff, both of whom were trained by the author in interviewing. One respondent declined to be taped, and instead submitted answers to the protocol questions in written form. All interviews were analyzed with NVivo (ver. 8) qualitative analysis software.

In developing a coding scheme for the interview transcripts, the author first used simple descriptive codes to group together answers to questions regarding (i) the goals of the 3-Tier Pilot, (ii) each element of the pilot process (memory recall exercise, physical observation, etc.), (iii) training, (iv) intra-office workflows, and (v) inter-branch communication. The author also assigned descriptive codes corresponding to job class of the respondent, the size of the office (if they worked in one of the six pilot field offices), and office location. Secondly, the author developed analytical codes based in part on the results of the staff survey. These included the various definitions of customer service as well as certain related concerns such as perceived impact on wait times, perceived discrimination (based on either age or language), the importance of personalized attention in customer transactions, and potential improvements to traffic safety. Finally, a second set of analytical codes were inductively developed from the interview material itself. These last codes had to do with disparate views regarding the purpose of driver competency assessment tools.

Survey of Customers

In order to gather feedback on customer attitudes regarding 3TAS, the author administered a simple six-question survey to a stratified random sample of customers who participated in the pilot. This survey asked customers about their views on the ease of 3TAS as a whole as well as the ease of following the instructions for each of the assessment tests, whether they had spent a reasonable amount of time during their visit to the field office, whether CA DMV staff were courteous and respectful, whether they thought 3TAS was fair to all customers, and finally their confidence in the utility of 3-Tier for improving traffic safety.

Due to concerns about the relevance of the questions (alternatively, the reliability of customers' memories of their experiences in the pilot), the survey was administered as soon as practicable after the completion of the field office portion of the pilot (October 31, 2007). All customers with completed applications at that time (n = 10,699) were stratified according to one of four mutually exclusive categories. Those customers with incomplete applications at the time the sample was constructed (n = 1,146) were not included in the sampling frame. The sampling strata matched the tiers of 3TAS, with a fourth stratum for Tier 3 recipients of the educational intervention. Using SPSS (ver. 14), each stratum was randomly sampled, with over-sampling for all but Tier 1 customers. The final sample consisted of: 4,167 Tier 1 customers (49% of this stratum); 770 Tier 2 customers (66% of this stratum); 453 Tier 3 customers who received the educational intervention but did not take a drive test (88% of this stratum), and 481 Tier 3 customers who had to take an on-the-road drive test (86% of this stratum). The responses of a small number (N = 98) of customers later determined to have been processed erroneously were dropped from the analysis.

This stratified sampling was, unfortunately, done before it was determined that the data regarding receipt of the educational intervention were corrupt. As a result, the sampling design weights reflect this original four-fold stratifying scheme, since that determined a customer's probability of inclusion in the sample. However, the non-response weights were modified to consist of three categories: Tier 1 customers, Tier 2 customers plus those Tier 3 customers who were thought to have received the educational intervention but did not take a drive test, and Tier 3 customers who took an on-road drive test. This weighting scheme was more methodological sound than the four-category scheme in the sense that all customers could be reliably distinguished from one another by the presence of specific pieces of paperwork in their files that were either automatically generated (in the case of the PRT) or procedurally required (in the case of a drive test score sheet).

The survey was distributed in two waves: the first was mailed on December 7, 2007 and the second five weeks later (on January 16, 2008). Therefore, a maximum of six months elapsed between when a customer first enrolled in the pilot and their receipt of the survey. Each survey was labeled with a randomly-generated unique identifier; this allowed for later matching of individual responses to demographic variables drawn from CA DMV's driver record database. All responses returned within six months of the second mailing were retained for analysis.

Separate logistic regression equations were constructed for each question, predicting the likelihood of *disagreeing* with a given statement; this was done to highlight those factors that may contribute to negative perceptions of 3TAS. The responses of customers on each question were re-coded from a four-category Likert-type scale ("Agree Strongly," "Agree," "Disagree," and "Disagree Strongly") to a dummy category of "Agree" or "Disagree." Missing data on any individual question were not imputed. The independent variables used in the final regression equations included: customer age (constructed as a dummy variable, with those aged 65 or older coded as "1"), gender, number of convictions in the prior 3 years, number of at-fault crashes in the prior 3 years, and depth of assessment in the 3-Tier system (i.e., whether a customer was assessed at Tier 1, Tier 2, or Tier 3). Two variables were dropped from the final models for lack of significance: the office at which a customer's transaction was processed, and whether they were a Driver Safety referral. All data were weighted to control for sampling design and non-response bias. For further details on the construction of the sample, the construction of the sampling design and non-response weights, and the methodological implications of the exclusion from the sampling frame of customers with incomplete applications, see Module #3 of the Appendix to this report.

Estimation of Robustness of the Pelli-Robson Contrast Sensitivity Charts

In the surveys and interviews, a number of staff raised concerns about the robustness of the Pelli-Robson contrast sensitivity charts under varying light conditions. Staff were especially concerned about the possibility that customers assessed on charts seen in conditions of bright light, glare, or shadows had more difficulty achieving a passing score on this assessment. Staff were also concerned that certain types of customers (particularly older customers) had more difficulty passing this assessment in these circumstances. In keeping with the standards of utilization-focused evaluation, and as a method for incorporating staff feedback and concerns directly into this report, the author determined that it was necessary to conduct a formal analysis of customer outcomes on the Pelli-Robson contrast sensitivity assessment.

In order to estimate the potential impact of imputed chart location on customer outcome, it was first necessary to identify the chart on which each individual customer was assessed for potential contrast sensitivity limitations. Because the identity of the chart was not directly recorded at the time of processing, the chart on which each customer was assessed was imputed using a combination of known data. This required the matching of information from multiple data sources: the raw paperwork used to process customers during the pilot, the CA DMV Audits database, and the driver record. This matching was done primarily on driver license number and the ID number of the technician who processed a given customer's transaction. Once these matches were made, each customer was assigned a data point denoting the specific Pelli-Robson chart on which they were presumed to have been tested. The imputation of chart location was based upon the specific terminal at which a customer's renewal fees were collected/cashiered. The match between terminals and charts was established by the author during the course of site visits that involved mapping each office. The author also individually interviewed field office technicians regarding their use of charts at each terminal. These interviews allowed the author to identify those terminals where technicians reported using more than one chart (often because of considerations stemming from perceived variation in light conditions). Customers seen at these "indeterminate" terminals could not therefore be reliably linked to a specific chart, and so were excluded from the analysis. Also excluded from the analysis were customers who failed the visual acuity assessment, or who were Driver Safety referral cases; both of these types of customers often made multiple visits to a field office, could not be reliably linked to a specific terminal, and hence could not be reliably linked to the Pelli-Robson chart on which they were assessed. The methodological limitations that derive from these exclusions, as well as the analytic limitations inherent to this method of imputing chart location, are discussed at some length in Module #4 of the Appendix to this report.

In order to estimate the potential impact of variation across staff in the implementation of this assessment, technicians were first ranked according to the proportion of customers they observed as having any Tier 1 limitation (physical function, acuity, contrast sensitivity, or memory). Cross-tabulations were then calculated which compared staff within offices, and each technician was assigned an adjusted standardized residual. Any technician two or more standard deviations away from the average fail rate for their office was flagged as a statistical outlier. Technicians that were above the mean for their office—meaning they were more likely than their colleagues to identify customers as possessing Tier 1 limitations—were labeled "over-orthodox." Those who were below the mean were labeled "under-orthodox." All other staff (including those who processed fewer than 10 customers over the course of the pilot) were labeled "average" and

served as the reference category in the analysis. For a more extended discussion of the specific methodology used in these calculations, see Module 4 of the Appendix to this report.

Once charts and technicians were thus coded, the likelihood of an individual failing the contrast sensitivity assessment was calculated using hierarchical logistic regression. The dependent variable was re-coded from an ordinal scale (pass, somewhat fail, frank/extreme fail) to a dummy variable with both types of fails combined.[14] The following independent variables were included as predictors: customer age (defined ordinally in 15-year increments, starting at age 30, with those ≤30 years old as the reference category), whether a customer possessed a limited-term license or had a long-standing vision condition on record (these were combined into a single measure), imputed chart location (with one chart at each office serving as the reference category for that office), and staff "orthodoxy." Office location served as the level-2 grouping variable, and was entered into the equation as a random effect. To ensure proper model fit, all data from the Vacaville office had to be excluded from the analysis. For further details on the specifics of equation modeling and methodological constraints, see Module 4 of the Appendix to this report.

Estimation of the Potential Costs of Statewide Implementation

The estimation of the potential costs of statewide implementation are based in part, but only in part, on the calculation of what it cost to implement the 3-Tier Pilot. These calculations were adjusted for a number of factors that were assumed would differ substantially between the pilot as implemented, and the process as recommended for implementation, should that be judged by policymakers and the Executive Branch of CA DMV as warranted.

First, if 3TAS is implemented statewide, it may be applied to a somewhat higher proportion of the driving population than occurred during the pilot. This would be the case, for instance, assuming that 3-Tier materials are translated into all languages in which CA DMV transacts business with customers. This would also be the case if 3TAS is applied to customers holding both Class C (non-commercial) licenses and motorcycle licenses. To estimate the extension of 3TAS to all languages currently in use by DMV customers, the author drew data from the California Health Interview Survey, the most recent statewide survey of the general population that includes measures of language use (University of California, Los Angeles, Center for Health Policy Research, 2007). To estimate the extension of 3TAS to holders of motorcycle licenses, the author drew from a combination of CA DMV licensing records.

[14] Extreme/frank fails occurred rarely enough that they could not be analyzed separately.

Secondly, these calculations were made on the assumption that any adoption of 3TAS would occur in an automated, electronic, or otherwise largely computer-based format. The collection of assessment data in electronic format is assumed to be more efficient than the collection of data in paper-and-pencil format, as was done during the pilot. The assumption of automation required adjustment of the calculations of processing times collected during the pilot. These calculations were also adjusted on the assumption of certain changes to 3-Tier procedures to maximize efficiency while ensuring adequate opportunities to assess customers for potential driving-relevant limitations. In addition, the estimation of the costs of statewide implementation includes the costs of reprogramming the DMVA (or its successor, the EASE system) to include data fields for the collection of 3-Tier Assessment System information.

Third, these estimates of the cost of statewide implementation were made on the assumption that any impact of 3TAS on the processing efficiency of the field offices would be balanced by the hiring of new staff to adjust for additional workload. Processing efficiency and customer wait times are currently of extreme importance in the implementation of any new initiative at CA DMV. Therefore, the estimated costs of statewide implementation include an estimate of the additional staff positions necessary to implement 3TAS with no negative impact on CA DMV's current commitment to timely and efficient processing of customers in the field offices and in Driver Safety.

Fourth, the estimate of the costs of statewide implementation include a calculation of the cost to develop training materials for all CA DMV field office and Driver Safety staff in 3-Tier Assessment System procedures. In addition, costs are calculated for the delivery of training in 3-Tier procedures to all field office and Driver Safety staff statewide. Incorporated into the estimation of the costs of training are certain assumptions regarding initial and ongoing quality control monitoring.

Finally, the estimate of the costs of statewide implementation includes a calculation of the cost of new equipment required to deliver certain assessment tests. This includes the purchase and set-up of Pelli-Robson contrast sensitivity charts in every CA DMV field office. Also included are the purchase of hardware and programming for the delivery of the Perceptual Response Test (PRT); these calculations were made on the assumption that the PRT would be administered on a stand-alone computer terminal.

The reader should bear in mind that the estimate of the costs of a statewide rollout of 3TAS were made on the basis of assumptions that may no longer hold true at the time of implementation. If

3TAS is adopted for implementation, the format of the system may need to be altered on the basis of policies and procedures not currently in place at CA DMV. These estimates should therefore be understood as best-faith efforts given currently available information; they may require re-calculation at some future point, using different assumptions unknown to the author at this time.

RESULTS

The following section describes the results of the pilot, as well as the results of the various post-pilot sub-analyses conducted as part of the process analysis.

Pilot Outcomes

Customer Participation Rates and Process Outcomes for Baseline Cohort

In order to construct a comparison/control group, data were collected on customers renewing their licenses in a field office via standard (non 3-Tier) procedures, or who were referred from Driver Safety to a field office for a drive test, during a baseline period approximately nine months prior to the actual pilot. The baseline period extended from September 1, 2006 through the end of January, 2007. Any renewal applicant that started their basic Class C license renewal process during this time period was included if the application was completed prior to March 31st of 2007; any Driver Safety customer who was referred for a drive test during this time period was also included. Data were collected from the same six field offices, and the Sacramento Driver Safety Office (DSO), as were later used for the pilot. Similar requirements for collection of data on customers were used during both baseline and pilot cohort periods; in other words, these were customers who would also have participated in the pilot had they renewed their licenses nine months later. A small proportion of baseline cohort customers (96 customers) changed their license class during the two-year follow-up period following their participation. These customers likely possess substantially different driving habits and risk profiles than Class C license holders. They were therefore dropped from the analysis and not included in any of the figures presented in the main body of this report.

Table 3 lists the number of 3-Tier eligible customers identified during baseline, by month of enrollment (application date for renewal customers, first drive test for referral customers).

Embedded within this table are 15 customers who were, for a variety of reasons, referred to Driver Safety from one of the field offices. Summarizing these latter cases is somewhat complicated due to missing and/or contradictory data regarding the originating source and type of referral.

Table 3

Baseline Cohort, by Month of Enrollment

Month of enrollment	Renewal Customers			Driver Safety Customers
	No drive test required	Drive test for limited-term vision condition	Drive test for failing vision standard	From DSO to Field[a]
Sept. 2006	1256	14	1	26
Oct. 2006	1036	4	4	37
Nov. 2006	708	9	2	41
Dec. 2006	693	9	1	32
Jan. 2007	920	4	3	35
Feb. 2007	0	0	0	15
Mar. 2007	0	0	0	3
Total	4613	40	11	189

[a]Two customers who took their first drive test as the result of a vision disorder were, for reasons unrelated to their vision, later referred to Driver Safety during the baseline period. They each appear only once in this table, depending on their first encounter with DMV: one took their first drive test due to a limited-term condition, while the other took their first drive due to failing the department's vision standard. Neither is included in the column for referrals from DSO to Field.

Starting in 1997, the California Department of Motor Vehicles (CA DMV) instituted a change in the length of the term for driver license. This change extended the normal term between renewals from four to five years. This shift had the result that the number of renewal transactions in the field offices every fifth year (starting in 2002) plummets by approximately 70% (from around 175,000 licenses/month to around 50,000 licenses per month, statewide). The baseline period occurred during one of these five-year lulls in license renewals. Among other effects, this meant that the number of observed renewal customers was substantially lower during baseline as compared with the pilot period. It was not expected that the shift in numbers would accompany a shift in the type of driver; however, it was determined during the data analysis that the age and prior violation record of regular-term baseline and pilot-period renewal customers are, in fact, substantially different (see 106-107); there do not appear to exist statistically significant demographic differences between the two cohorts among limited-term renewal customers or Driver Safety referral cases.

Table 4

Source of Referral, and Originating P&M Action Reason Codes for Baseline Cohort

		N (% of total)
Source of Referral	Law Officer	70 (37.0)
	Medical Professional	73 (38.6)
	Field Office	11 (5.8)
	Calendar re-examination for progressive condition	0
	Confidential letter from community member	0
	Missing data/unknown	35 (18.5)
Action Reason Code	Alcohol	0
	Mental condition (unspecified)	9 (4.8)
	Alzheimer's	3 (1.6)
	Dementia	16 (8.5)
	Physical condition (unspecified)	40 (21.2)
	Cardiovascular disorder	4 (2.1)
	Diabetes Mellitus	4 (2.1)
	Neurological disorder	7 (3.7)
	Vision	3 (1.6)
	Lapse of consciousness (LOC)	8 (4.2)
	LOC (alcohol related)	2 (1.1)
	Drug addiction	3 (1.6)
	Lack of skill	80 (42.3)
	Lack of knowledge	2 (1.1)
	Lack of skill and knowledge	7 (3.7)
	Negligent operator	1 (0.5)
Total		189 (100)

The number (or type) of observed Driver Safety referral cases was not expected to be different; there were no substantial changes to Driver Safety procedures during or just prior to the baseline period. The source of the original referral, and the P&M action reason codes as listed on the DL11D form for baseline customers are listed in Table 4. The proportion of Driver Safety customers listed in Table 4 as originating from a Field Office referral differs from the total reported in the discussion of Table 3. This discrepancy arises from several factors, the most important of which lies in different data sources: the data in Table 4 are based upon the DL11D

forms used by Driver Safety to schedule drive tests in the field offices, while the data in Table 3 are based upon the drive tests conducted in the field offices. Of those customers listed in Table 4 as referred to Driver Safety from a field office, eight were referred either for a reportable vision condition, or for failing one or more drive tests originally required because of an underlying vision condition that was not correctable to CA DMV's visual acuity standard. The remaining three cases were referred for physical conditions, the specific nature of which was left unspecified in their driver record.

There were also eight customers in the baseline cohort referred to Driver Safety for a Lapse of Consciousness (LOC) P&M condition. While the vast majority of LOC customers were excluded from the analysis during both pilot and baseline, these particular individuals had additional factors in their referral case that merited inclusion the pilot.

Table 5

Descriptive Statistics on Baseline Cohort

	Age					Gender	Prior violations[a]
	Mean (*SD*)	< 45 YO (*N*)	45 – 69 (*N*)	70 – 74 (*N*)	> 75 YO (*N*)	% Female (*N*)	Mean # of "points" (*SD*)
Field Office renewals[b] (*n* = 4613)	40.93 (19.8)	67.3% (3105)	17.6% (811)	2.9% (135)	12.2% (562)	41.5 (1916)	0.98 (1.6)
Limited-term license (*n* = 40)	76.80 (8.0)	N/A (0)	12.5% (5)	22.5% (9)	65.0% (26)	52.5 (21)	0.03 (0.2)
Drive test for failing vision standard (*n* = 11)	65.82 (21.7)	27.3% (3)	9.1% (1)	9.1% (1)	54.6% (6)	90.9 (10)	0.46 (1.2)
Driver Safety referrals[c] (*n* = 189)	63.54 19.8)	16.9% (32)	32.8% (62)	11.1% (21)	39.2% (74)	40.2 (76)	0.68 (1.2)
All baseline customers (*n* = 4853)	42.16 (20.5)	64.7% (3140)	18.1% (879)	3.4% (166)	13.8% (668)	41.7 (2023)	0.96 (1.6)

[a]These figures include any negligent operator points accumulated in the three years prior to the date of application (renewal customers) or date of first drive test (referral customers).
[b]These figures include two customers referred to Driver Safety for reasons unrelated to vision.
[c]These figures include 4 customers on limited-term licenses.

Descriptive Statistics on Baseline Cohort

Table 5 lists basic descriptive statistics—age, gender, and mean number of negligent operator points in the prior 3 years—for the baseline cohort.

In this and in similar tables for the pilot-period cohort, the mean age is provided as well as the proportion falling into one of four age strata: younger than 44, 45-69, 70-74, and older than 75. Negligent operator points are additions to an individual's driver record that record convictions for most serious traffic violations. For specific details on the kinds of convictions that result in a negligent operator point, see Gebers & Roberts (2004).

Customer Participation Rates and Process Outcomes for Pilot Cohort

The field office portion of the pilot period extended from Monday June 4, through Wednesday October 31, 2007. Any customers enrolled via renewal procedures through a field office during the "lab" period (May 1 through June 1) were not included in formal data analysis. If renewal customers began their application between the beginning of June and the end of October, but completed their application between October 31 and December 31, 2007, they were retained in the records and are included in the descriptive statistics presented below. A small proportion of those who participated in the pilot (106 customers) changed their license class during the two-year follow-up period following their participation in the pilot, either by adding a motorcycle endorsement or by converting to a commercial license. These customers likely possess substantially different driving habits as compared to non-commercial motor vehicle drivers; they are consequently also likely to possess substantially different risk profiles as regards crashes and traffic violations. They were therefore dropped from the analysis and are not included in any of the figures presented in the main body of this report.

The discussion of customer outcomes and process flows in the subsequent sections are organized by assessment tier and, within tiers, by assessment domain. Descriptive statistics detailing the relationship between customer demographics and assessment outcomes are reserved for a subsequent sub-section (see below, pp. 82-91). Table 6 lists the number of 3-Tier customers processed during the pilot period, by month of enrollment (application date for renewal customers, first drive test for referral customers). Embedded within Table 6 are 20 customers who began their applications as renewal applicants, but were then referred to Driver Safety and processed appropriately during the course of the pilot.

TIER 1: PHYSICAL OBSERVATION PROTOCOL

As part of the Field Office renewal process portion of the pilot, a total of 10,883 customers were enrolled and correctly processed using 3-Tier procedures. This includes all three sub-columns included under the heading "renewal applicants" in Table 6. However, it excludes any customers who were processed erroneously, a sub-population discussed elsewhere in this report. All of these customers were processed at Tier 1, and underwent the physical observation, memory, visual acuity, and contrast sensitivity assessments. The disposition of customer outcomes on the physical observation assessments are presented in Table 7.

"Other" limitations noted by DMV staff ran the gamut, and included such things as the use of a wheelchair, self-reported neuropathy, casts and braces (or other such evidence of ostensibly temporary injuries), hearing loss, and the use of oxygen tanks. In some cases staff used the space allotted to explain in writing their observations of a limitation that might easily have fallen into another category (e.g., the absence of fingers, shaky handwriting, a stiff hand).

Table 6

Pilot Cohort, by Month of Enrollment

	Renewal applicants			Driver Safety referrals
Month of enrollment	No drive test required	Drive test for limited-term vision condition	3-Tier Assessment System-triggered drive test	From DSO to Field
Jun. 2007	1739	37	81	0
Jul. 2007	1982	33	88	24
Aug. 2007	2249	45	84	38
Sept. 2007	1971	30	71	15
Oct. 2007	2353	49	71	24
Nov. 2007	0	0	0	15
Total	10294	194	395	116

Table 7

Pilot Cohort Customers (Renewals Only) with Potential Physical Limitations, by Type

	Type of limitation	*N* of customers observed (% of all field office renewals)
Upper body observation	Loss of arm or hand	10 (0.1)
	Obvious shaking	113 (1.0)
	Obvious stiffness	12 (0.1)
	Other potential limitation	23 (0.2)
	Condition already on record	4 (<0.1)
Lower body observation	Unable to walk if not aided	198 (1.8)
	Loss of use of leg or foot	4 (<0.1)
	Obvious shaking	2 (<0.1)
	Obvious stiffness	56 (0.5)
	Other potential limitation	68 (0.6)
	Condition already on record	5 (<0.1)

Because any given customer might have multiple potential physical limitations, the observations were cumulatively scored. These data are presented in Table 8.

Table 8

Pilot Cohort Customers (Renewals Only), Cumulative Count of Potential Physical Limitations

	N of customers observed (% of total with observed physical limitations)
No potential physical limitations noted	10,449 (96.0)
1 potential physical limitation noted	395 (3.6)
2 potential physical limitations noted	31 (0.3)
3 or more potential physical limitations noted	8 (0.1)

TIER 1: VISION ASSESSMENT

Customers underwent two vision assessments as part of Tier 1. Staff were trained to administer the Snellen visual acuity assessment first; assuming a satisfactory outcome, the customer would then take the Pelli-Robson contrast sensitivity assessment. If a customer could not pass the department's visual acuity standard on the Snellen chart, they may also have been tested on the Optec 1000 Vision Tester, a desk-mounted binocular device for the assessment of visual acuity. In most cases, if a customer could not achieve the department's visual acuity standards on either the Snellen chart or the Optec 1000 Vision Tester, they were given a referral (DMV form DL62) and asked to undergo professional evaluation by their own eye doctor (there are some exceptions, discussed in the next paragraph). Upon returning to the field office with a form completed by a vision specialist, they were then tested again. In some cases this referral process resulted in a customer's receipt of a new prescription for vision correction (e.g., new glasses or contacts) that then enabled them to pass the department's visual acuity standard. If a customer could not pass the department's visual acuity standard despite correction they were asked to take an on-road drive test to assess their ability to drive safely and compensate for any potential vision limitations.[15] Table 9 shows customer outcomes on CA DMV's visual acuity standard during the 3-Tier Pilot.

Table 9

Pilot Cohort Outcomes (Renewals Only) on the Visual Acuity Assessment

	N of customers (% of all field office renewals)
Pass	10,637 (97.8)
Fail	113 (1.0)
Fail, department has record[a]	124 (1.2)

[a] See paragraph below for explanation.

Some customers have a stable vision condition that results in failure according to the department's vision standards. This may include one of a range of conditions that result in reduced acuity. If an applicant can pass the department's minimum standard (20/200 acuity with correction in at least one eye, as measured by a professional vision specialist), and has a

[15] The department also maintains an absolute minimum vision standard. If a customer cannot achieve a visual acuity of at least 20/200 in one eye with correction (as verified by a professional vision specialist), the department will neither schedule a drive test, nor issue a license. In such instances a revocation of the driving privilege is issued.

condition determined by their optometrist/ophthalmologist to be stable in nature, and can demonstrate safe driving skills in an on-road drive test despite their vision limitation, a notation is added to their driving record. This is then referred to as a "long-standing condition" and drivers with such conditions are not typically required to undergo any further drive tests unless their optometrist/ophthalmologist later notifies CA DMV of a change in their vision health. Thus, those 3-Tier customers with a previously-noted long-standing condition ("fail, department has record") were not required to take an additional drive test, despite failing the department's visual acuity standard. They may, however, have been required to take a 3-Tier drive test for other conditions unrelated to vision.

If a customer could pass the department's visual acuity standard, they were then assessed for potential contrast sensitivity limitations using the Pelli-Robson chart. This assessment admitted of three potential outcomes: pass, somewhat fail, and extreme fail. The distribution of outcomes is arrayed in Table 10.

Table 10

Pilot Cohort Outcomes (Renewals Only) on the Pelli-Robson Contrast Sensitivity Assessment

	N of customers (% of all field office renewals)
Pass	9,208 (84.6)
Fail at Line 1 ("Extreme Fail")	3 (<0.1)
Fail at Line 4 ("Extreme Fail")	72 (0.7)
Fail at Line 5 ("Somewhat Fail")	1,488 (13.7)
Not Assessed	112 (1.0)

Those not assessed on the Pelli-Robson chart included a mix of customers with long-standing vision conditions, as well as some customers who could not pass the visual acuity standard even after a referral to a vision specialist.

A couple hundred customers were required to see a vision specialist due to failure on the visual acuity assessment (see above, Table 9, p. 62), and in some of these cases customers were assessed for contrast sensitivity at a date subsequent to their initial application. In about 100 of these cases, their score on the contrast sensitivity was recorded on their 3-Tier Tracking Sheet,

rather than the Tier 1 Score Sheet. The vast majority of these customers passed the contrast sensitivity assessment; eight somewhat failed, and one had a score of extreme fail. The line on which this last customer failed (1 versus 4) is unknown. Given the distribution for other customers who extreme failed on this assessment, they were imputed as failing at line 4.

TIER 1: MEMORY RECALL ASSESSMENT

The final component of Tier 1 consisted of the memory recall test. The distribution of outcomes on this assessment is arrayed in Table 11.

Table 11

Pilot Cohort Outcomes (Renewals Only) on the Memory Recall Assessment

	N of Customers (% of all field office renewals)
Pass	10,765 (98.9)
Fail	118 (1.1)

TIER 1: CUMULATIVE ASSESSMENT OUTCOMES

Table 12

Pilot Cohort (Renewals Only) Cumulative Scores on the Tier 1 Assessments

	N of Customers (% of all field office renewals)
Pass (total score of 0)	8,912 (81.9)
Somewhat fail (total score of 1)	1,729 (15.9)
Extreme/Frank fail (total score of 2 or more)	225 (2.1)
Missing (failed visual acuity)	17 (0.2)

With the exception of the contrast sensitivity assessment (which was only administered if a person had successfully passed the visual acuity assessment), each assessment test was designed to be independent of the others. Thus, a given customer's total score on the Tier 1 assessments (physical observation, contrast sensitivity, and memory recall) was cumulative of the three component assessment scores. The distribution of cumulated scores on the Tier 1 assessment tests is displayed in Table 12.

As a practical matter, staff were instructed to truncate a customer's total score at 2, the trigger for administration of Tier 3 assessment. In Table 12, the distribution of outcomes is also truncated at a total score of 2. At least 48 customers had total scores of 3 or higher on the Tier 1 assessments; however, this proportion should be treated with caution given staff training protocols (i.e., some customers noted as having two limitations may in fact have had more, but the technician noted only two). Those noted as "missing" in Table 12 did not pass the visual acuity assessment even after referral and correction, or because of a long-standing condition. These customers were never assessed for contrast sensitivity, and so had incomplete cumulative scores. As a practical matter, these 17 customers all had scores of 0 on the physical and memory recall assessments.

TIER 2: WRITTEN TEST OF THE RULES OF THE ROAD

All customers enrolled in 3-Tier as a result of an in-office license renewal were, by definition, required to take the 18-question written test of the rules of the road.[16] This, plus an assessment of perceptual processing speed (discussed below) constituted Tier 2 of the 3-Tier Assessment System (3TAS). The disposition of customer outcomes at each written test attempt is arrayed in Table 13. Of the three customers who failed their sixth test, one passed on their seventh attempt, one on their eighth attempt, and the third had to take the test thirteen (13) times before passing.

The overall fail rate on the written renewal test among 3-Tier Pilot participants is somewhat lower than what has been reported in past R&D studies (Masten, 1998a; Masten, 1999; Chapman & Masten, 2002; Reiner & Hagge, 2006). Prior studies generally found that about one third (depending on the study) of applicants fail their first attempt at the English-language renewal test. Among 3-Tier participants 20% of applicants failed the written test on the first attempt.

Prior studies do report a substantial range across field offices, however, and the rate found within the 3-Tier Pilot population is well within the range reported most recently: 11-69% (Reiner & Hagge, 2006). Variation in fail rates across offices may be a product of unmeasured demographic differences within the population (in, for instance, educational attainment); this may in part also account for the relatively low overall fail rate found in the 3-Tier Pilot.

[16] Original applicants (which include applicants from out of state who may hold a license in another jurisdiction) take a 36-question test. The tests are given on a double-sided sheet of paper with half of the questions on each side; renewal applicants are instructed to only fill out the first half of the test while original applicants fill out both sides.

Table 13

Pilot Cohort Outcomes (Renewals Only) on the Written Renewal Test

Attempt	Outcome	*N* of Customers (% of that attempt)
First Test	Passed	8,673 (79.7)
	Failed	2,209 (20.3)
	Declined to Attempt	1 (<0.1)
Second Test	Passed	1,760 (79.7)
	Failed	448 (20.3)
	Declined to Attempt	1 (<0.1)
Third Test	Passed	347 (77.5)
	Failed	100 (22.3)
	Declined to Attempt	1 (0.2)
Fourth Test	Passed	70 (70.0)
	Failed	29 (29.0)
	Declined to Attempt	1 (1.0)
Fifth Test	Passed	18 (62.1)
	Failed	11 (37.9)
Sixth Test	Passed	8 (72.7)
	Failed	3 (27.3)

Prior studies have also generally found that the fail rate for English renewal applicants in particular rises substantially with each subsequent attempt between the first and third tests. Reiner & Hagge (2006), for instance, found that the overall fail rate was about 34% for the first attempt, but rose to 63% for the third attempt; Chapman & Masten (2002) also reported a rise in the fail rate from 31% (first attempt) to 50% (third attempt). The pattern reported here differs: the fail rate is basically stable for the first three attempts (20-22%), and rises only modestly for the fourth (29%) and fifth (37.9%) attempts. The consequences of failure on the test were substantially greater in the 3-Tier Pilot as compared to prior studies, however. Whereas normal DMV procedures only call for an applicant to submit a new application on the third failure (and therefore pay a second renewal fee), in the 3-Tier Pilot applicants were advised that they would be required to take an on-road test of driving skill if they failed the written renewal test three or more times. It is probable that this provided a greater incentive than normal to study and prepare

for the written test; however without a more rigorous methodology for examining the consequences of testing procedures (e.g., a randomizing experimental design), this speculation must remain tentative. It is also possible that the low fail rate on the renewal test observed in the pilot is at least partly a product of the Hawthorne effect; prior studies of the written renewal involved the passive collection of data, and so test-takers were not aware of their participation in an evaluation study.

TIER 2: PRT

The second component of Tier 2 consisted of the Perceptual Response Test, or PRT. As with the Pelli-Robson chart, this assessment admitted of three possible outcomes: pass, somewhat fail, and extreme fail. Customers who timed out ("aborted") were treated as frank/extreme fails, though as a practical matter many of these were given multiple opportunities to improve their score. The distribution of outcomes is presented in Table 14:

Table 14

Pilot Cohort Outcomes (Renewals Only) on the Perceptual Response Test

	N of customers (% of all PRT takers)
Pass (17-23 milliseconds)	2,012 (88.0)
Somewhat Fail (24-40 milliseconds)	12 (0.5)
Extreme Fail (41-500 milliseconds)	19 (0.8)
Extreme Fail (abort/timed out)	244 (10.7)
Total number of PRT takers	2,287

Given differences in scoring procedures, as well as differences in sample populations, it is not really possible to compare the fail rates reported here with those reported in prior studies using similar versions of this test (e.g., Owsley & McGwin, 2004; Staplin, Gish & Wagner, 2003).

TIER 3: EDUCATIONAL INTERVENTION

There were two components to assessment at Tier 3: the educational intervention, and the on-road drive test. The educational intervention further consisted of three components: the

California Driver Handbook, a pamphlet titled "On the Right Track," and two short (2-minute) DVD-based presentations on contrast sensitivity and perceptual speed. The *California Driver Handbook* is the standard reference text distributed by CA DMV to customers preparing for a non-commercial Class-C written test. Because of the subject matter, it also covers the kinds of skills that are assessed through the on-road drive test. The "On the Right Track" pamphlet was specifically developed for the 3-Tier Pilot, and focused on how drivers might best prepare for the on-road drive test. To some extent, this pamphlet was developed with the intent that its users might not have taken an on-road drive test in many years; hence, it discussed in a general way the kinds of skills and competencies which the drive test is designed to measure. It also included information (such as phone numbers and website addresses) regarding the kinds of programs and support services available for older drivers, as well as those with physical or other kinds of driving-relevant limitations. These programs include Mature Driver Improvement Courses, CarFit, the AARP Driver Safety Program, the Driving School Association of California, and the American Occupational Therapy Association's Older Driver Resource Center. The two DVD presentations focused more narrowly on the relationship between outcomes on the Pelli-Robson contrast sensitivity chart and the PRT, the kinds of underlying health issues typically indicated by compromised contrast sensitivity and perceptual speed, and how these can affect one's ability to drive safely. This presentation came in the form of a Microsoft PowerPoint-type series of still slides, with voice-over. A physical copy of the presentation was also distributed to the customer in the form of a handout.

The protocols developed for the pilot called for these materials to be distributed to different categories of customers. Any customer who was required to take a drive test, regardless of the reason, was to be given copies of the *California Driver Handbook* and the "On the Right Track" pamphlet. For customers originating from field-office license renewals, these materials were to be distributed by the 3-Tier Manager I who scheduled the drive test. For customers originating from a Driver Safety referral, these materials were to be distributed by the Hearing Officer who scheduled the drive test.

The DVD was to be shown (and the accompanying handouts distributed) to a randomized sample of those customers who had demonstrated some level of potential impairment in contrast sensitivity or perceptual speed. Specifically, customers who had "somewhat failed" on either the PRT or contrast sensitivity assessments, and who had a driver license that ended in an odd-numbered digit, were to be shown the appropriate video and given a handout. All other customers—those with an even-numbered final digit on their driver license, those who had

"extreme failed" the PRT or contrast sensitivity assessments, and all Driver Safety referral cases—were not supposed to be shown the video. However, if they were required to take a drive test, they were to be provided with copies of the *California Driver Handbook* and "On the Right Track." For a discussion of the theoretical justification of this randomizing experimental protocol, please see the Introduction (pp. 24-25) of this report.

Table 15 shows the frequency of distribution of the various educational materials. The data do not allow us to distinguish between those customers who viewed the DVD on perceptual speed and those who viewed the DVD on contrast sensitivity.

Table 15

Pilot Cohort Customers (Renewal and Referral Applicants) Reported as Receiving Educational Intervention Materials

	N of customers (% of all customers)
California Driver Handbook	494 (4.5)
"On the Right Track" pamphlet	520 (4.8)
Educational DVD and handout for contrast sensitivity or perceptual speed	786 (7.2)

Given the data presented in Table 14 on PRT outcomes, as well as information provided during the interviews with staff (see Module 2 of the Appendix to this report), it appears that the DVD on perceptual speed was shown very rarely. Assuming that pilot protocols were followed (but see next paragraph), the maximum number of customers who may have seen this video was ten, five of whom also somewhat failed on the contrast sensitivity assessment (and so may have seen both videos).

Unfortunately, it appears that the randomizing protocol for distribution of the DVD and handouts on contrast sensitivity and perceptual speed was followed haphazardly. Moreover, the paperwork used to record the distribution of the educational materials is at best an imperfect record of who did and did not receive the educational materials. For instance, nineteen (19) Driver Safety customers are recorded as having watched the DVD and receiving the handout(s). None of these customers took the contrast sensitivity or perceptual speed assessments, and furthermore, the Driver Safety Office did not have copies on hand of the DVDs or handouts. It thus appears that

the paperwork in these cases was filled out by mistake, producing type 1 (false positive) errors. On the other hand, there are 216 cases of customers who ought to have received the DVD video and handout for contrast sensitivity but for whom there is no record that this was done. Of these, over half (126) come from one field office alone; at this office the staff member with primary responsibility for scheduling drive tests specifically reported to the author that they distributed the materials widely and freely, as in their view the materials were very helpful to customers in preparing for the drive test. Again, it thus appears that for some unknown, but probably substantial, number of these customers the paperwork was filled out incorrectly, leading to data with type 2 (false negative) errors. Finally, just among Field Office renewal customers, there were 253 cases of customers who are recorded as having received education intervention when this was not called for in their particular case (they had an even-numbered final digit on their driver license, they "extremely failed" on the contrast sensitivity assessment, or they passed both the contrast sensitivity and perceptual speed assessments but were asked to take a drive test because of multiple potential physical limitations). Of these, slightly over half (130) came from one field office (different from the one mentioned previously). Given both the magnitude of the number of errors as well as their non-random distribution, it does not appear that the data on this particular component of the 3-Tier process are reliable. For a discussion of the qualitative reports on this matter, see the Appendix to this report (especially Module 2). For a discussion of the methodological implications of the maladministration of this component of the pilot, see the Discussion and Conclusions (pp. 173-175) of this report.

TIER 3: THE ON-ROAD DRIVE TEST

The final component of 3TAS involved the on-road drive test. This came in two forms: the SDPE and the Area Driving Performance Evaluation (ADPE). As a general matter, a customer had the opportunity to take the SDPE up to three times. Either as their first drive test, or after having failed one or more SDPEs, a customer had the opportunity to take an ADPE. As a practical matter, about half of those who took an ADPE (10 out of 18 total attempts) did so as their first drive test. In the pilot, a customer could make up to two attempts to pass an ADPE. However, according to pilot procedures, a customer could attempt at most three drive tests, regardless of what combination of SDPE or ADPE they chose to take. In the tables presented below, customers are tabulated according to which drive test attempt they were making (first, second, or third), what type of test they were taking (SDPE or ADPE), and whether they were a Field Office renewal or Driver Safety referral customer.

Table 16 presents the fail rate (and subsequent outcome) on all first attempts at the SDPE. One caveat should be noted regarding the data presented in Table 16. In two cases—both renewal customers—the first SDPE attempt was in fact their second drive test. Both of these customers took (and passed) an ADPE and then expressed a desire to take the SDPE, which they then also passed.

Table 16

Pilot Cohort Outcomes (Renewal and Referral Customers) on the 1st SDPE Attempt

Customer type	Outcome	*N* of customers (% of total for customer type)
FOD Renewal	Passed	448 (77.0)
	Failed, attempted second SDPE	128 (22.0)
	Failed, attempted first ADPE	2 (0.3)
	Failed, license suspended or revoked	2 (0.3)
	Postponed/rescheduled	2 (0.3)
Total of first SDPE drives for renewal customers		582 (100)
DSO Referral	Passed	77 (67.0)
	Failed, attempted second SDPE	20 (17.4)
	Failed, attempted first ADPE	2 (1.7)
	Failed, license suspended or revoked	9 (7.8)
	Failed, license renewed or reinstated	2 (1.7)
	Postponed/rescheduled	2 (1.7)
	No show, suspended	3 (2.6)
Total of first SDPE drives for referral customers		115 (100)

The results presented here are broadly similar to those reported in earlier R&D research on drive tests among written test renewal applicants (Romanowicz & Hagge, 1995), where fail rates were about 24%. However, the fail rate reported here for Driver Safety referral customers is somewhat lower than that found in previously published research (Masten, 1998b), where fail rates on the SDPE ranged from 42% to 60% (depending on the field office region). This latter study used a quite different sampling frame (all Driver Safety referral cases, as opposed to 3-Tier eligible customers), and this likely accounts in part for the disparate findings.

Table 17 presents the relationship between drive test outcomes and customer reports of having undergone behind-the-wheel training prior to taking the on-road drive test. Referrals and renewal customers are combined for purposes of simplicity. Tests that were postponed or re-scheduled were dropped from this table.

Although there is a mild trend suggesting that self-report of behind-the-wheel training correlates with increased likelihood of passing the first SDPE attempt, these differences do not rise to standard levels of statistical significance ($\chi^2 = 2.214$, $df = 2$, $p > 0.10$).[17]

Table 17
Pilot Cohort (Renewals and Referral Customers Combined) Drive Test Outcomes (1st SDPE) and Prior Behind-the-Wheel Training

Received behind-the-wheel training?	*N* of Customers (% of first SDPE attempt)	Number passing (passage rate as a % of customers reporting same answer)
Yes	114 (16.6)	90 (78.9)
No	521 (75.6)	397 (76.2)
Blank/no answer	54 (7.8)	37 (68.5)
Total	689 (100)	N/A

Table 18 presents outcomes on the second SDPE, again by customer source (renewal or referral process). The number of field office renewal customers taking the second test includes postponed/rescheduled drives reported in Table 16 (one referral customer who postponed their drive did not reschedule during the pilot period). The total also includes two customers whose first drive test was an ADPE.

[17] There is some evidence that for those customers for whom no answer on this question was recorded, their answers may be re-coded as "no" (i.e., they did not receive behind-the-wheel training). Among those for whom no answer on this question was recorded, ten took a second drive test (all of them SDPEs). Of these, all have answers on the training question, and nine (90%) reported having received no training in preparation for their second drive test. If the blanks/non-answers on the training question are re-coded as "no," the passage rate on the first SDPE for customers who reported received no behind-the-wheel training remains nearly unchanged at 75.5%. Similarly, there remains no statistical difference in passage rate as compared to those who affirmatively reported receiving training ($\chi^2 = 0.629$, $df = 1$, $p > 0.10$).

Table 18

Pilot Cohort Outcomes (Renewal and Referral Customers) on the 2nd SDPE Attempt

Customer type	Outcome	*N* of customers (% of total for customer type)
FOD Renewal	Passed	108 (81.8)
	Failed, attempted third SDPE	20 (15.2)
	Failed, attempted first ADPE	2 (1.5)
	Failed, license suspended or revoked	2 (1.5)
Total of second SDPE drives for renewal customers		132 (100)
DSO Referral	Passed	11 (50.0)
	Failed, attempted third SDPE	5 (22.7)
	Failed, attempted first ADPE	0
	Failed, license suspended or revoked	6 (27.3)
	Failed, license renewed or reinstated	0
	Postponed/rescheduled	0
Total of second SDPE drives for referral customers		22 (100)

The fail rates on the second SDPE drive test are not directly comparable to results published in previous R&D studies; previously published results are generally either for first attempts only, or report totals in a format that does not disaggregate first versus subsequent attempts. As a general matter it is worth noting that while the fail rate for renewal customers decreases (i.e., a greater percentage pass on the second attempt than on the first attempt), the fail rate for referral customers increases.

Table 19 presents the relationship between outcomes on the second SDPE and self-reports of prior behind-the-wheel training.

Here the apparent effect of behind-the-wheel training appears reversed; however as with Table 16 there is no statistical relationship ($\chi^2 = 1.702$, $df = 2$, $p > 0.10$), even when blank answers are re-coded as "no" ($\chi^2 = 0.452$, $df = 1$, $p > 0.10$).

Table 19

Pilot Cohort (Renewals and Referral Customers Combined) Drive Test Outcomes (2nd SDPE) and Prior Behind-the-Wheel Training

Received behind-the-wheel training?	*N* of customers (% of second SDPE attempt)	Number passing (passage rate as % of customers reporting same answer)
Yes	50 (32.5)	37 (74.0)
No	86 (55.8)	66 (76.7)
Blank/no answer	18 (11.7)	16 (88.9)
Total	154 (100)	N/A

Table 20 presents the outcomes on the third SDPE drive test.

Table 20

Pilot Cohort Outcomes (Renewal and Referral Customers) on the 3rd SDPE Attempt

Customer type	Outcome	Number of Customers (% of customer type)
FOD Renewal	Passed	16 (76.2)
	Failed, license suspended or revoked	5 (23.8)
Total third SDPE drives for renewal customers		21 (100)
DSO Referral	Passed	4 (80.0)
	Failed, license suspended or revoked	1 (20.0)
Total third SDPE drives for referral customers		5 (100)

Table 21 presents the relationship between outcomes on the third SDPE and self-reports of prior behind-the-wheel training.

Any effect of behind-the-wheel training on passage rate for the 3rd SDPE is statistically insignificant ($\chi^2 = 0.024$, $df = 1$, $p > 0.10$).

Table 21

Pilot Cohort (Renewals and Referral Customers Combined) Drive Test Outcomes (3rd SDPE) and Prior Behind-the-Wheel Training

Received behind-the-wheel training?	*N* of Customers (% of third SDPE attempt)	Number passing (passage rate as % of customers reporting same answer)
Yes	18 (69.2)	14 (77.8)
No	8 (30.8)	6 (75.0)
Blank/no answer	0	N/A
Total	26 (100)	N/A

Due to their relative rarity, Table 22 presents the passage rate for the ADPE with referral and renewal customers combined.

Table 22

Pilot Cohort Outcomes (Renewal and Referral Customers) on the 1st ADPE Attempt

Outcome	*N* of customers (% of all ADPE drive tests)
Passed	12 (75.0)
Passed, requested SDPE	2 (12.5)
Failed, took second ADPE	2 (12.5)
Total first ADPE drives	16 (100)

Of the three Driver Safety customers taking the ADPE, one passed on the first attempt while the other two had to make a second attempt. Both failed their second attempt. Due primarily to the high passage rate on this test, it is not possible to correlate self-report of having received behind-the-wheel training with likelihood of passing the ADPE. Nine customers reported no training, two reported having received training, and four customers had no data on this question.

The ADPE was used quite rarely, as noted in Table 22. Of those taking an ADPE, 6 had taken one or more SDPE tests first. It appears that the ADPE is particularly rare for customers enrolled in 3-Tier through a Driver Safety referral; only three referral customers took an ADPE and two of these did so only after taking an SDPE first. An additional two customers requested an SDPE upon passage of a first ADPE. The rarity of this test stems from potentially multiple sources:

lack of knowledge of its existence on the part of customers who might request it, the perceived undesirability of an area restriction even for those for whom it might be appropriate, and the expense of administering this test as compared to an SDPE. It also appears that customers are relatively unlikely to be willing to pay more than the usual renewal fee to take this test. As part of the drive test scheduling interview, the 3-Tier Manager Is (and Hearing Officers) were trained to poll the customer regarding their willingness to pay an additional fee to take an ADPE. Unfortunately, there is a high rate of non-response to this question, which limits the interpretability of the responses. Only 42 valid answers were recorded in the data, of which only three came from customers who in fact took an ADPE. Of the valid answers, 39 reported that they would pay no additional money to take an ADPE and 3 reported that they would be willing to pay up to $75 more to take this type of test. For qualitative evidence regarding views of the pilot staff on this question, see the Appendix to this report (especially Module 2).

Also rare were Special Instruction Permits (SIP) and Special Restricted Licenses (SRL), options available for drivers who have failed a drive test (or who have a suspended license for some other reason) but who, in the judgment of the examiner or the Hearing Officer, may improve their skill with practice and/or formal training. These require that a driver must always be accompanied by another adult driver (e.g., a registered occupational therapist, driving instructor, or licensed driver over the age of 25) until such time as they pass another drive test. According to data collected in the pilot, a total of 11 SIPs or SRLs were issued during the pilot; 5 after a first SDPE attempt, 4 after a second SDPE attempt, and the remainder after an ADPE failure. Of all SIPs/SRLs issued, 3 were given to Driver Safety referral customers.

Revocations and suspensions were also quire rare. Of the 705 customers who took drive tests, 29 exited the program with a suspended or revoked license. Of these, 20 were Driver Safety referral customers and 9 were Field Office renewals. Eleven of these suspended/revoked Driver Safety cases already possessed a suspended license; their participation in 3-Tier thus did not change their licensing status.

ROUTES TO THE PRT

3TAS was explicitly designed to pilot a method by which to identify drivers in need of additional assessment of their driving skills. As a tiered system of assessment, only a small minority of customers passed from Tier 1 to Tier 2. As a multi-domain system of assessment, the route by which a customer might pass from Tier 1 to Tier 2 could involve one of a number of decision-

points. Table 23 presents a tabulation of the various routes by which customers might be required to take the PRT. The totals presented in this table do not precisely match those presented in prior tables; in a few cases customers refused to take the PRT. Included is a calculation of the pass rate on the PRT for each category of customer assessed with this test. Because Driver Safety referral customers were not required to take the PRT, they are excluded from the calculations.

Consistent with the intended design of 3TAS, customers with only one identified potential limitation were relatively likely to pass the PRT. For instance, customers who failed the written knowledge test twice but had no other identified limitations, or who had one potential limitation identified at Tier 1, but passed the written knowledge test on the first or second attempt, had a pass rate on the PRT in excess of 90%. With increasing numbers of limitations (regardless of type) the likelihood of failure on the PRT rises.

Table 23

Routes to PRT, With Pass Rate by Route Type (Renewal Customers Only)

Customer type	Sub-type (*N*)		Pass rate on PRT
Tier 1 score = 0	Failed written test twice or more	(308)	91.6%
Tier 1 score = 1	Passed on first or second written test	(1610)	92.0%
	Failed written test twice or more	(107)	75.7%
Tier 1 score = 2	Passed on first or second written test	(199)	62.3%
	Failed written test twice or more	(22)[a]	36.4%
Other[b]	Failed visual acuity test, or long-standing condition	(23)	78.3%
	Tier 1 = 0, passed on first or second written test	(18)	100.0%
Total		(2287)	

[a] Includes one customer who declined to take the written test a second time.
[b] These customers were given the PRT in error, but otherwise processed correctly.

As a substantive matter, the Pelli-Robson contrast sensitivity played a critical role in routing people to the PRT. Among those with a Tier 1 score of 1, between three-quarters and four-fifths (78-79%) had somewhat failed the contrast sensitivity assessment; the remainder had a limitation identified through the physical observation or memory recall assessments. Of those with a Tier 1 score of 2 or more, over a third (33-36%) extreme failed on the contrast sensitivity assessment, while almost three-fifths (59%) somewhat failed; the remainder (5-8%) were required to take the

PRT solely because of two or more limitations identified through the physical observation or memory recall assessments.

Table 23 also highlights the soundness of the design of the assessment system, whereby the PRT was intended to be administered only to those customers with a potential limitation identified at Tier 1. A small number of customers (41) were given the PRT in error, but otherwise processed correctly. Slightly more than half failed the visual acuity assessment (or had a long-standing vision condition on record), the rest were given the PRT after failing the written test once only. Especially in the latter case, the PRT was clearly superfluous—none of these customers failed the assessment.

ROUTES TO THE DRIVE TEST

While over ten thousand customers were processed using 3-Tier procedures at Tier 1, and only a small minority of that group was assessed at Tier 2, yet a smaller minority were flagged for CA DMV's most comprehensive assessment tool, the on-road drive test. Because 3-Tier was a multi-domain system of assessment, there were many reasons for which someone might be required to take a drive test.

Table 24 presents a calculation of the various routes by which customers came to take an SDPE drive test. The figures presented here do not sum to precisely the same total number of first drive tests presented in prior tables: customers might be required to take a drive test for more than one reason, and this leads to overlap between categories. Nor do the data presented here correspond precisely with the figures presented in prior tables regarding outcomes on various assessment tests. Some customers, upon failing specific assessment tests that would have triggered a drive test, were referred to Driver Safety instead; these are not included in this table for the sake of simplicity.

Table 24

Routes to the Drive Test (Renewal and Referral Customers) and

Fail Rates for the 1st SDPE Attempt

Customer type	Reason for drive test	*N* of customers (fail rate on 1st SDPE)[a]
FOD regular-term license renewal	Failed visual acuity assessment	34 (2.9%)
	Tier 1 score = 0, failed written test 3 or more times[b]	60 (23.3%)
	Tier 1 score = 0, failed written test twice, extreme fail/abort on PRT	22 (13.6%)
	Tier 1 score = 1, failed written test 3 or more times[c]	10 (40.0%)
	Tier 1 score = 1, Somewhat fail on PRT	4 (25.0%)
	Tier 1 score = 1, extreme fail/abort on PRT[d]	136 (21.3%)
	Tier 1 score = 2, no other condition	112 (23.2%)
	Tier 1 score = 2, failed written test 3 or more times[c]	5 (20.0%)
	Tier 1 score = 2, extreme fail/abort on PRT	45 (28.9%)
FOD limited-term license renewal	Previously-identified progressive vision condition	190 (26.3%)
Driver Safety Referral	Physical and/or mental (P&M) condition	110 (30.0%)

[a] Excludes drive tests that were postponed/rescheduled.
[b] This includes 6 customers who refused to take the PRT.
[c] This includes 1 customer who refused to take the PRT, but excludes those who extreme failed/abort on the PRT.
[d] This includes 15 customers who failed the written three times.

Table 25

Source of Referral, and Originating P&M Action Reason Codes for Pilot Cohort

		Pilot period (%)
Source of Referral	Law Officer	60 (51.7)
	Medical Professional	32 (27.6)
	Field Office	7 (6.0)
	Calendar re-examination for progressive condition	4 (3.4)
	Confidential letter from community member	2 (1.7)
	Missing data/unknown	11 (9.5)
Action Reason Code	Alcohol	1 (0.9)
	Mental condition (unspecified)	4 (3.4)
	Alzheimer's	2 (1.7)
	Dementia	9 (7.8)
	Physical condition (unspecified)	22 (19.0)
	Cardiovascular disorder	6 (5.2)
	Diabetes Mellitus	3 (2.6)
	Neurological disorder	3 (2.6)
	Vision	1 (0.9)
	Lapse of consciousness (LOC)	11 (9.5)
	LOC (alcohol related)	0
	Drug addiction	1 (0.9)
	Lack of skill	48 (41.4)
	Lack of knowledge	3 (2.6)
	Lack of skill and knowledge	0
	Negligent operator	2 (1.7)
Total		116 (100)

Because some of the cell-size counts are relatively small (e.g., only four customers had a Tier 1 score of 1, with a somewhat failing score on the PRT), the range of fail rates on the first SDPE should be taken as approximations. That said, the fail rate for customers who were required to take a drive test because of a limitation in their visual acuity (the first line in the table) is extremely low.

DRIVER SAFETY REFERRALS

Table 25 lists the source of referral, and the originating P&M codes, for pilot cohort customers whose participation in the pilot derived from a Driver Safety referral. The reader may compare these data to those shown in Table 4 (p. 57), which displays parallel data for the baseline cohort.

As a general matter, lapse of consciousness (LOC) cases were excluded from the pilot. The 11 LOC customers included in Table 25 were retained due to other characteristics of their case that merited inclusion (e.g., LOC was the formal code entered into their permanent driver record, but the more detailed information on their DL11D indicated that the LOC in question was due to a medical condition that required an SDPE drive test). Despite the fact that there were no changes between baseline and pilot period in the procedures related to the processing of Driver Safety customers, there does exist a substantial difference in the number of customers in the two populations. The baseline period has a sample size approximately 60% larger than the pilot period (189 vs. 116). Moreover, the distribution of referrals according to the originating source (law officer, medical professional, confidential letter from a member of the community, etc.) is markedly different. The pilot period had substantially more referrals from law officers than baseline (52% vs. 37%), but fewer from medical professionals (28% vs. 38%). While it is true that the baseline period had somewhat more missing values on this question (meaning that the specific field in the DL11D was not filled out by the Hearing Officer), it is not appropriate to impute missing values for these data, and the differences therefore cannot be reliably reconciled.[18]

Descriptive Statistics on Pilot Cohort

3TAS is designed to identify those customers most at risk for traffic violations and crashes, providing them with an enhanced level of testing scrutiny as well as additional education regarding how to improve their driving skills. While 3TAS is not age-based *per se*—customers from across the age spectrum were included in the pilot cohort—the various assessment tests that constitute 3TAS were designed to flag age-related limitations in physical function, cognition, and vision. The tables below describe the age distribution of pilot cohort customers, according to assessment outcomes.

[18] However, the P&M action reason code—which is part of the permanent driver record—was imputable for a small number of missing values (n=7) left blank or otherwise recorded erroneously.

CHARACTERISTICS OF PILOT COHORT BY TIER 1 ASSESSMENT OUTCOME

In whole and in part, the outcomes on every Tier 1 assessment test correlate with age. Table 26 displays the age distribution of those observed with or without the various limitations identified in the physical observation protocol.

Table 26

Age Distribution of Pilot Cohort (Renewals Only) by Type of Observed Physical Limitation

			Mean age, in years (*SD*)		
	Type of limitation (*N* of those observed)		With limitation	Without limitation	*t*-test [2-tailed][a] (95% CI)
Physical observation – upper body	Loss of arm or hand	(10)	67.10 (15.49)	55.58 (20.63)	2.35* (.44 – 22.60)
	Obvious shaking	(113)	74.33 (8.55)	55.39 (20.62)	22.85** (17.30 – 20.58)
	Obvious stiffness	(12)	77.83 (6.62)	55.56 (20.62)	11.60** (18.05 – 26.49)
	Other limitation[2]	(23)	71.61 (16.58)	55.55 (20.63)	4.64** (8.88 – 23.24)
	Condition already on record	(4)	66.00 (13.74)	55.59 (20.63)	1.52 (-11.43 – 32.26)
Physical observation – lower body	Unable to walk if unaided	(198)	72.58 (11.00)	55.27 (20.63)	21.45** (15.71 – 18.89)
	Loss of use of leg or foot	(4)	73.25 (3.50)	55.58 (20.63)	10.03** (12.14 – 23.19)
	Obvious shaking	(2)	72.00 (4.24)	55.59 (20.63)	5.46 (-21.02 – 53.85)
	Obvious stiffness	(56)	75.11 (8.40)	55.49 (20.62)	17.22** (17.34 – 21.90)
	Other limitation[b]	(68)	70.65 (13.45)	55.48 (20.63)	9.23** (11.89 – 18.45)
	Condition already on record	(5)	59.60 (24.70)	55.59 (20.62)	0.36 (-26.66 – 34.69)

[a] All *t*-tests do not assume equal variances.
[b] Does not include those customers marked as blank/missing.
* *p*-value < .05
** *p*-value < .01

Clearly, most of the questions that constituted the physical observation protocol flagged potential physical limitations whose presence correlates with age: those with observed limitations were, on average, anywhere from 10 to 20 years older than those with no observed physical limitations. In general these differences were statistically significant; the only exceptions were those questions regarding conditions for which CA DMV already had record (both upper and lower body) and obvious shaking in the lower body. These questions also had very small Ns, which affects any tests of statistical significance. This also has important substantive implications, as fewer than 10

people out of over 10,000 seen through standard renewal procedures had a condition on the record for which their compensatory skill had previously been assessed by CA DMV. Moreover, only two people were observed with obvious shaking in the lower body.

Table 27 presents the age distribution of those observed with and without physical limitations, by the cumulative number of limitations so observed. In addition to the mean age of customers observed with various numbers of limitations (none, 1 only, 2 or more), the table displays the number of customers stratified by age (less than 45, 46-69, 70-74, and greater than 75 years of age).

Table 27

Age Distribution of Pilot Cohort (Renewals Only) by Cumulative Count of Observed Physical Limitations

N of observed limitations	Mean age (*SD*)	*N* of customers in each age stratum (percent of customers within that age cohort)			
		< 45 (%)	45 – 69 (%)	70 – 74 (%)	> 75 (%)
No observed limitations (10,449)	54.88 (20.62)	3929 (99.6)	2055 (97.3)	2285 (94.8)	2180 (90.3)
One limitation (395)	72.61 (10.98)	15 (0.4)	51 (2.4)	120 (5.0)	209 (8.7)
≥2 limitations (39)	74.62 (11.47)	2 (0.1)	5 (0.2)	6 (0.2)	26 (1.1)
Total	55.59 (20.63)	3946	2111	2411	2415

Note: Gamma = 0.64, significant at the <0.01 level.

It is clear that age correlates with the number of observed physical limitations; this correlation is also statistically significant. That said, these limitations are observed only rarely, and there is no obvious cut-off age at which they appear. Not only did staff observe some younger participants with physical limitations, the overwhelming majority of older participants (those aged 75 or above) were observed to be free of potential driving-relevant limitations.

This correlation with age also appears in regard to the other assessment elements of Tier 1. Table 28 displays the distribution of outcomes on the memory recall assessment, by age stratum.

Table 28

Age Distribution of Pilot Cohort (Renewals Only) by Outcome on the Memory Recall Assessment

Memory recall assessment outcome (*N* of customers)	Mean Age (*SD*)	*N* of customers in each age stratum (percent of customers within that age cohort)			
		< 45 (%)	45 – 69 (%)	70 – 74 (%)	> 75 (%)
Passed (10,756)	55.42 (20.62)	3935 (99.7)	2101 (99.5)	2376 (98.5)	2353 (97.4)
Failed (118)	71.10 (13.86)	11 (0.3)	10 (0.5)	35 (1.5)	62 (2.6)
Total	55.59 (20.62)	3946	2111	2411	2415

Note: Gamma = 0.58, significant at the <0.01 level.

Table 29 presents the distribution, by age stratum, of outcomes on the visual acuity assessment.

Table 29

Age Distribution of Pilot Cohort (Renewals Only) by Outcome on the Visual Acuity Assessment

Visual acuity assessment outcome (*N* of customers)	Mean Age (*SD*)	*N* of customers in each age stratum (percent of customers within that age cohort)			
		< 45 (%)	45 – 69 (%)	70 – 74 (%)	> 75 (%)
Passed (10,637)	55.19 (20.61)	3937 (99.8)	2081 (98.6)	2353 (97.6)	2275 (94.2)
Failed (237)	73.35 (11.50)	9 (0.2)	30 (1.4)	58 (2.4)	140 (5.8)
Total	55.59 (20.62)	3946	2111	2411	2415

Note: Gamma = 0.66, significant at the <0.01 level.

As with the physical observation protocol, age does correlate with outcomes on this assessment, and this correlation is statistically significant. However, the association is weak, owing largely to the rarity of failure on this assessment. Even among those aged 75 or older, fewer than 3% of customers failed this assessment.

Age correlates with outcomes on the visual acuity assessment, and this correlation is statistically significant. However, there is no clear cutoff point for determining excess risk. About one sixth of those who failed this assessment were younger than 70, while even among those aged 75 or older, fewer than 6% of customers failed.

Table 30 displays the distribution, by age stratum, of customer outcomes on the Pelli-Robson contrast sensitivity assessment. Due to the small number of customers who extreme failed on this assessment, those who failed on Line 1 are combined with customers who failed on Line 4 into the category "extreme fail." Those who were not assessed for contrast sensitivity are excluded from the analysis.

Table 30

Age Distribution of Pilot Cohort (Renewals Only) by Outcome on the Contrast Sensitivity Assessment

Contrast sensitivity assessment outcome (*N* of customers)	Mean Age (*SD*)	*N* of customers in each age stratum (percent of customers within that age cohort)			
		< 45 (%)	45 – 69 (%)	70 – 74 (%)	> 75 (%)
Passed (9,212)	52.47 (20.49)	3885 (98.5)	1912 (91.2)	1835 (77.1)	1576 (67.0)
Somewhat Fail (1,487)	72.41 (10.57)	59 (1.5)	177 (8.4)	529 (22.2)	723 (30.8)
Extreme Fail (75)	76.92 (6.50)	0 (*N/A*)	7 (0.3)	16 (0.7)	52 (2.2)
Total	55.39 (20.62)	3944	2096	2380	2351

Note: Gamma = 0.69, significant at the <0.01 level.

As with other elements of Tier 1, age stratum correlates with outcomes on this assessment, and this association is statistically significant. And while there is no age at which this assessment clearly differentiates between groups, a noticeably greater percentage of customers over age 70 somewhat fail the contrast sensitivity test in comparison to younger cohorts.

All of the Tier 1 assessment tests thus individually correlate with age, which is to say that each of the Tier 1 assessment tests individually flags age-related driving-relevant limitations in vision, cognition, and physical function. In addition, all of the tests in combination are also correlated

with age, as demonstrated in Table 31. Those with incomplete totals (e.g., those who were never assessed for contrast sensitivity) are excluded from the analysis.

Table 31

Age Distribution of Pilot Cohort (Renewals Only) by Cumulative Score on the Tier 1 Assessments

Tier 1 total score (*N* of customers)	Mean Age (*SD*)	*N* of customers in each age stratum (percent of customers within that age cohort)			
		< 45 (%)	45 – 69 (%)	70 – 74 (%)	> 75 (%)
Pass (total score of 0) (8,915)	51.91 (20.44)	3860 (97.8)	1866 (88.6)	1740 (72.3)	1446 (60.1)
Somewhat Fail (total score of 1) (1,729)	71.66 (11.31)	84 (2.1)	226 (10.7)	615 (25.5)	804 (33.4)
Extreme Fail (total score ≥2) (225)	76.49 (6.91)	2 (0.1)	15 (0.7)	53 (2.2)	155 (6.5)
Total	55.56 (20.63)	3946	2107	2408	2405

Note: Gamma = 0.69, significant at the <0.01 level.

Age and cumulative number of identified limitations thus correlate, and this correlation is significant. Although older customers were more likely to be identified as having one or more driving-relevant limitations, three-fifths of those over the age of 75 had no identified limitations.

CHARACTERISTICS OF PILOT CUSTOMERS BY TIER 2 ASSESSMENT OUTCOME

Passage or failure on the written renewal test does not exhibit a consistent relationship with age, as shown in Table 32. Those who declined to attempt a test (four cases, one individual at each test attempt) are excluded from the analysis. Due to the small number of observations (only 28 customers had to make five or more attempts at the written renewal test), only failures up to the fourth attempt are shown. There are some small differences (5-6 years in the expected direction) in the mean ages of customers failing their second and third attempts at the written test. These differences are statistically significant in both cases. However, this relationship is not evident at the first or fourth attempts, where the mean ages of those passing versus those failing are essentially identical.

Table 32

Age Distribution of Pilot Cohort (Renewals Only) by Outcomes on the Written Test

Written test attempt	Outcome (*N* of customers)	Mean Age (*SD*)	*N* of customers in each age stratum (percent of customers within that age cohort, for that attempt)			
			< 45 (%)	45 – 69 (%)	70 – 74 (%)	> 75 (%)
First[a]	Pass (8673)	55.69 (20.51)	3114 (78.9)	1717 (81.3)	1923 (79.8)	1919 (79.5)
	Fail (2209)	55.20 (21.07)	832 (21.1)	393 (18.7)	488 (20.2)	496 (20.5)
Second[b]	Pass (1760)	54.00 (21.07)	702 (84.4)	322 (81.9)	378 (77.5)	358 (72.2)
	Fail (448)	59.84 (20.45)	130 (15.6)	71 (18.1)	110 (22.5)	137 (27.6)
Third[c]	Pass (347)	58.53 (21.06)	112 (86.2)	55 (77.5)	78 (70.9)	102 (74.5)
	Fail (100)	64.22 (17.65)	18 (13.8)	16 (22.5)	32 (29.1)	34 (24.8)
Fourth[d]	Pass (70)	63.94 (17.99)	14 (77.8)	9 (56.3)	23 (71.9)	24 (70.6)
	Fail (29)	64.48 (17.27)	4 (22.2)	7 (43.8)	9 (28.1)	9 (26.5)

[a] Gamma = 0.01, not significant.
[b] Gamma = -0.21, significant at the <0.01 level.
[c] Gamma = -0.18, significant at the <0.05 level.
[d] Gamma = 0.08, not significant.
Not shown: four cases (one at each attempt) who declined to take the test.

Outcomes on the PRT test are associated with age, as shown in Table 33. The comparison group (those who passed the PRT) here consists only of those customers who took the PRT, and excludes all customers who terminated their participation in the pilot at Tier 1. This has the effect of constraining the variation present in the data, since those who took the PRT were substantially older than the 3-Tier Pilot population as a whole. It is therefore all the more instructive that there remain significant differences in age across all outcomes on this assessment (somewhat fail, extreme fail, and abort) as compared with those who passed. That said, there is no clear age at which outcomes on this test are consistently different: a few of those among

younger age strata failed this test, and the overwhelming majority (>80%) of customers older than 75 passed this test.

As a side note, according to the design of the pilot those with scores of 41-500 (extreme fail) were treated similarly to those who timed out on the test (abort)—all were asked to advance to Tier 3 and so to take an on-road drive test. According to these data, there was no significant difference in mean age between extreme fails (77.7 years) and aborts (75.9 years) (t = 1.44, p = 0.16).

Table 33

Age Distribution of Pilot Cohort (Renewals Only) by Outcome on the PRT

PRT score (*N* of customers)	Mean Age (*SD*)	*N* of customers in each age stratum (percent of customers within that age cohort)			
		< 45 (%)	45 – 69 (%)	70 – 74 (%)	> 75 (%)
Pass (2,012)	68.65 (14.96)	214 (98.6)	293 (94.8)	662 (89.6)	843 (82.5)
Somewhat Fail (12)	74.58 (8.85)	0 (0)	1 (0.3)	5 (0.7)	6 (0.6)
Extreme Fail (19)	77.74 (5.34)	0 (0)	0 (0)	5 (0.7)	14 (1.4)
Abort (244)	75.86 (7.06)	3 (1.4)	15 (4.9)	67 (9.1)	159 (15.6)
Total	69.53 (14.44)	217	309	739	1022

Note: Gamma = 0.45, significant at the <0.01 level.

CHARACTERISTICS OF PILOT CUSTOMERS BY TIER 3 ASSESSMENT OUTCOME

In examining the age distribution of Tier 3 customers, it is useful to distinguish between those customers required to take a drive test specifically because of 3TAS, and those customers who would have taken a drive test even in the absence of the 3-Tier Pilot. Those who would have taken drive tests regardless of pilot participation include Driver Safety referrals and limited-term license customers. Table 34 displays the age distribution of customers making their first attempt at the SDPE. Customers who postponed their first drive test to a later time are excluded from the analysis. All types of fails are combined.

Table 34

Age Distribution of Pilot Cohort (Renewals and Referrals) by Outcomes on the First SDPE

Source of drive test (*N* of customers)	Outcome (*N*)	Mean Age (*SD*)	*N* of customers in each age stratum (percent of customers within that age cohort)			
			< 45 (%)	45 – 69 (%)	70 – 74 (%)	> 75 (%)
3-Tier process[a] (389)	Pass (307)	71.88 (11.58)	17 (77.3)	32 (80.0)	90 (81.1)	168 (77.8)
	Fail (82)	73.91 (12.88)	5 (22.7)	8 (20.0)	21 (18.9)	48 (22.2)
Limited-term[b] license (190)	Pass (140)	76.02 (7.88)	1 (100)	14 (93.3)	33 (78.6)	92 (69.7)
	Fail (50)	78.84 (7.08)	0 (*N/A*)	1 (6.7)	9 (21.4)	40 (30.3)
Driver Safety referral[c] (110)	Pass (77)	59.66 (19.63)	18 (100)	33 (76.7)	3 (50)	23 (53.5)
	Fail (33)	74.82 (12.29)	0 (*N/A*)	10 (23.3)	3 (50)	20 (46.5)

[a] Gamma = -0.05, not significant.
[b] Gamma = -0.37, significant at the 0.05 level.
[c] Gamma = -0.62, significant at the 0.01 level.

The relationship between age and outcomes on the first drive test depend, in part, on the population of interest. For drivers identified as needing assessment through the 3-Tier process specifically, age is unrelated to passage on the first SDPE: across age cohorts the fail rate falls within a narrow band (19-23%). For drivers previously identified as having a progressive vision disorder or whose enrollment in the pilot stemmed from a Driver Safety referral, age does have a statistically significant relationship to likelihood of passing the drive test. In both cases (limited-terms and Driver Safety referrals) older drivers are substantially and significantly more likely than younger drivers to fail their first attempt at the SDPE. In the case of limited-term license holders, this may be a product of disease progression making it more difficult to compensate for declines in vision health and still drive safely. For Driver Safety referrals, this may reflect the variety of reasons for which customers are referred for assessment and examination. Younger customers were somewhat more likely to be referred for lapses of consciousness and stable physical conditions—conditions that may be readily correctable by various means (changes to medication, adjustments to vehicle control systems, etc.). Approximately half of those older customers in the Driver Safety pool (27/50 of those aged 70 and older) were referred for lack of

skill—hazardous driving behaviors identified by law enforcement or other sources and reported to CA DMV.[19] In other words, many older customers were required to take a drive test because of previously-identified dangerous driving behavior. That said, because of the small cell-size counts, these correlations should be treated with some caution.

Table 35

Age Distribution of Pilot Cohort (Renewals and Referrals) by Outcomes on the Second SDPE

			N of customers in each age stratum (percent of customers within that age cohort)			
Source of drive test (*N* of customers)	Outcome (*N*)	Mean Age (*SD*)	< 45 (%)	45 – 69 (%)	70 – 74 (%)	> 75 (%)
3-Tier process[a] (82)	Pass (66)	73.08 (14.00)	5 (100)	8 (100)	17 (73.9)	36 (78.3)
	Fail (16)	76.31 (5.06)	0 (*N/A*)	0 (*N/A*)	6 (26.1)	10 (21.7)
Limited-term[b] license (50)	Pass (42)	78.07 (6.85)	0 (*N/A*)	1 (100)	7 (77.8)	34 (85.0)
	Fail (8)	80.75 (5.95)	0 (N/A)	0 (N/A)	2 (22.2)	6 (15.0)
Driver Safety referral[c] (22)	Pass (11)	73.00 (18.50)	1 (100)	2 (25.0)	1 (100)	7 (58.3)
	Fail (11)	70.64 (14.38)	0 (N/A)	6 (75.0)	0 (N/A)	5 (41.7)

[a] Gamma = -0.27, not significant.
[b] Gamma = 0.15, not significant.
[c] Gamma = 0.30, not significant.

Table 35 displays the age distribution of customers taking the second SDPE test.

There does not appear to exist any statistical association between age and likelihood of passing the second SDPE, regardless of customer type (3-Tier process, limited-term license, or Driver Safety referral). However, because of small cell-size counts (especially among younger age strata), this lack of statistical association should be treated with caution. It is also worth noting that the overall fail rate (regardless of age) remains roughly the same between the first and second SDPE, at least for 3-Tier process customers (approx. 20%) and limited-term license

[19] The total number of Driver Safety cases over the age of 70 includes one customer who took an ADPE.

holders (16-26%). For Driver Safety referrals, the fail rate increases substantially between the first attempt (30% fail rate) and the second attempt (50% fail rate).

Because of small cell-size counts, it is not meaningful to disaggregate customers taking the 3rd SDPE, or the ADPE, by age stratum. Therefore, in Table 36, the mean age of customers passing and failing are compared.

Table 36

Age Distribution of Pilot Cohort (Renewals and Referrals) Taking a 3rd SDPE or an ADPE

Test attempt and type	Source of drive test requirement (*N*, pass rate)	Mean age, in years (*SD*)		*t*-test [2-tailed][a] (95% CI)
		Failed	Passed	
Third SDPE	All sources combined (24, 75.0%)	72.83 (11.86)	76.61 (7.85)	0.73, 0.49 (-8.66 – 16.21)
First ADPE	All sources combined (16, 87.5%)	84.50 (0.71)	80.57 (7.33)	1.94, 0.07 (-0.41 – 8.26)
Second ADPE	All sources combined (2, 50.0%)	84	85	N/A

[a] All *t*-tests do not assume equal variances.

Given the age-related nature of the limitations assessed by the various components of 3TAS, it is worth noting that taking a drive test (regardless of type or attempt) is correlated with age. Those taking drive tests were, on average, 17.6 years older than those who did not advance to Tier 3 ($t = 32.87$, $p. < .01$); furthermore, only 20% of those customers who took drive tests were younger than age 70. This has the effect of constraining the variation within the data in Tables 34-36. This in turn constrains any potential variation in the age profile of failing and passing customers. To the extent that differences exist in the age profile of those passing versus failing the drive-test, these differences are small and statistically significant only for the first attempt (Table 34), and then only for drivers whose drive test requirement stemmed from a previously-identified progressive vision disorder (limited-term license holder) or a Driver Safety referral.

Process Analyses

In conducting the current process evaluation, the author followed the principles of "utilization focused" evaluation (Patton, 2008; Rossi, Lipsey & Freeman, 2004). This approach highlights the importance of the utility of the evaluation itself—the degree to which the information produced in the evaluation will be useful to those making decisions about whether, and how, to implement any elements of the evaluated project. Adoption of a utilization-focused approach to the process evaluation of the 3-Tier Pilot has specific implications for the manner in which this process evaluation was conducted. In particular, this evaluation was conducted with attention to (a) the situational context of the project, and (b) its potential or intended uses and users. This required flexibility in the choice of specific techniques of analysis, the presentation of results, and in the interpretation of practical implications of the analyses. It also required flexibility in evaluating processes and outcomes even (perhaps especially) where those processes and outcomes were surprising or contradicted the findings of others. The ultimate goal is to ensure, as far as practicable, that the findings of the analysis are useful for those making future decisions regarding policy and implementation. The findings may thus include a range of alternative implications. These alternatives are provided both to emphasize the contextually-situated nature of a program of the size and scope of 3-Tier, while at the same time allowing for implementation possibilities that may have quite different implications on a substantive level.

The Costs to Implement the 3-Tier Pilot

The bulk of the cost to implement the 3-Tier Pilot came in the form of personnel. These costs included: added staff positions in the pilot field offices to provide coverage for the expected increase in workload resulting from the pilot; the funding of training for staff in the new assessment procedures; and the funding of researcher time in the preparation and oversight of the pilot as well as the analysis of the resulting data. Secondary costs included the purchase of new equipment necessary for some of the assessment tests, contractual services related to the programming of one of the new assessment tests (the PRT), the purchase of new equipment necessary for the secure electronic storage of customer data during the pilot, and travel expenses related to oversight of the pilot as well as presentation of the resulting data to various stakeholders. Table 37 consolidates data drawn from the quarterly reports submitted to the Office of Traffic Safety, the funding agency for the pilot.

Table 37

The Cost to Implement the 3-Tier Pilot

Cost Category	Amount[a]
Personnel (salary, benefits, etc.)	$ 989,935
Travel	$ 23,942
Contractual services	$ 3,600
Other (equipment purchases, etc.)	$ 16,227
Total	$1,033,705

[a] Figures rounded to the nearest whole dollar.

To some degree these reported costs may underestimate the amount of time spent by Field Operations Division (FOD) staff on the pilot, and especially the amount of time indirectly spent managing the workload demands produced by pilot-related changes to field office procedures. While the grant paid for additional positions to provide coverage for expected increases in workload, these positions constituted a small minority of the total staff working in the six pilot field offices. Given the nature of working conditions in the field offices, the effects of any increase in workload were shared by *all* staff at the pilot offices. For example, any decrease in customer processing efficiency (and consequent effect on wait times) was spread office-wide, and not confined just to those staff working with 3-Tier customers. These costs are not really captured in the figures reported in Table 37.

These reported costs also do not capture any expenses incurred as a result of the added workload associated with 3-Tier eligible customers processed by the Sacramento Driver Safety Office (DSO). Because the increase to workload for that Branch did not rise to the level of hiring additional staff, this was not captured in costs charged to the grant. Nevertheless, the tasks for Hearing Officers associated with participation in the pilot impacted the workload experienced by the Sacramento Branch Office, especially in terms of additional paperwork required for the completion of a given customer's case file.

In addition, these reported costs do not precisely capture some of the expense of oversight and management of the pilot. This includes some of the costs associated with (a) increased demand placed on the Departmental Training Branch (DTB) in preparing and delivering classes in new procedures (especially refresher training for the Licensing Registration Examiners (LREs) who conducted 3-Tier drive tests), (b) increased managerial oversight of the pilot by FOD Region III

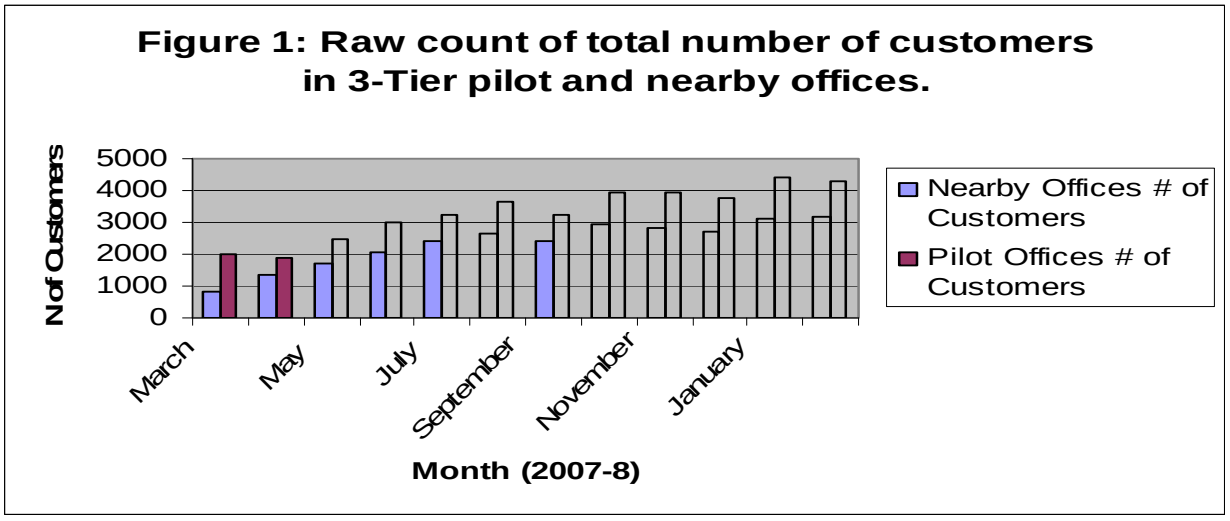
and FOD Staff Services, and (c) increased managerial oversight of the pilot by Driver Safety Training and Procedures. These costs were absorbed by CA DMV directly, and are not estimable given available data.

Customer Migration

GROSS CUSTOMER FLOWS BEFORE, DURING, AND AFTER THE 3-TIER PILOT

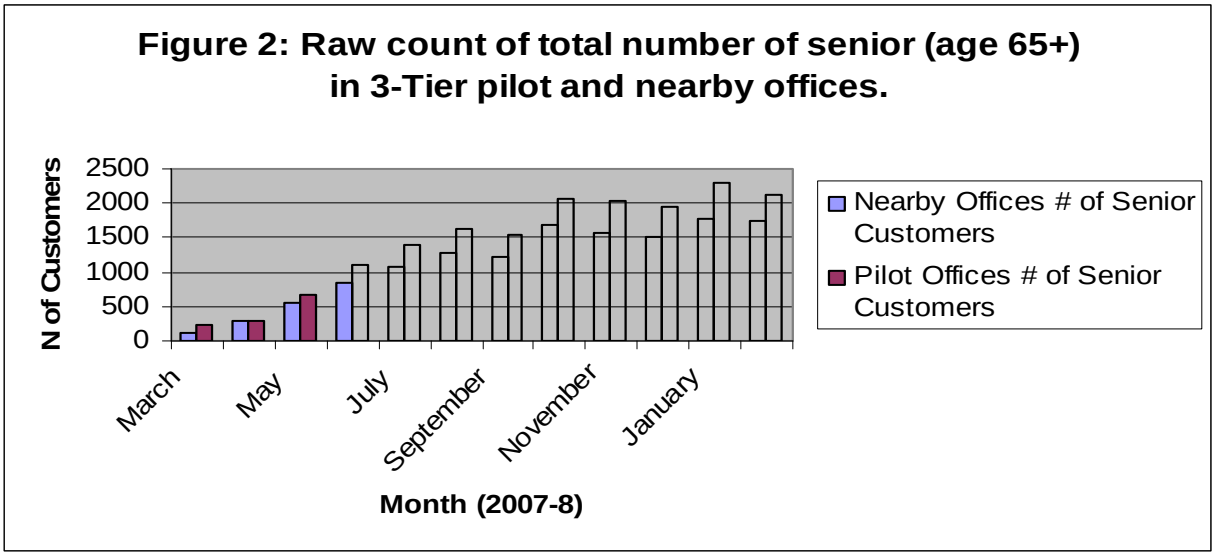
One method of estimating the potential problem of customer migration is to compare the gross number of customers processed in 3-Tier Pilot offices in comparison to (a) the number of customers processed in nearby offices, and (b) the number of customers processed in 3-Tier offices just prior to, and just after, the pilot period. The following figures display the unique number of driver license renewal customers[20] making visits to 3-Tier Pilot offices as well as the seven closest offices deemed most likely to be the destination for any customers seeking to avoid participation in the 3-Tier Pilot. These nearby offices include: Davis, Lodi, Napa, Placerville, Rocklin, Roseville, and Woodland. These data are drawn from DMV's internal Audits database.

Figure 1 displays the total number of customers:



[20] Customers making multiple visits are counted only once.

Figure 2 displays the number of senior customers (those aged 65+) visiting these same offices:



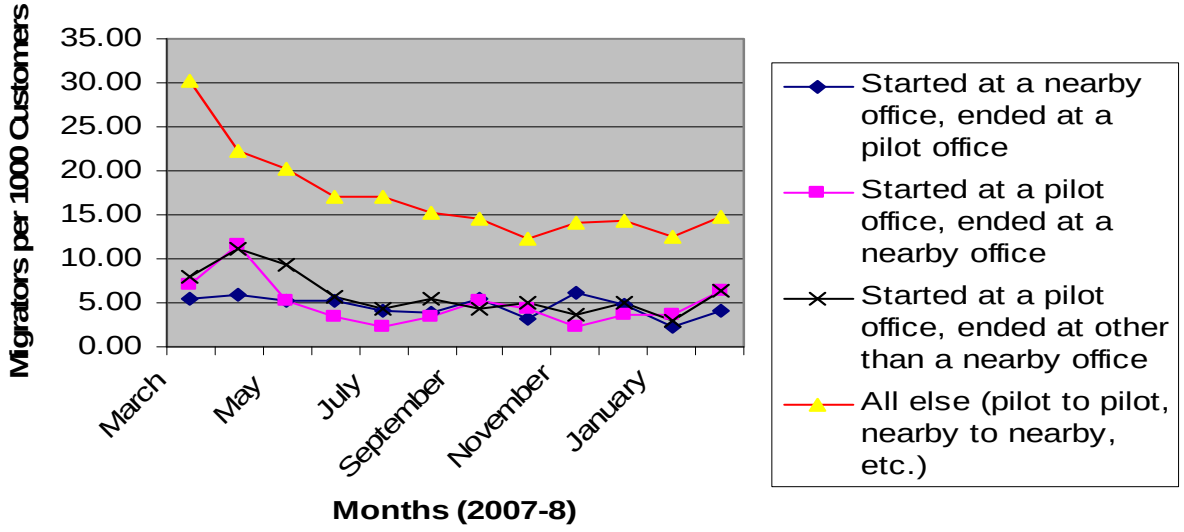
It does not appear from these data that customers migrated away from pilot offices toward nearby offices to avoid participation in 3-Tier, or at least not in substantial numbers. Indeed, while the overall number of customers increased compared to the months just prior to 3-Tier (more on which below, in the discussion of the baseline period data), the ratio of customers visiting pilot offices to those visiting nearby offices is remarkably stable over the period: during the pilot (June-October 2007) this ratio is 1.37, while the ratio for the pre- and post-pilot months (April-May and November-February) is 1.39. Furthermore, the trend lines are correlated at either $r = 0.97$ (total N of customers) or $r = 0.99$ (total N of senior customers). In other words, the shapes of the two data curves over the course of the three periods (pre-pilot, pilot, and post-pilot) are essentially identical, random error permitting.

CUSTOMERS SWITCHING FIELD OFFICES BEFORE, DURING, AND AFTER THE 3-TIER PILOT

Counting the flow of all customers, or even just all senior customers, into field offices may obscure the number of migrating customers if such occurrences are rare. To estimate what may have been a rare but nevertheless potentially important data trend, the author constructed estimates, based on DMV's internal Audits database, of the rate of office-switching before, during, and just after the 3-Tier Pilot period. In this model, a migrating customer was defined as one who began a license renewal at one office but was then issued their license at a different office. Separate estimates were constructed for customers switching from a pilot office to a nearby office, from a nearby office to a pilot office, from a pilot office to some office other than

a nearby office (i.e., one outside of the immediate geographic area), and a rump category of "all else" that includes customers who switched from one pilot office to another pilot office, from a nearby office to another nearby office, or from a nearby office to one out of the area. Figure 3 presents these estimates, converted to a rate (migrating customers per 1000) to account for the fact that the nearby offices processed fewer customers, on average, than did the pilot offices.

Figure 3: Migrating customers before, during, and just after the 3-Tier pilot.



Two patterns may be discerned from Figure 3. First, the overall rate of migrating customers did not rise during the pilot period. If anything there appears to have been a decline in office migration as compared to the pre-pilot period. This may relate to certain oddities of the baseline period, discussed in more detail below. Secondly, the rate of customers migrating from pilot to nearby offices (which would occur if customers were attempting to avoid participating in the 3-Tier Pilot) was essentially identical to the rate of customers migrating from nearby to pilot offices. Taken together, these data patterns suggest that while a certain amount of customer migration occurs at DMV field offices, the underlying rate of migration between offices was not noticeably affected by the 3-Tier Pilot. In other words, customers switching from one field office to another may simply constitute statistical noise. DMV customers are not required to use any particular field office (indeed, to the extent possible, customers are encouraged to conduct their transactions by mail or internet, to save time and money). Many individuals use offices near their home, or their place of work, or some other locality for any number of idiosyncratic reasons having very little to do with licensing assessment.

MIGRATING CUSTOMERS IDENTIFIED DURING THE 3-TIER PILOT

All of that aside, it is an incontestable fact that some individuals did, in fact, switch from a pilot office to a non-pilot office. Seventy-one (71) customers enrolled in the 3-Tier Pilot, but then completed their license renewal process at a non 3-Tier office.[21] The demographic characteristics of these 71 customers are detailed in Table 38. For comparison, parallel descriptive statistics for all 3-Tier Pilot customers are provided. As a general matter, it appears that those customers who chose to complete their applications at a non 3-Tier office were somewhat younger and substantially more likely to have negligent operator points on their records, as compared to the universe of 3-Tier customers.

Table 38

Characteristics of Migrating and Non-Migrating Customers (Pilot Cohort)

	Mean age (*SD*)[a]	Proportion female[b]	Mean number of negligent operator points in prior 3 years (*SD*)[c]
Migrating customers (*n* = 71)	49.32 (22.45)	46.5%	1.32 (2.27)
All pilot cohort (*n* = 10,999)	55.67 (20.63)	47.7%	0.35 (0.87)

[a] *t*-test = 2.38 (equal variances not assumed), significant at <0.05 level.
[b] χ^2 = 0.04, not significant.
[c] *t*-test = 3.63 (equal variances not assumed), significant at the <0.01 level.

The various stages in the application process at which these customers ceased participation in the pilot are detailed in Table 39. In the absence of targeted surveys or interview data, it is impossible to know for certain why any given individual chose to switch from a pilot to a non-pilot office. That said, it would be difficult to say on the basis of Table 39 that substantial numbers of customers were opting out of participation in the pilot because of 3-Tier procedures *specifically*.

[21] This excludes one customer who completed their non-commercial application at a non-pilot office, then immediately filed for a commercial license.

Table 39

Final Known Assessment Stage of 3-Tier Customers with Completed Applications at a Non 3-Tier Office

Tier at exit	Final known assessment hurdle	*N* (% of total)
Tier 1	Failed visual acuity	5 (7.0)
	Extreme fail on contrast sensitivity	1 (1.4)
Tier 2	Prior to first written test	18 (25.4)
	After first written test fail	30 (42.3)
	After second written test fail	2 (2.8)
Tier 3	After third written test fail	5 (7.0)
	After fourth written test fail	2 (2.8)
	Prior to first scheduled drive test	6 (8.5)
	After first drive test fail	2 (2.8)
Total number of migrating customers		71

Many of these migrating customers may have switched offices because of some other (non 3-Tier) issue, such as a change in residence.[22] Some appear to have required additional time to pay certain fees associated with traffic violations, failure-to-pay or failure-to-appear court sanctions, and DUI offenses. These aside, if one combines those that failed the contrast sensitivity assessment with all those who were definitely subject to a drive test, approximately 21 customers appear to have declined to participate in 3-Tier under circumstances of enhanced, specifically pilot-related, assessment.[23] Given the overall size of the pilot sample (n = 10,999), or even that sub-sample of 3-Tier customers who took drive tests due specifically to 3-Tier related assessment outcomes (n = 389), it is unlikely that the number of migrating customers identified here would materially change either the process or the outcome findings. That said, sensitivity analyses will be performed in the outcome analysis to better quantify the potential parameters of any biased introduced by these migrating customers.

[22] Of these 71 customers 26 (or slightly over one-third) appear on the basis of the address listed on their driver record to have moved residences during the period that they were renewing their license. It seems probable that, at least in these cases, switching offices was a result of the move in residence rather than a result of enhanced assessment associated with license renewal.

[23] This number combines the following categories: failed visual acuity (5), failed contrast sensitivity (1), three time written test fail (5), four time written test fail (2), prior to first scheduled drive test (6), and drive test fail (2).

QUALITATIVE EVIDENCE REGARDING CUSTOMER MIGRATION

It is of course possible that customers who migrated from one office to another did so without first starting their transaction at a pilot office. This may have included customers who read about the pilot in the paper (or saw a news report on television) and by some means determined which offices were included in the program. This would not have been difficult, as each of the pilot offices featured new and rather obvious pieces of equipment related to the new assessment tests. The Pelli-Robson contrast sensitivity assessment charts, in particular, were hung from the ceiling in all of the pilot offices and look quite different from the Snellen visual acuity charts. The Pelli-Robson charts were often featured prominently in the various articles and stories published on the pilot. It is therefore at least conceivable that certain customers, upon seeing the Pelli-Robson charts in an office, turned around and drove to the next (non-pilot) field office.

To indirectly gauge the potential size of this lost sample population, informal interviews were conducted of staff at some of the nearby offices. Staff were asked if they had overheard any customers asking about the pilot and, if so, what these customers had said. In particular, staff were asked if they knew of any customers who reported coming to that (non-pilot) office instead of going to a pilot office. Staff at these non-pilot offices reported that they *did* receive questions from some customers regarding the 3-Tier system. However, they did *not* report that these customers appeared to have come there instead of going to a pilot office. Rather, the questions (as reported by staff) tended to be of an informational nature, reflecting curiosity about the new program.

Each of these sources of data—gross customer flows, customers identified through the Audits system as switching from office to office, 3-Tier customers who completed their applications at non-Tier offices, and informal staff reports—independently suggests that while some small number of individuals may have avoided the 3-Tier Pilot, this did not constitute a substantial methodological threat to the validity of the findings. To the degree that individuals were moving from one office to another during the course of a license renewal, this likely consisted at least to some degree of individuals in the midst of moving their primary residence, using offices that are near their place of work as opposed to near their home, or otherwise statistical noise generated by a mobile urban population.

Processing Errors in Pilot Period

Procedural errors (as opposed to data recording errors) took multiple forms during the pilot period. Summarizing them is no simple task, not least because in a non-trivial number of cases multiple procedural errors occurred. Table 40 lists, as best as can be reconstructed, the number and type of uncorrectable processing and data errors committed during the 3-Tier Pilot. Where a customer has multiple errors, only the more serious error is tabulated. Less serious errors are listed first.

There are a number of caveats to be noted regarding the interpretation of the data presented in this table. First, there is no method by which to estimate parallel figures for the baseline period. Thus, there exists no straightforward way to gauge the *relative* magnitude of the number of errors committed during the pilot, in comparison to some established baseline number of errors. To estimate the degree to which processing errors were associated with the pilot program itself—as opposed to flowing from the standard organizational difficulties inherent to processing thousands of customers in a busy public agency setting—the author must use alternative methods of analysis. Secondly, there is no reliable method by which to estimate less visible forms of error that did not lead to, for instance, clearly contradictory information within the recorded data. This includes the anecdotally reported variation in the administration of the memory recall test, and the anecdotally reported variation in the administration of the contrast sensitivity assessment. In these latter two instances, any errors in processing will show up as bias in the findings, rather than quantifiable (and thus measurable and controllable) error counts. For further discussion of the methodological implications of these two forms of error, see the relevant sub-sections of the Discussion and Conclusions (pp. 182-182 and 183-185). For an analysis of some empirical data regarding variation in the administration of the contrast sensitivity assessment, see Module 4 of the Appendix.

Each of the error categories listed in Table 40 likely derives from a variety of issues and problems. Because these issues and problems intersect with findings drawn from other process analysis results (in particular, the staff surveys and interviews), they are discussed at more length in the conclusions. Second, these data include no estimation of the number of errors committed in the administration of the educational intervention. A number of staff reported in interviews (see Module 2 of the Appendix) that they administered the educational intervention substantially more often than is in fact recorded in the paper files for the customers they processed. Reconstructing these data is therefore difficult, and no attempt was made to estimate the extent

Table 40

Uncorrectable Data and Processing Errors, by Type

Error category	Error sub-category	*N* of customers
Non 3-Tier customer	Motorcycle endorsement	36
	Took written test in language other than English	24
	Commercial license applicant	23
	Took written test orally (person-to-person or audio)	16
	Renewal, but written test not required	10
	Original license applicant	6
	Began application at non-pilot office	3
	Sub-total	118
Missing document or data	Written test results missing, unknown number of fails	137
	DL62 (referral to professional vision specialist) missing	81
	Customer completed application at non-pilot office	71
	Drive test score sheet missing	11
	Documents missing for Driver Safety Referral case	10
	Missing 3-Tier Tracking Sheet	10
	Tier 1 Score Sheet missing	2
	Pelli-Robson contrast sensitivity assessment not administered	6
	Name/DL mismatch	4
	Sub-total	332
PRT not given	Two time fail on written test	55
	Somewhat fail on contrast sensitivity assessment	36
	Tier 1 score ≥ 1	16
	Sub-total	107
Drive test not given	Three time fail on written test	122
	Extreme fail or abort on PRT	56
	Tier 1 score ≥ 2	42
	Failed visual acuity standard	2
	Tier 1 = 1 and PRT = somewhat fail	3
	Sub-total	225
Unnecessary procedure	Wrong drive test type given	5
	Drive test given when not required	2
	Sub-total	7
Other	Customer deceased before re-licensing	2

of erroneous processing that occurred in this element of 3TAS. Third, customers who took the PRT even though it was not required in their case are not included in Table 40. Anecdotally it appears that these instances may have at least partly arisen out of personal curiosity on the part of customers about this new test (i.e., they asked to take it, even though it was not required). In any case it does not appear that taking the PRT when it was not required resulted in substantially different outcomes for these individuals: none of them failed the assessment (see Table 23, p. 77, above). Finally, these figures do not include the 686 "lagging" customers, i.e., those who completed their application sometime after 12/31/07. Many of these customer files also have incomplete data, documents missing, or procedural errors. These data are discussed in the next sub-section.

The existence of these processing errors has a number of implications for the process analyses discussed in this report. In the first instance, over 200 drive tests were not given that were technically required under 3-Tier Assessment System procedures. If these had been given, the number of reported 3-Tier Assessment System-generated drive tests would have increased by nearly 40% (from 389 to 614, counting only first SDPEs. Compare Table 34, p. 89, above).[24] This constitutes a substantial underestimate of the number of drive-tests generated by 3TAS. Because the time required to administer an on-road drive test constitutes a substantial portion of the added workload of 3TAS to current CA DMV processes and procedures, this potentially biases any estimation of the costs of a potential statewide rollout. This potential bias has been taken into account in the estimates presented in this report.

Secondly, however, the existence of these erroneously processed customers constitutes a potential source of bias in the estimation of the demographic and behavioral characteristics of the pilot cohort. Table 41 compares the mean age, gender distribution, and prior violation rates of erroneously processed customers in comparison to the pilot cohort.

[24] This does not include the number of drive tests that would also have been required for those customers who should have taken the PRT, and who would have extreme failed or aborted had they done so. This is probably a small number, on the order of 10-12 customers, given the fail rate for this test reported in Table 14, p. 67, above. It also does not include the (also probably small) number of drive tests that may have been generated by customers for whom we have no precise estimate of the number of times they failed the written test.

Table 41

Characteristics of Erroneously Versus Correctly Processed Customers (Pilot Cohort)

	Mean age (*SD*)[a]	Proportion female[b]	Mean number of negligent operator points in prior 3 years (*SD*)[c]
Erroneously processed customers (*n* = 664)	58.00 (20.45)	48.2%	0.56 (1.27)
All pilot cohort (*n* = 10,999)	55.67 (20.63)	47.7%	0.35 (0.87)

[a] t-test = 2.85 (equal variances not assumed), significant at the 0.01 level.
[b] $\chi^2 = 0.06$, not significant.
[c] t-test = 4.37 (equal variances not assumed), significant at the <0.01 level.

All types of pathways to pilot participation (regular-term license renewal, limited-term license renewal, and Driver Safety referral) are combined. However, customers who were clearly not 3-Tier eligible (e.g., commercial license applicants, those who later upgraded to a commercial license, those who were identified as taking the written test in a language other than English, etc.) are excluded from the analysis. This has the primary effect of reducing the reported *N* among erroneously-processed customers. In comparison to the rest of the pilot cohort, erroneously processed customers are slightly older (by just over two years), but at the same time somewhat more likely to have negligent operator points on their record. The potential effects of these differences on the analyses conducted in this report are discussed in further detail in the conclusions.

Customers with Lagging Applications

CA DMV strives to make the license renewal process occur as quickly as is practicable given a customer's circumstances. That said, some customers required multiple visits to a field office before completing their application; this occurred most obviously for customers requiring evaluation by a licensed vision specialist, or who needed to schedule a second (or third, etc.) written test, or who needed to schedule an on-road drive test. To encourage the timely completion of all applications, two notices were mailed to 3-Tier Pilot customers who had not completed their application by Oct. 31, 2007. One was sent to customers needing to take a drive test (this was sent out in November and early December), while a separate notice was sent to customers needing to take the written knowledge test (this was sent out in early December).

Despite these efforts, nearly 700 customers did not complete their applications before Dec. 31, 2007. Although they are not included in any of the formal analyses that form the bulk of this report, they are useful for understanding what (if any) effects 3-Tier might have on delaying or discouraging customers from renewing their driver license. Table 42 provides simple descriptive statistics of these customers. It is worth noting here that a substantial proportion of those with outstanding applications as of December were disproportionately likely to have been enrolled in the pilot in October. In other words, despite the letters sent out in December, some number of incomplete applications was to be expected. Of these, nearly half completed their application within twelve months of the end of the pilot.

Table 42

Pilot Cohort (Renewals and Referrals) with Incomplete Applications as of 12/31/07

		N of customers(% of total lagging applicants)
Month enrolled in pilot	June	86 (12.6)
	July	105 (15.4)
	August	137 (20.1)
	September	139 (20.4)
	October	216 (31.5)
Date eventually licensed	January-March, 2008	175 (25.6)
	April-June, 2008	71 (10.4)
	July-September, 2008	58 (8.4)
	October-December, 2008	17 (2.5)
	Not licensed within 12 months of 3-Tier Pilot participation	362 (53.0)
Listed reason on driver record for pending application as of 12/31/08	Suspended/Revoked[a]	63 (9.2)
	No written test results	44 (6.4)
	Failed 1st or 2nd written test	145 (21.2)
	Failed 3 or more written tests	54 (7.9)
	Referred to vision specialist	45 (6.6)
	Failed drive test	5 (0.7)
	All else[b]	10 (2.7)
Total *N* of incomplete applications as of 12/31/07		683 (100)

[a] Includes one customer suspended after having been issued their license (in January of 2008).
[b] Includes: awaiting SSN verification (3), application voided (2), photo required (1), and deceased (4).

Also worth noting is the fact that a disproportionate number of customers with incomplete applications also had substantial involvement with the legal system, as indicated by the rather high percentage of suspended/revoked licenses. These are drivers with suspensions due to factors unrelated to 3-Tier; while the pilot did result in some (18 total) suspensions and revocations related to drive-test failures, those listed here (63, or nearly four times as many) are due mainly to factors such as negligent operator points, DUI and other alcohol-related violations, or outstanding citations and court fees. In addition, many of those listed above in the categories "no written test results" or "failed first or second test" also had outstanding fees due to DUIs, failure-to-appear notices for court appointments, or failure-to-pay violations for traffic citations.

These patterns are confirmed statistically in Table 43, which presents the age, gender, and prior violation distribution characteristics for the lagging customers and the rest of the pilot cohort (renewals and referrals combined). Customers who later changed their license class are excluded from the analysis.

Table 43

Characteristics of Lagging Customers Versus Customers with Completed Applications (Pilot Cohort)

	Mean age (*SD*)[a]	Proportion female[b]	Mean number of negligent operator points in prior 3 years (*SD*)[c]
Lagging Customers (*n* = 683)	54.86 (20.78)	57.5%	0.64 (1.27)
All pilot cohort (*n* = 10,999)	55.67 (20.63)	47.7%	0.35 (0.87)

[a] *t*-test = 0.99 (equal variances not assumed), not significant.
[b] χ^2 = 25.01, significant at the <0.01 level.
[c] *t*-test = 5.88 (equal variances not assumed), significant at the <0.01 level.

In comparison to those in the pilot cohort who completed their applications prior to Dec. 31 2007, the lagging customers are more likely to be female, and substantially and significantly more likely to have negligent operator points on their record. However, there are no significant differences between the two groups in terms of age.

There exist a handful of customers who appear to have failed to complete their application for reasons potentially related to 3-Tier procedures. Forty-five of those customers with incomplete

applications are listed as having been referred to a vision specialist for failing the department's vision standard. It is unlikely that these customers would have passed the department's vision standard absent the 3-Tier process. Only five were referred for professional examination because of a failure on the Pelli-Robson contrast sensitivity assessment; the rest failed the department's normal visual acuity standard. A similar pattern holds true for the five applicants with incomplete applications due to a drive test failure: three were asked to take a drive test because of a failure on the department's visual acuity standard, while a fourth was listed with a pattern of multiple physical limitations (including the use of a wheelchair) that would likely have triggered a referral to Driver Safety even in the absence of 3-Tier observation procedures. This leaves potentially 6 total customers—5 vision referrals due to failure on the contrast sensitivity assessment, plus one drive-test customer who failed the PRT—with incomplete applications due purely to 3-Tier procedures.

Comparison of Baseline and Pilot Cohorts (Effect of Shift in License Term on Baseline Period Data)

The utility of any comparisons of the baseline and pilot cohorts depends, in part, on the nature of their demographic characteristics (e.g., gender, age), as well as on pre-pilot driving behavior (e.g., violation rates). Because the sampling design for enrollment of customers into pilot and baseline cohorts were essentially the same, it was assumed that this would serve to control for any pre-existing differences in demographic and behavioral characteristics associated with the various dependent variables that will be analyzed in the outcome analysis (especially license disposition, crash risk, and violation rates). Tables 44-49 test this assumption, showing data on background demographic characteristics (age, gender) and violation rates for baseline and pilot cohorts. These tables are arranged by enrollment path (basic renewal process, limited-term renewal, Driver Safety referral) and variable of interest (age, gender, and violation rate). These tables exclude nine customers who participated in both cohorts (baseline and pilot). This has the effect of slightly deflating the number of Driver Safety customers in each cohort; however, this does not appear to have any affect on the statistical significance of the distribution of the data.

Tables 44-46 display the distribution of customers by age. For standard-term (5-year) renewals, there exist statistically significant, and substantial, differences in the age distribution of baseline and pilot customers.

Table 44

Comparison of Age Distribution Among Pilot and Baseline Cohorts

(5-Year Renewal Applicants)

Cohort (*n* of customers)	Mean Age (*SD*)	*N* of customers in each age stratum (percent of customers within that cohort)			
		< 45 (%)	45 – 69 (%)	70 – 74 (%)	> 75 (%)
Baseline (4,620)	40.97 (19.80)	3108 (67.3)	810 (17.5)	135 (2.9)	567 (12.3)
Pilot (10,657)	55.15 (20.58)	3944 (37.0)	2093 (19.6)	2360 (22.1)	2260 (21.2)

Note: *t*-test for difference in means (not assuming equal variances) = 40.16, $p < 0.01$. χ^2 for distribution across age strata = 1515.22, $p < 0.01$.

Table 45

Comparison of Age Distribution Among Pilot and Baseline Cohorts

(Limited-Term Renewal Applicants)

Cohort (*n* of customers)	Mean Age (*SD*)	*N* of customers in each age stratum (percent of customers within that cohort)			
		< 45 (%)	45 – 69 (%)	70 – 74 (%)	> 75 (%)
Baseline (41)	75.73 (10.47)	1 (2.4)	5 (12.2)	9 (22.0)	26 (63.4)
Pilot (222)	76.74 (7.40)	1 (0.5)	17 (7.7)	50 (22.5)	154 (69.4)

Note: *t*-test for difference in means (not assuming equal variances) = 0.59, $p > 0.10$. χ^2 for distribution across age strata = 2.84, $p > 0.10$.

Among limited-term license holders and Driver Safety referrals, however, there do not appear to exist any substantial or significant differences in the age distribution across cohorts. Table 44 also highlights the degree to which 3TAS, as administered in this pilot, was applied to customers from a wide range of ages. Over half of the customers enrolled in the 3-Tier Pilot as a result of a standard five-year license renewal were younger than age 70.

Table 46

Comparison of Age Distribution Among Pilot and Baseline Cohorts

(Driver Safety Referrals)

Cohort (*n* of customers)	Mean Age (*SD*)	*N* of customers in each age stratum (percent of customers within that cohort)			
		< 45 (%)	45 – 69 (%)	70 – 74 (%)	> 75 (%)
Baseline (184)	63.55 (19.77)	31 (16.9)	61 (33.3)	20 (10.9)	72 (39.1)
Pilot (111)	63.39 (19.42)	21 (18.9)	43 (38.7)	6 (5.4)	41 (36.9)

Note; *t*-test for difference in means (not assuming equal variances) = 0.07, $p > 0.10$. χ^2 for distribution across age strata = 3.21, $p > 0.10$.

Tables 47 through 49 display the gender distribution and prior violation record (number of negligent operator points accumulated in the previous 3 years) for baseline and pilot cohorts. For standard (5-year) license holders, there are statistically significant differences across cohorts in both measures. For limited-term license holders and Driver Safety referrals, there exist no statistically significant differences across cohorts in either measure.

Table 47

Comparison of Gender Distribution and Violation Rates Between Pilot and Baseline Cohorts

(5-Year Renewal Applicants)

Cohort (*n* of customers)	Violation rate	Gender
	Mean # of points in prior 3 years (*SD*)	*N* of women (% of cohort)
Baseline (4,620)	0.98 (1.60)	1925 (41.7)
Pilot (10,657)	0.35 (0.88)	5076 (47.6)

Note: *t*-test for difference in means (not assuming equal variances) = 25.24, $p < 0.01$. X^2 for gender distribution = 46.18, $p < 0.01$.

Table 48

Comparison of Gender Distribution and Violation Rates Between Pilot and Baseline Cohorts

(Limited-Term Renewal Applicants)

Cohort (*n* of customers)	Violation rate	Gender
	Mean # of points in prior 3 years (*SD*)	*N* of women (% of cohort)
Baseline (41)	0.02 (0.16)	21 (51.2)
Pilot (222)	.06 (0.24)	118 (53.2)

Note: *t*-test for difference in means (not assuming equal variances) = 1.18, $p > 0.10$. χ^2 for gender distribution = 0.05, $p > 0.10$.

Table 49

Comparison of Gender Distribution and Violation Rates Between Pilot and Baseline Cohorts

(Driver Safety Referrals)

Cohort (*n* of customers)	Violation rate	Gender
	Mean # of points in prior 3 years (*SD*)	*N* of women (% of cohort)
Baseline (184)	0.68 (1.16)	75 (40.8)
Pilot (111)	0.60 (0.93)	49 (44.1)

Note: *t*-test for difference in means (not assuming equal variances) = 0.57, $p > 0.10$. χ^2 for gender distribution = 0.33, $p > 0.10$.

Regular-term (5-year) license renewal applicants are substantially younger in the baseline cohort—by approximately 14 years—as compared to the pilot cohort. Only a small minority (about 1/6) of the baseline cohort are over the age of 70. By contrast, over 40% of pilot customers were of this age.

As age 70 marks the point at which CA DMV requires all customers to renew their licenses with a visit to a DMV field office, along with re-taking the 18-question written test and the vision assessment test with every renewal, this has a number of implications both for the outcome analysis as well as any process measures. In particular, these differences suggest that any

calculations of the costs of potential implementation must take into account both (a) the substantial variation across years in the sheer number of DMV customers renewing their licenses in the field offices, and (b) the related variation in customer demographics (especially age) from year to year.

Regular-term license renewal applicants in the baseline cohort are also substantially and significantly more likely to be male, and to have recent violations on their record, as compared to the pilot cohort. This has important implications for the outcome analysis, and statistical adjustments will be made at that time to correct for the inherent demographic and violation-rate differences that exist between these two groups. However, there do not appear to exist substantial differences across cohorts in the age and gender distribution, or the prior violation records, of limited-term renewal applicants and Driver Safety referral customers.

Results of the Management and Staff Survey

Upon the conclusion of the field office portion of the 3-Tier Pilot, the author distributed surveys (*n*=130) to the staff and managers in the pilot field offices and Driver Safety office which had participated in the pilot. These surveys were designed (a) to gather suggestions from staff on how best to revise or improve 3TAS, (b) to collect qualitative data regarding the existence of errors and deviations from pilot protocols, (c) to collect qualitative data regarding the likely sources or reasons for errors and deviations from pilot protocols, (d) to assess staff views on the impact of the pilot on customer service, and (e) to identify potential areas of improvement in the training provided in 3-Tier procedures. In addition, the distribution of this survey was implicitly intended to improve communication flows between R&D and both FOD and Driver Safety Branch. The full documentation of the results of the staff survey—including a description of the methods for sampling and data analysis—are presented in Module #1 of the Appendix to this report. A summary of the results of this survey are discussed below.

SUGGESTED IMPROVEMENTS TO THE 3-TIER PROCESS

Staff and management's suggestions for improvements to the 3-Tier process came in two forms. First, there were a number of proposals regarding how to streamline the process so that it took less time. These focused on reducing or eliminating excess or redundant questions on the Tier 1 Score Sheet and 3-Tier Tracking Sheet, the two paper forms used to collect data on each customer. California DMV currently relies on a computer-based system (the DMVA) for

collecting and archiving most customer data related to the issuing of driver licenses in the field offices. This includes information regarding whether a customer has passed or failed the department's visual acuity standard, has passed or failed the written test of the rules of the road, the class of license for which they are applying, any current restrictions on their license, any recent crashes or violations reported to DMV by law enforcement, as well as a host of other variables. The adoption of any portion of the 3-Tier process will likely involve reprogramming the DMVA system to include a number of additional required data fields.[25] These might include fields for entering data regarding whether an individual has passed or failed the contrast sensitivity and memory recall tests, the recording of any observations of potential driving-relevant physical limitations, the recording of outcomes on the PRT, etc.

A number of respondents also made suggestions regarding the process by which staff observed customers for potential driving-relevant physical limitations. These suggestions were made with the intent of reducing the amount of time required to process a given customer's transaction. As implemented during the pilot, staff were trained to observe each customer for potential upper-body limitations over the course of the transaction at the counter station to which the customer was first called. Training protocols then called for the observation of lower-body physical limitations while walking with the customer to the video capture station (VCS), where the photo image for the customer's license is taken along with a digital record of their thumbprint. Several staff suggested that this second portion of the process could be altered either by (a) having a technician observe a customer's lower body movements while processing their transaction at the original counter station, or (b) having the technician working at the VCS separately observe each customer for potential driving-relevant physical limitations. The technician working at the VCS would then separately enter into the DMVA system (or its successor) any data regarding their observations of each customer's potential physical limitations.

The second type of suggestion as to how to improve the 3-Tier process stemmed from questions which customers directed to staff about various 3-Tier assessment tests. Staff reported receiving questions from customers about the purpose of the Driving Habits Survey (as well as about specific question wording), the justification for the memory recall assessment, and what was being measured by both the Pelli-Robson contrast sensitivity charts and the PRT. As a result of these questions, some staff in turn made specific suggestions regarding these process elements.

[25] It is in fact more likely that, if 3TAS is adopted statewide, that any reprogramming will occur on the *successor* to the current DMVA system. A major re-tooling of the computer system in CA DMV field offices is scheduled for statewide rollout sometime soon after the publication of this process report, but prior to the publication of the outcome report.

These suggestions all had in common the necessity of proper training in the purpose of the 3-Tier process. To the degree that staff understand the nature and justification for driver competency assessment, they can communicate this in appropriate ways to DMV customers.

VARIATION IN THE IMPLEMENTATION OF 3-TIER PROCEDURES

Some of the responses to the staff and management survey suggested that there existed variation in the implementation of certain 3-Tier procedures. This included the Pelli-Robson contrast sensitivity test, the memory recall test, and the PRT. This variation in implementation was revealed, sometimes indirectly, in the critiques and suggestions that were made regarding how to improve the 3-Tier process.

Several respondents raised concerns about the robustness of the Pelli-Robson contrast sensitivity chart under different light conditions. These concerns took different forms, but respondents most commonly suggested that passage or failure on this assessment depended, in their view, on the presence of shadows from adjacent charts or on the presence of glare from direct sunlight streaming through nearby windows. There exists little evidence in the academic and clinical literatures that luminance levels should substantially affect the likelihood of passage on this assessment, assuming normal vision health (Cox, Norman, & Norman, 1999; Rovamo, Kukkonen, Thppana & Näsänen, 1993; Zhang, Pelli, & Robson, 1989). To the extent that individual contrast sensitivity differs by luminance levels, this may in fact be an indicator of the presence of certain kinds of medical conditions (e.g., macular degeneration, cataracts, age-related changes to the neural mechanisms associated with vision) for which the Pelli-Robson chart is specifically designed to be a screening assessment (Brown & Garner, 1983; Sloane, Owsley & Jackson, 1988; Anderson & Holliday, 1995).

According to current DMV field office procedures, if a customer cannot pass the Snellen visual acuity chart assessment, they may be offered the opportunity to try another chart elsewhere in the office. Customers may also take the visual acuity assessment on an Optec 1000 Vision Tester (a small desk-mounted binocular device). This procedure was adopted for use with the Pelli-Robson chart, and customers were allowed to use charts other than the one associated with the desk at which they happened to cashier their transaction.[26] As a result, some unknown number customers appear to have "switched" Pelli-Robson charts. Given the evidence in the clinical and

[26] Due to funding constraints, however, it was not possible for the purposes of the pilot to alter the Optec 1000 Vision Tester to include a contrast sensitivity component.

academic literatures, this is unlikely to have led to substantially different outcomes at the individual level. However, in response to staff concerns raised here and in the interviews, the author conducted a formal analysis of the sources of variation in customer outcomes on the Pelli-Robson chart (see below, pp. 133-137, as well as Module #4 of the Appendix to this report).

Several respondents also raised concerns about the memory recall test. These comments appear to have been partly directed at protecting customer privacy and information security, one of the primary organizational goals of CA DMV. Training protocols for the memory recall exercise called for the technician to ask that the customer write down their Social Security number on the back of their paper application (DMV Form DL 1RN or DMV Form DL44); this application was then disposed of securely, to ensure the protection of a customer's identity and personal information. Written comments on the surveys, however, suggest that there existed some variation in the implementation of this procedure. It would appear that in some unknown number of instances customers were asked to state their SSN verbally, as opposed to writing it down. There is no evidence that the security of any customer's personal information was ever compromised during the pilot. However, it is unclear if this variation altered the likelihood of individual customers passing or failing this assessment test.

A substantial number of respondents also raised concerns about the PRT. Some of these comments suggested that customers were offered multiple opportunities to take the test, especially if they reported confusion or anxiety on their first attempt. Taking this assessment test multiple times was certainly allowed under 3-Tier training protocols. However, no attempt was made to record data on the number of attempts made by any given customer. Only a customer's final results on this test were scanned to their electronic data file. Hence, there is no record of (a) how many customers attempted the PRT multiple times, (b) which customers attempted the PRT multiple times, or (c) whether or not taking the PRT more than once did, in fact, lead to an increased likelihood of passage on this assessment test.

SOURCES OF VARIATION IN IMPLEMENTATION OF 3-TIER PROCEDURES

By suggesting various improvements to the 3-Tier process, CA DMV staff also pointed, indirectly, to possible sources of the variation in implementation experienced during the project.

These sources include two overlapping directives that govern DMV's organizational mission: to provide excellent customer service and to enhance the safety of California's motoring public.[27]

In the first instance, CA DMV has recently touted its success in reducing the average wait times in field offices across the state. This was accomplished through various measures, not the least of which involved adoption of a computerized queuing system (the DMVQ, or Customer Service Queuing Management System). The DMVQ provides constant feedback to individual staff regarding how long individual transactions take. In addition it provides real-time data to office managers regarding the current wait times for customers in line at any given moment. As a result, there is constant encouragement at all levels of the hierarchy—from frontline Motor Vehicle Field Representatives (MVFRs) all the way up the supervisory and management chain—to reduce the amount of time any given transaction takes. This pressure to increase efficiency in processing transactions may militate against the provision of individualized personal attention—even though both of these constitute "good customer service." Moreover, the pressure to increase efficiency in processing transactions may have contributed to some of the kinds of data-collection errors which required correction in the quality assurance process.

In another way, providing individual personal attention also typically means being knowledgeable and cheerful with customers, enhancing their experience and thereby improving the sense of a satisfactory office visit. DMV staff are encouraged by various means to adopt this kind of retail-oriented demeanor. This occurs most often through the periodic training modules distributed and discussed at regular weekly staff meetings. In a fundamental way, however, objectively assessing driving-relevant limitations does not necessarily feel "nice." In particular, having to explain to a customer that they will need to take additional assessment tests may raise the possibility that a customer has an "unsatisfactory" experience at the field office. After all, who actually enjoys taking tests? However, taking active steps to keep the roads safe for all drivers is a key goal of CA DMV—even when a given individual may be unhappy about what this means in their particular case.

Finally, DMV staff are required by law to treat all customers in a non-discriminatory manner with regard to personal characteristics irrelevant to safe driving. This includes all protected classes covered under relevant state and federal laws. However, the 3-Tier process is designed specifically to facilitate the identification of potential driving-relevant physical, mental and

[27] See the department's most recent strategic plan (http://www.dmv.ca.gov/pubs/strat_plan-09.pdf), which lays out in some detail the performance measures related to both of these goals (see esp. pp. 8-10). The department also has two additional goals, related to ensuring the security of personal information and enhancing consumer protection.

visual limitations, in keeping with California Vehicle Code section 12814(a-c). This means that staff must be particularly attuned to what constitutes appropriate identification of (for instance) driving-relevant physical limitations versus what might constitute inappropriate discrimination against an individual with a physical disability. Similarly, as evidenced by the remarks on the survey, CA DMV staff are especially concerned with inappropriate discrimination on the basis of age. Staff raised these concerns in three particular contexts: the identification of driving-relevant visual limitations with the Pelli-Robson chart, the identification of driving-relevant cognitive conditions (memory, executive function) that were flagged by the memory recall test, and the assessment of perceptual speed with the PRT. In all three cases, at least some staff were concerned about the perception of discrimination on the part of customers undergoing assessment using these tests. There thus exists a perceived dilemma on the part of CA DMV staff; this dilemma lies in having to provide legally equivalent treatment to all CA DMV customers, while at the same time identifying and assessing the kinds of potential limitations that impact safe driving.

PERCEIVED IMPACT OF THE 3-TIER PILOT ON CUSTOMER SERVICE

The survey contained two questions which gathered data on the perceived impact of 3-Tier on customer service. The first used an ordinal Likert-type scale to assess the respondent's views, as expressed on a scale from "very positive" to "neutral" to "very negative." The modal response was "neutral," with roughly a third reporting a positive impact and somewhat less than a fifth reporting a negative impact. There may be a mild trend regarding office size; to some degree, respondents at smaller field offices were more likely to associate 3-Tier with a positive impact on customer service. There was also an association with job category: LREs and 3-Tier Manager Is were more likely to associate 3-Tier with a positive impact on customer service; other kinds of managers were more likely to associate 3-Tier with a negative impact.

The second source of data was an open-ended follow-up to the first, inviting the respondent to elaborate on their answer. Several definitions of what constitutes good customer service emerge from these data; what these categories reveal is the degree to which "customer service" is defined somewhat differently by different respondents. The different meanings of customer service appear partially (but not entirely) to coincide with different job duties.

A substantial number of respondents equated good customer service with minimal wait times in the field offices. To the degree that respondents defined good customer service as synonymous with efficient processing of transactions and minimal wait times, 3-Tier was seen as having a

negative impact on customer service. Which is to say, inasmuch as 3-Tier was perceived to lengthen per-customer processing times (and so potentially to increase wait times for customers in the field offices), it was perceived to have a negative impact on customer service *qua* production efficiency. This view was most commonly expressed among managers, who have the final responsibility for ensuring high standards of productivity and efficiency within their field offices.

A second group of respondents defined good customer service in terms of universal treatment and discrimination. In this view, good customer service was synonymous with a uniform, essentially homogenized experience of renewing one's license; hence, anything that discriminated between different kinds of customers had, by definition, a negative impact on customer service. Discrimination as regards age (i.e., discrimination against seniors) was the most common concern, but by no means the only one. Some staff reported that they were uncomfortable with the fact that the pilot enrolled only those customers taking the written law test in English. Others respondents noted that they (or customers) were anxious that 3-Tier "singled out" people for special treatment. In a similar manner, a number of respondents noted that participation in 3-Tier tended to produce anxiety or even fear among some customers. These views occurred among respondents from a number of job categories.

To the degree that respondents defined good customer service in terms of personal attention, 3-Tier was seen as having a positive effect. By slowing down a transaction somewhat, and even by inviting opportunities for discussion of the various assessment tests, 3-Tier was seen as improving customer service. This view was closely tied to views expressed by other respondents that 3-Tier had a positive impact on customer service by assuring safer driving and preventing crashes and violations. These sentiments were most commonly expressed among LREs and 3-Tier Manager Is.

SUGGESTED IMPROVEMENTS TO TRAINING IN 3-TIER PROCEDURES

Many of those surveyed critiqued the quality of training for the 3-Tier Pilot. The brunt of these concerns related to the consistency of the information conveyed during training. These critiques stem, in part, from the complexity of this project and the difficulties inherent in implementing temporary new procedures in an agency setting, while at the same time minimizing disruption to other aspects of CA DMV field office productivity. To improve training, many staff emphasized consistency of information relayed, to reduce confusion at the field office level. Additional

specific suggestions included incorporating simulated "walk-throughs" (or role-playing exercises); this technique is already used to some extent by DTB. As an extension of this, a substantial number of respondents spoke positively of the value of on-the-job experience in getting familiar with the "feel" and flow of new procedures.

Less directly, training in 3TAS process must include additional material on the nature of specific assessment tools: what they test, and their usefulness for improving traffic safety. This includes most especially the Pelli-Robson contrast sensitivity chart, the memory recall exercise, and the PRT. Although these topics were covered extensively in training, there remained some concern and confusion among staff regarding these assessment tests.

Results of the Management and Staff Interviews

In addition to surveys, the author conducted formal qualitative interviews (*n*=49) with a non-random stratified sample of staff and managers who had worked on the project during both planning and implementation. These interviews were designed to (a) assess staff understanding of the pilot goals, (b) determine the nature and extent of the pilot's perceived impact on office workflows and inter-branch/inter-division cooperation, (c) gather suggestions on how to improve the 3-Tier process, (d) gather qualitative evidence regarding variation in the implementation of various 3-Tier procedures and pilot elements, (e) determine any patterns regarding staff understanding of the purpose of 3-Tier procedures (f) document CA DMV staff perceptions of 3-Tier's impact on customer service, (g) collect information regarding the sources of any deviations from project protocols, and (h) identify potential areas for improvement of training. The full documentation of the results of the staff interviews are presented in Module #2 of the Appendix. A summary of the results of the interviews are discussed here.

STAFF AND MANAGEMENT UNDERSTANDING OF 3-TIER PILOT GOALS

Across nearly all job categories, staff and management identified the overall goal of the 3-Tier process as improving traffic safety by developing tests to better evaluate driver competency and skill. Consonant with these overall goals, staff also spoke of the importance of maintaining and preserving mobility, especially for senior drivers. At the same time, staff viewed 3-Tier as providing the opportunity to flag certain medical conditions in their early stages, combined with providing education for customers and (in the case of vision conditions), referral to medical professionals. Finally, staff identified the 3-Tier Pilot as providing an opportunity for CA DMV to act as an active, progressive, public agency; staff were excited to be on the forefront of testing

new procedures for creating a safer driving environment. The articulation of these goals spanned the hierarchy, with representatives of all job categories expressing these statements. The one exception to this pattern involved Driver Safety Hearing Officers. When asked about the projects goals, many of these latter respondents emphasized the inadequacy of training they had received in preparation for the pilot, and a consequent lack of clarity on the project's purpose.

IMPACT OF THE PILOT ON OFFICE WORKFLOWS AND INTER-BRANCH/INTER-DIVISION COORDINATION

Respondents identified several ways in which the 3-Tier Pilot affected intra-office coordination of work. These changes were attributed primarily to the necessity of maintaining pre-pilot standards for office productivity and efficiency (i.e., low wait times), and secondarily to the requirements of implementing a new set of processes that were, especially at first, confusing. In order to manage the demands of instituting a new set of procedures, while at the same time maintaining expectations for low wait times, staff reported that they spoke to their immediate office-mates more often than they had before the pilot, sharing concerns and answering questions about the project. Combined, these changes involved somewhat more communication between front-line employees working at the counters (e.g., MVFRs and SMVTs) and LREs. In addition, the 3-Tier Pilot may have increased the amount of communication between front-line employees and their direct supervisors (Manager Is). There appears to have been little or no effect on communication between front-line employees and higher-level managers, or between Manager Is and higher-level managers.

Less directly, the interviews provided some evidence that the 3-Tier process itself, quite apart from its novelty or its perceived impact on wait times, induced increased communication between front-line employees, LREs, and Manager Is in the pilot field offices. This was attributed to the fact that MVFRs had responsibility for collecting certain information through the 3-Tier process (observations of physical limitations, for instance) that LREs and Manager Is needed in order to counsel those customers scheduled for drive tests and assessed at Tier 3 of the process.

Respondents from Driver Safety reported no changes to intra-office coordination of work as a result of 3-Tier. This was true despite reports from Hearing Officers of substantial frustration and confusion as to what the project involved. The lack of any changes to intra-office coordination within Driver Safety was attributed to the independent nature of the job duties of a Hearing Officer. While Field Office staff engage in substantial coordination of efforts under normal (non

3-Tier) conditions, Hearing Officers rarely share responsibilities for processing Driver Safety referral cases. 3-Tier procedures did not substantively alter this arrangement of responsibilities.

Respondents from both divisions reported changes to inter-branch/inter-division communication and coordination. At the most basic level, 3-Tier appears to have produced a marked increase in the amount of communication across the three branches most involved in the project: Field Office, Driver Safety, and R&D. This increase in cross-division communication was seen as positive by those interviewed.

More specifically, respondents from Field Office noted that the use of three designated liaison staff was of enormous benefit to ensuring successful completion of the project. These staff served as channels of communication, especially between the pilot field offices and R&D, and as point-persons for answering questions and solving operational dilemmas. Respondents noted especially how valuable it was that these staff had experience and knowledge specific to the culture and procedures of CA DMV field offices. This experience gave them credibility among those interviewed; this was tied especially to a "problem-solving orientation" seen as critical to the resolution of questions and dilemmas in a timely and efficient manner.

Respondents from Driver Safety Branch were much less likely to mention these liaison staff in the interviews. This may have been due to the fact that the designated liaison between R&D and Driver Safety was the manager of the Sacramento Driver Safety office; the three staff members mentioned above had very little direct contact with most of the Hearing Officers. However, those interviewed did report that the pilot produced an increase in the amount of communication between Driver Safety and the pilot field offices. This increase in communication involved the scheduling of drive tests for 3-Tier customers referred to Driver Safety for evaluation of their driving skill. While under non-pilot procedures this kind of drive-test scheduling normally occurs through an online (electronic) system, during the pilot it occurred via phone and fax. Respondents noted that the increase in communication was, in principle, a good thing. However, the use of outmoded technology (phone as opposed to e-mail) was seen as both troublesome and time-consuming.

SUGGESTED IMPROVEMENTS TO THE 3-TIER PROCESS

In general, the data collected in the interviews regarding improvements to the 3-Tier process reiterated that which was collected in the surveys. Staff members' suggestions focused on two kinds of improvements, both intended to increase production efficiency. First, most of those

interviewed assumed that any implementation of 3-Tier procedures would involve eliminating as much paperwork as possible in favor of a paperless, computer-based system data collection. Second, several respondents suggested altering the protocol for the observation of potential physical limitations so that either (a) all observations would occur while at the initial counter window, or (b) the technician working at the video capture station would separately observe each customer for potential lower-body physical limitations.

VARIATION IN THE IMPLEMENTATION OF 3-TIER PROCEDURES

The interviews revealed some variation in the implementation of 3-Tier procedures. This variation occurred with some elements of the process but not others. Those process elements that dealt with the assessment of memory and perception appear to have been subject to the widest variation in implementation. Because of its utility as a customer-service management tool, the educational intervention was administered in a manner substantially different from the original pilot design.

Two kinds of variation appear to have occurred in the administration of the memory recall test. In the first instance, respondents reported that some front-line staff asked customers to verbally state their Social Security number. Training protocols for the pilot called for customers to write down this number on the back of their license renewal application; this application was then later destroyed to protect customer security and privacy. There is no evidence that the security of any customer's identity was ever compromised during the course of the pilot. It is not clear if administering the test in verbal as opposed to written format had any impact on individual customers' likelihood of passage/failure. However, respondents did report varying estimates of how many customers failed this assessment test. While some staff estimated that upwards of 10% of their applicants failed this assessment, other staff flatly stated that no-one ever failed. Those who reported widely varying estimates worked in the same offices and so processed essentially the same kinds of customers. Absent experimental verification or population-based estimates, staff reports in variation in the outcomes on this assessment (0% failure rate versus 10% failure rate) may plausibly lie either in the way in which staff implemented the assessment, or in naturally occurring variation across customers.

According to the data collected in the interviews, there was relatively little variation in the implementation of the physical observation protocols. While a few staff expressed mild unease in being asked to assess customers' driving-relevant physical capabilities, this cannot be linked to

variations in the practice of this observation protocol. Respondents appear to have regarded this component of the 3-Tier process as procedurally straightforward.

There also appears to have been relatively little variation in the implementation of the visual acuity assessments. The use of the Snellen chart for this assessment required no change from current (non-3 Tier) renewal procedures.

The Pelli-Robson chart was administered in a manner substantially similar to the Snellen chart, and so staff reported comfort and familiarity with its use. Some respondents reported switching Pelli-Robson charts periodically, to accommodate customer concerns regarding glare and shadows. This practice was consistent with current office procedures for visual acuity assessment. No data were collected regarding which customers requested the use of alternate Pelli-Robson charts. However, a formal analysis was conducted on the variation in customer outcomes on this assessment by chart location and technician (see pp. 133-137, as well as Module #4 of the Appendix to this report). This analysis revealed substantial variation in passage rates on this assessment test, according to which technician administered the test and controlling for other variables (including imputed chart location).

In the administration of the PRT, respondents noted in the interviews that they allowed customers to take this assessment multiple times. This practice was within pilot protocols, although no data were collected on the number of times any given individual took this assessment.

Staff reported substantial variation in the administration of the educational intervention. This variation occurred across two dimensions. Although there were two sets of educational materials—one on contrast sensitivity and the other on perceptual speed—only one was used extensively. Very few customers appear to have somewhat failed the PRT, which would have triggered the administration of the materials designed for that assessment. Second, it appears that the randomizing protocol for the distribution of these materials was not followed consistently. According to the pilot design, only those customers who somewhat failed the contrast sensitivity or PRT assessments, and who had an odd-numbered final digit to the driver license, were to be given these materials. As reported in the interviews, these materials were deemed so useful for drive-test preparation that they were freely distributed. In particular, respondents reported that the videos and brochures proved effective at answering customers' questions and reducing the anxiety often associated with taking an on-road drive test. However, in the course of document review for quality assurance and data entry, it was determined that the relevant data fields

intended for recording when these materials were distributed were used far less often than reported in the interviews. In other words, some respondents who reported in the interviews that they distributed these materials quite often were, according to the paper files, among those least likely to make use of the educational intervention. This suggests a serious discrepancy between implemented practice and recorded data regarding this process element.

The administration of written renewal tests and on-road drive tests involved only one change from current (non 3-Tier) procedures. Under 3-Tier procedures, a customer who failed the written test 3 or more times was required to take an on-road drive test; under current (non 3-Tier) procedures, a customer who fails the Class C written test 3 or more times is required to file another renewal application, which is to say pay an additional fee, but a drive test is not required. There appears to have been no substantial variation between offices in the implementation of these process elements, aside from the errors listed in Table 40 (p. 101, above. See also pp. 176-177 for a discussion of the methodological implications of the processing errors committed in the administration of the written renewal test and on-road drive test). Any variation between offices in the distribution of processing errors may derive in part from office layout: offices with separate testing rooms had a somewhat higher proportion of customers who were licensed despite failing the written renewal test three or more times.

In the design of the pilot it was anticipated that there would be an increase (relative to the baseline period) in the use of SIPs, SRLs, and in the administration of the ADPE. In no case did staff report an increase in the use of these license and testing options. Because these licensing tools were used so rarely, it is not really possible to determine if there exists substantial variation (by office or by individual staff person) in their use.

VARIATION IN STAFF UNDERSTANDING OF THE PURPOSE OF 3-TIER PROCEDURES

The interviews revealed substantial variation among staff in their understanding of the purpose of specific 3-Tier procedures; this was especially true for those assessment tests dealing with memory and perception.

In regards to the memory recall exercise, a substantial number (approximately half) of those interviewed questioned the validity and utility of this test for assessing skills relevant to driving. Many of those interviewed appeared to misunderstand the purpose of the test, suggesting that it assessed long-term habits (i.e., whether or not someone had memorized their Social Security

number) rather than memory and executive function. A few of those interviewed explicitly called into question the validity of the test, arguing that it had no predictive relationship to safe driving. Other staff expressed the view that they did not feel that they possessed the training appropriate to administer *any* test of cognitive function, not even one as simple as the memory recall test used for the 3-Tier Pilot.

By contrast, there appears to have been little expressed variation in understanding the purpose of the physical observation protocol. In fact, several of those interviewed suggested that they saw the observation of potential driving-relevant physical limitations as positive, especially as it may have led to more personalized service for customers with physical disabilities.

Similarly, respondents did not report notable variation in the purpose of either vision assessment (visual acuity, or contrast sensitivity). Both tests were regarded as integral to assessing driving competency. Both were also seen as opportunities for DMV to provide referrals for customers to health professionals for potentially early-stage progressive disorders.

Among those interviewed, there exists widespread criticism of the validity and utility of the PRT for assessing skills relevant to driving. Criticism of the PRT was sometimes muted and sometimes explicit, but in general negative evaluations of the worth of this assessment tool outnumbered positive evaluations. Where staff reported negative evaluations of the worth of the PRT, this was typically framed in terms of customer reaction (confusion, anxiety). In addition, there appears to be substantial misunderstanding of what this assessment actually measures. Many staff reported that the PRT measures response time or reflexes; only a few articulated that it measures perceptual speed.

The educational interventions, especially the materials on contrast sensitivity, were regarded as vitally useful as a customer service tool. This was especially true for customers preparing for a drive test. Staff also reported anecdotally that they believed the educational materials materially improved customers' passage rates on the road test. This is somewhat surprising, given that the educational intervention was not designed to prepare people for CA DMV's on-road driving test. Instead, the educational materials were designed to produce long-term changes in driving skills and habits in particularly challenging conditions (dusk/dawn, inclement weather, complex intersections). These positive customer service and drive-test outcomes were reported by multiple respondents.

The 3-Tier Pilot used two of CA DMV's three on-road tests: the SDPE and the ADPE. As both are part of CA DMV's current (non 3-Tier) repertoire of driving assessment tools, staff reported confidence in the utility and validity of these tests for assessing individuals' skills on the road. Some of those interviewed noted that customers practiced and improved their driving habits and skills precisely because they knew they were being evaluated. LREs and Manager Is, in particular, reported that many of their customers took behind-the-wheel training (with friends, family members, and even in some cases with paid professional instructors) before showing up for their on-road tests. Although this was not an explicit design goal of the 3-Tier Pilot, this raises the possibility that the drive test serves both as an assessment of driving skill and as an inducement to drivers to improve their driving skills.

There also exists variation in staff understanding regarding the use of the ADPE, specifically as to why it was not used, or used only rarely, during the 3-Tier Pilot. Staff in both the field offices and Driver Safety expressed a variety of views on this matter. In the first instance the ADPE, precisely because it was seen as so restrictive, was viewed as the test of "last resort," the final option available for those who are moving towards de-licensure because of declines in health and driving skill. Second, many of those interviewed held that the ADPE was appropriate only for customers who live and drive in rural contexts. As the pilot took place in urban and suburban field offices, very few customers enrolling in the pilot did most of their driving in the kinds of environments deemed appropriate by staff for an area driving restriction.

PERCEIVED IMPACT OF THE 3-TIER PILOT ON CUSTOMER SERVICE

As in the surveys, the interviews revealed that "customer service" admits of slightly different definitions, depending on the context of the question and the person being interviewed. For many respondents, especially managers, good customer service is synonymous with production efficiency and low wait times in the field offices. It is difficult to overstate the degree to which those interviewed were concerned about this; nearly all of those interviewed expressed some degree of concern with how much time 3-Tier procedures took, and thus with the potential effect of implementation of 3TAS procedures on field-office wait times. When asked what could be done to address these concerns, those interviewed suggested eliminating any paperwork in favor of computer-based data collection, and hiring additional staff.

For other respondents, especially MVFRs, good customer service was defined in terms of the amount of personalized attention spent on individual customers (addressing concerns, answering

questions, explaining different assessment tests, etc.). In this view, 3-Tier provided unique opportunities to observe and converse with customers, which in turn was seen as allowing for the collection of otherwise-lost data on potential limitations to driving skill. Those interviewed were sensitive to the conflict between these two definitions of customer service. To the extent that 3-Tier encouraged individualized attention for customers, each transaction was seen as taking longer; therefore threatening production efficiency and low wait times.

For a third set of respondents, good customer service lay in the absence of discrimination. This in turn was defined as the provision of consistent, homogeneous customer experiences while in the office. This concern was revealed in three ways. First, respondents noted that a driving competency assessment system like 3-Tier should apply to all renewals. Implicitly, therefore, staff would likely not support any policy that instituted enhanced assessment starting at a specific age—which in any case would contravene both departmental policy and the California Vehicle Code.[28] Secondly, some staff argued that any given element of 3TAS should not "discriminate" against any particular group. This second definition of discrimination was raised in the contexts of two particular 3-Tier process elements: the memory recall exercise, and the PRT. Both were viewed, by some staff, as unfairly and inappropriately discriminating against the elderly. In other words, because seniors were more likely to fail these assessments, staff viewed this pattern as a problem with the tests, rather than as an indication that certain kinds of driving-relevant cognitive and perceptual problems are to some extent linked to age. Third, but less commonly, staff noted that the tiered nature of the 3-Tier system opened up the possibility for claims of discrimination from customers. Because only some, rather than all, customers were flagged for Tier 2 or Tier 3 assessment (based on Tier 1 indicators of potential limitations), a subset of these customers asked questions, raised concerns, and in general demanded to know why they were subject to "unusual" treatment in comparison to other customers. Staff typically responded to these concerns by focusing on 3-Tier's potential for improving traffic safety, and its value for helping customers identify potential health problems and improve their driving skill. However, as staff noted, answering these questions generally took extra time and lengthened individual transactions.

[28] Respondents also raised this issue, quite eloquently, with regards to language. California DMV is committed to providing services to all California road users in keeping with relevant state and federal laws in this matter.

SOURCES OF VARIATION IN IMPLEMENTATION OF 3-TIER PROCEDURES

Such variation as appeared in the implementation of 3-Tier procedures during the pilot appears from the interviews to have arisen from (a) training, and (b) inherent tension among the various organizational goals which DMV staff and managers are expected to fulfill.

Many of those interviewed, though by no means all, criticized the training offered for the pilot. These criticisms focused on the consistency, from class to class, of the information offered during training. Respondents also noted that the examples of various assessment tools (charts, paperwork, testing machinery) differed between what was presented during training classes and what was ultimately used during the pilot. In general, managers focused on the consistency of information provided to their staff while staff focused on the differences in paperwork and tools. Despite these critiques, it is not clear from the evidence gathered in the interviews that inconsistencies in training can entirely explain variation in implementation of procedures. The variation in implementation of different procedures does not appear to coincide with when different cohorts of staff took training, nor does variation in implementation appear to coincide with the complexity of pilot procedures and paperwork (simplification having been the main thrust of revisions during training). Thus, while staff had specific suggestions for how to improve training, other factors besides training also contributed to variation in implementation.

In particular, there appears to exist tension among the goals which DMV staff are expected to fulfill as part of their job duties. These staff goals derive ultimately from two of the agency's core goals as outlined in its mission statement: to enhance and improve customer service, and to improve traffic safety for California's road users. As noted above, improved customer service was variously defined by those interviewed: efficient office production and low wait times, personalized attention, and universal/homogenous treatment. To the degree that individual staff operated with one of these definitions in mind, this may have led to somewhat different implementation of 3-Tier process elements in comparison to what was implemented by other pilot staff. Furthermore, staff reported some tension between assessing drivers for potential driving-relevant limitations (and so ultimately improving traffic safety) and enhancing customer service (especially as defined by the provision of universal treatment). These two goals seem most in tension (at least according to the data gathered in the interviews) when it comes to the assessments used for cognitive and perceptual function (memory recall, the PRT).

Staff reported unease in their relative lack of training in the clinical basis for the cognitive/perceptual assessments; it was in regards to these assessments in particular that a secondary form of goal tension appeared. In some contexts, staff spoke of the purpose of assessment testing as constituting a kind of hurdle that all customers could or should be able to clear. In other contexts, staff spoke of assessment testing as a method for gauging competency and skill. Staff were most likely to speak of assessment in terms of competency when it came to assessments with which they were most familiar—in particular, that is, with assessments that are already part of DMV's repertoire (such as vision testing) or that are part of a given job-category's usual set of duties (such as, in the case of LREs, the observation of customers' compensation for physical limitations). Staff were most likely to speak of assessment in terms of a hurdle, something that everyone had to clear before renewing their driving privilege, when they did not completely understand the traffic safety purpose of a given assessment test. This was particularly the case of assessments related to memory and perception, and may explain why (some) staff reported administering the PRT multiple times. It may also explain some of the variation in the administration of the contrast sensitivity assessment (see Module #4 of the Appendix).

SUGGESTED IMPROVEMENTS TO TRAINING IN 3-TIER PROCEDURES

In the interviews, staff and managers echoed the critiques of training raised in the surveys. The most common concerns involved the consistency of training. Driver Safety Hearing Officers voiced this criticism in the strongest terms, though this view was common among all respondents. Among managers the suggested solution for this involved deploying training at the field-office level, in modules appropriate for a weekly morning staff meeting. This was seen as avoiding potentially conflicting views among staff within each office, while at the same time avoiding potential staffing shortages and consequent disruption to field office production. Managers also suggested the incorporation of periodic "refresher" training modules; this was seen as a mechanism for reinforcing prior knowledge, while also allowing for the possibility of adjustment for local circumstances unique to individual field offices. Refresher training was, in fact, developed and delivered during the implementation of the pilot.[29] Among non-managerial staff, the most common critique was directed towards differences between the forms used as training materials and those used in the actual pilot. At all levels of the hierarchy, and across both divisions, respondents endorsed the use of role-playing and hands-on practice sessions. This

[29] It is also worth noting that delivery of training at the field-office level, as opposed to a DMV regional training center, leaves open the possibility of variation in implementation of procedures *across* offices.

technique—already in use by DTB—was seen as having a host of advantages. Not only would it reduce initial anxiety at the use of previously-unknown procedures and assessment tools, it would allow for the exploration of different customer-service scenarios.

It also seems clear that if those portions of the 3-Tier process related to cognition and perception are implemented, that training materials related to these assessment tools must be enhanced and expanded. Given the variation in implementation of different assessment tools, not to mention the explicit statements of those who participated in the project, many staff felt uneasy assessing customers for cognitive and perceptual function, were unfamiliar with the clinical basis for the assessment tools used to flag potential cognitive and perceptual limitations, and ultimately were unclear on the relationship between cognitive limitations and traffic safety. If these assessment tools are included in any future implementation of 3-Tier procedures, those staff responsible for implementation must be trained not just in the use of these tools (how to test), but also their function (what they test for), and their justification (why DMV is testing for these things).

Pilot Effects on Staff Workload

The 3-Tier Pilot affected staff workload at the participating Field and Driver Safety offices in multiple ways. This included (i) some unknown effect on the efficiency of customer processing and wait times in the field offices, (ii) an increase in the number of drive tests administered by the pilot field offices, specifically as a result of 3-Tier procedures, (iii) the addition of a new job category (the 3-Tier Manager I) with wholly new job duties, (iv) qualitative changes to the duties expected of the incumbents of various positions, but especially of front-line office staff (e.g., MVFRs) in the field offices, and (v) certain changes to inter-division communication within the DMV hierarchy that were likely temporary and confined to the pilot period. However, it should also be noted that 3TAS applied to only a small proportion (approximately 15%, see Table 53 p. 142) of driver license renewal customers, which in turn constitute only a fraction of field office transactions. 3TAS applied to an even smaller proportion of Driver Safety referral customers, the bulk of whose work consists of processing other types of hearings (e.g., Admin Per Se/DUI cases). Thus, while the pilot had an impact on field office and Driver Safety workload, this occurred in the midst of a great many other kinds of transactions which DMV conducts with the public.

QUANTITATIVE IMPACT ON PROCESSING EFFICIENCY/WAIT TIMES

As noted elsewhere (see discussion of the estimates of costing a statewide rollout, pp. 140-141 below) the estimation of the amount of time to process a 3-Tier transaction is a difficult task. Even more difficult is the estimation of the effect of this added "3-Tier time" on the efficiency of processing *non*-3-Tier customers. To the degree that 3-Tier customer transactions took longer than similar license renewal-type transactions, it is possible—perhaps even likely—that this was time that could have been spent processing additional customers, and hence this added time may have reduced the overall efficiency of the pilot field offices. However, measuring the size of this effect is essentially impossible for the simple reason that too many alternative factors impact field office processing efficiency—and many of these are difficult or impossible to estimate independently.

For instance, substantial portions of a typical 3-Tier transaction—such as taking the written test of the rules of the road, taking the PRT, and taking a drive test—were "off the clock" and so did not contribute in a direct and easily measurable way either to that portion of processing time measured by the DMVQ, or to field office wait times. It is also true that the pilot offices saw substantial changes to the number and mix of customers seen before and just after the pilot. The change in the number and mix of customers between pilot period and just prior appears to have been due largely to long-term cyclicality in customer load in the field offices stemming from a change in the standard license term from four years to five. The change in the mix of customers between pilot period and just after was also due to non-3-Tier factors: soon after the conclusion of the pilot (February 2008), DMV opened a Business Services Center in the Florin area of Sacramento—this office now draws commercial transactions away from at least four of the pilot offices (Sacramento-South, Sacramento-Broadway, Carmichael, and Folsom). For all of these reasons, any estimation of 3-Tier's effect on processing and wait times, as captured in the DMVQ system, are suspect.

CHANGES TO THE NUMBER OF DRIVE TESTS GIVEN

It is somewhat difficult to determine with precision the scope of the change to the number of drive tests administered as a result of the 3-Tier Pilot. Any comparison to drive tests conducted during the baseline period is clouded by the fact that customers processed during that time appear to differ both in sheer number and in demographic characteristics (specifically, age) correlated with the likelihood of being required to take an on-road drive test. Thus, not only were twice as many customers processed during the pilot as compared with baseline, but more than

four times as many customers were taken on drive tests during the pilot specifically because they possessed a limited-term license. Even in the absence of 3-Tier Assessment System procedures—as many limited-term customers would have taken drive tests regardless of the pilot—a substantially greater number (and proportion) of customers were asked to take drive tests during the pilot period. That said, if one excludes all limited term customers, and all Driver Safety referral cases, then potentially 389 drive tests were generated specifically because of 3-Tier assessment processes. However, this excludes the 222 cases where customers should have been required to take a drive test specifically due to 3-Tier procedures, but were not (see Table 40, p. 101 above). Thus, something like 611 additional drive tests ought to have been generated specifically because of 3-Tier assessment procedures. It is probable that some of the limitations identified by 3-Tier procedures—especially vision and physical conditions—would have led to a drive test or a referral to Driver Safety. During baseline, for instance, four customers were referred from the field offices to Driver Safety on the basis of a physical condition, while two others were referred for failing the vision standard (one of whom also self-reported a diagnosis of diabetes mellitus). However, extrapolating from these patterns to the pilot would be difficult, and it is unclear how many pilot-period customers would have been referred to Driver Safety under current (non 3-Tier) procedures.

ADDITION OF NEW STAFF POSITIONS (3-TIER MANAGER I)

At each of the six pilot field offices, a new position was created: the 3-Tier Manager I. The incumbent of this position was responsible for a number of tasks related specifically to the project. This included a range of duties: administering the educational intervention materials; scheduling of 3-Tier drive tests; administering the "pre-drive counseling," including distributing and discussing drive-test preparation materials with customers one-on-one; scheduling of drive tests for customers enrolled in 3-Tier as the result of a Driver Safety action; maintaining the computers on which customers took the PRT; collection and review of all the paper documents on which were recorded 3-Tier customer data (Tier 1 Score Sheets, 3-Tier Tracking Sheets, Drive Test Score Sheets, PRT printouts, DL62 referral forms, DL11 transmittal forms, and DL11D referrals to Driver Safety); conversion of all paper documents to PDF electronic format for storage on a secure computer server; and communication with R&D regarding supplies, repairs or other operational concerns.

QUALITATIVE CHANGES TO JOB ROLES

In addition to the new position of 3-Tier Manager I, implementation of the pilot changed some of the duties expected of particular positions. This alteration of duties affected "front-line" staff (MVFRs and other job categories having direct contact with customers in the field offices) more than others. However, the duties of LREs and Driver Safety Hearing Officers also changed to some extent. To the degree that implementation of the pilot required the management of newly-trained staff, the job duties expected of office and administrative managers may have also changed to some degree.

The most significant changes in job duties affected the role of those MVFRs responsible for processing driver license and identification card transactions. 3-Tier customers constituted a sub-category of non-commercial driver license renewal transactions; hence any MVFR (or other front-line counter staff) conducting basic license renewal transactions could expect to process a 3-Tier customer during the pilot. Processing 3-Tier transactions involved the administration of new assessment tests that are not currently part of CA DMV license renewal procedures; this includes a second vision test (the Pelli-Robson contrast sensitivity chart), structured observation for driving-relevant physical limitations in the upper and lower body, a simple test of memory, and (for those customers assessed at Tier 2), administration of the PRT.

For LREs, the 3-Tier process involved some minor changes to job duties associated with relatively subtle changes to the drive test. Basically these involved incorporating all the cognitive components in the administration of the SDPE drive test, and conducting a more extensive pre- and post-drive test discussion with each 3-Tier customer. Inasmuch as LREs may have seen a different mix of customers during the pilot than otherwise, they may have administered proportionally more SDPE and ADPE drive tests.

For Driver Safety Hearing Officers, the 3-Tier process required the identification of certain customers as potential enrollees in the program. This included any referrals who were, due to the nature of the physical and mental (P&M) condition for which they were referred, required to take an SDPE drive test as part of their evaluation. Once identified, Hearing Officers conducted that portion of the pre-drive test counseling which, for other customers, would fall to the 3-Tier Manager I.

For field office managers, the 3-Tier process involved the implementation of a complex pilot project while maintaining the high standards of production and customer service for which CA

DMV has established a record. Office managers—especially those responsible for the management of offices in Region III, which includes CA DMV Headquarters—are periodically asked to implement new pilot programs. These programs vary in type and scope: recent examples include the testing of the DMVQ automated queuing system, and the adoption of debit/ATM card-type transactions. 3-Tier differed to some degree from past pilot projects largely in regards to the changes in basic license renewal procedures, as well as the high level of concern regarding data quality.

CHANGES TO INTER-BRANCH/INTER-DIVISION COMMUNICATION

Because of the complexity of the 3-Tier Pilot, R&D maintained close communication with the participating field offices and Driver Safety office, and FOD Region III. This included periodic site visits in addition to regular e-mail and phone calls between R&D and the office managers and 3-Tier manager Is. In addition, 3-Tier customers were tracked separately from other kinds of Driver Safety referral customers; this necessitated person-to-person communication—via phone calls and fax—between Driver Safety and the field offices at which these customers conducted drive tests (currently, most communication between these two branches occurs via e-mail). In each of these cases, the additional communication between branches constituted a shift from standard operating procedures.

Pilot-Produced Learning Outcomes for Management and Staff

There were three ways in which staff and managers learned from participating in the 3-Tier Pilot. At the most basic level, DMV staff learned new procedures for assessing driving-relevant limitations in vision, physical function, and cognition. In the case of vision, these new procedures were quite similar to already-familiar procedures in common use in the field offices and in Driver Safety; the administration of the Pelli-Robson contrast sensitivity chart in the field offices largely parallels that of the Snellen visual acuity chart. In the case of physical function, these new procedures were intuitively obvious to most staff in their connection to the evaluation of safe driving. The protocol for the structured observation of potential upper- and lower-body physical limitations also had the added advantage of being procedurally simple and straightforward. Staff were asked to look for, and mark the presence or absence of, a quite limited set of indicators of potentially limited physical function. All of these potential driving-relevant limitations were generally obvious to a minimally-trained observer working in a non-clinical setting. In the case of the assessments for cognition (memory recall) and perception (the

PRT), these new procedures involved both a new domain of assessment and a set of procedures without immediate parallels to current DMV practices. The feedback provided from surveys and interviews suggest that staff may require additional training, above that which was provided for the pilot, if these cognitive assessment tools are adopted for future use.

Second, staff and managers reported that participation in the 3-Tier Pilot induced a renewed commitment to one of DMV's core organizational goals: enhancing the safety of California's motoring public. This was deemed by those who participated as the primary positive benefit of the pilot. To the extent that specific project components were explicitly linked to this goal, staff and managers judged these components to be valuable additions to DMV's repertoire of processes and procedures for enhancing traffic safety.

Third, DMV Field Office and Driver Safety staff participated in the planning and evaluation processes of the 3-Tier Pilot. The planning process for the pilot involved extensive meetings with Field Office and Driver Safety managers, who learned about the project and contributed key feedback regarding implementation. During the evaluation phase, the surveys and the interviews constituted a key opportunity for DMV staff to reflect upon lessons learned during the pilot. These data were then analyzed with the explicit goal of summarizing staff expertise on 3-Tier processes for the purpose of preparing for possible future implementation.

Robustness of the Pelli-Robson Charts

On the basis of concerns expressed by staff regarding the robustness of the Pelli-Robson contrast sensitivity charts under variable light conditions, the author conducted a formal analysis of customer outcomes on this assessment. The methodology and results of this analysis are discussed at length in Module 4 of the Appendix to this report; what follows here is a summary of those findings.

Table 50 displays the results of a hierarchical logistic regression predicting customer failure (somewhat fail and extreme fail combined) on the Pelli-Robson contrast sensitivity assessment.

Table 50

Hierarchical Logistic Regression, Predicting Odds Ratios (Expβ) of 3-Tier Customer Failure (Somewhat or Extreme Fail) on the Pelli-Robson Contrast Sensitivity Chart

		β (*SE*)	Expβ (95% CI)
Age, in years (ref. cat. is ≤30 years old)		(.000)	
	31-45 years old	0.216 (.282)	1.241 (0.567 – 2.716)
	46-60 y.o.	1.030 (.273)*	2.800 (1.314 – 5.969)
	61-75 y.o.	3.259 (.219)**	26.021 (14.167 – 47.794)
	76+ y.o.	3.916 (.223)**	50.219 (27.029 – 93.317)
Confirmed vision disorder	On limited term license or has "long-standing vision condition"	2.499 (.287)**	12.168 (5.489 – 26.969)
Staff orthodoxy (ref. cat. is average)		(.000)	
	Customer tested by "under-orthodox" staff	-0.730 (.137)**	0.482 (0.330 – 0.705)
	Customer tested by "over-orthodox" staff	1.415 (.104)**	4.114 (3.085 – 5.488)
Broadway charts	11 of 13 charts not significant		
	Chart L	0.761 (0.346)†	2.141 (0.820 – 5.588)
Carmichael charts	12 of 14 charts not significant		
	Chart F	1.122 (0.327)*	3.072 (1.240 – 7.610)
	Chart H	0.907 (0.368)†	2.477 (0.891 – 6.885)
Fairfield charts	5 of 5 charts not significant		
Folsom charts	2 of six charts not significant		
	Chart A	-0.667 (0.266)†	0.513 (0.245 – 1.074)
	Chart E	-0.585 (0.268)†	0.557 (0.265 – 1.172)
	Chart F	-0.604 (0.227)†	0.546 (0.291 – 1.026)
South-Sacramento charts	6 of 6 charts not significant		
Office	(entered as random effect)	0.173 (0.152)	1.188 (0.780 – 1.1811)

Note: Effect sizes and odds ratios for non-significant charts are not reported in this table, but were included in the equation. N = 9268 (nested within 5 subjects, Vacaville office excluded, see text for explanation). -2 Log Likelihood = 5294.3. β of intercept = -18.595** (expβ = <0.001)

† Significant at the .10 level

* Significant at the .05 level

** Significant at the .01 level

Included in the regression are the following variables: customer age, whether the customer possessed a limited-term license or has a "long-standing vision condition" on record, whether a customer was processed by a staff member with a statistically high or low rate of assessing customers at Tiers 2 or 3 ("under-orthodox" versus "over-orthodox" staff) and the imputed location of the Pelli-Robson chart on which they were assessed for potential limitations to their contrast sensitivity.

The equation was modeled with two levels, office location serving as the second-order grouping variable. Chart location was entered as a series of dummy variables, with the chart closest to a given office's mean fail rate on the contrast sensitivity assessment serving as the reference category for the other charts in that office.

In order to properly specify the model, all data from the Vacaville office were excluded.

As with any logistic regression, the results are interpreted in terms of the difference in the likelihood (the odds ratio) of an outcome (in this case, failing the contrast sensitivity assessment), given a particular variable and controlling for other variables. All variables are thus most easily interpreted in terms of the presence or absence of a given condition, in comparison to some alternative condition. Thus, the effect of most of the variables in Table 50 are interpreted in comparison to a given reference category. Limited-term license holders, for instance, are substantially and significantly more likely to fail the contrast sensitivity test *in comparison to all customers with standard 5-year license terms* (and who have no previously identified long-standing vision condition on record). In the case of age, the increased likelihood of failing the contrast sensitivity test among those over the age of 75 is *in comparison* to those 30 years old or younger. Similarly, where chart effects are statistically significant, this is in reference to a chart *at that same office* that had a fail rate close to the average fail rate *for that office* (in other words, charts are compared to charts in the same office, not to charts in other offices).

Because of data limitations, it was simply not possible to measure luminance (brightness) levels directly, nor was it possible to collect data that might capture variation in luminance levels indirectly (e.g., proximity to external sources of light such as windows, time of day, season of the year). This limits the degree to which the analysis can directly engage the concerns raised by staff regarding variation in light levels and chart robustness; however, certain conclusions bearing on this question can still be drawn.

The two variables that exert the strongest effect on customer outcomes on this assessment (they have the largest β values) are (i) customer age, and (ii) whether or not the customer is on a limited-term license or has a long-standing vision condition noted on their driver record. In other words, the Pelli-Robson contrast sensitivity chart flags for further assessment those customers who have either already been diagnosed with a vision condition (the limited-term license holders) or who are at heightened epidemiological risk (because of age) for health conditions affecting vision. In the most basic sense, therefore, the Pelli-Robson contrast sensitivity chart operates substantially as it was intended to, and as found by prior research in the clinical and research literature.

The results of this analysis suggest that there may exist some variation in customer outcomes as predicted by imputed chart location. However, controlling for other variables, only 1 chart location (at the Carmichael office) has a statistically significant relationship with customer outcomes, while an additional 5 chart locations (one each at the Broadway and Carmichael offices, and three at the Folsom office) approach statistical significance. For those charts that approach statistical significance, the confidence interval around the estimated effect includes the value of 0, meaning that there is some chance that there is, in fact, *no effect* of chart location on customer outcome. For the single chart location at the Carmichael office found to have a significant effect associated with customer outcomes, close examination of the data reveal that 62% of the customers seen at this chart were seen by only two staff. It is therefore difficult in this instance to disentangle any effect of chart location from a potential effect associated with the staff who administered the assessment.

Perhaps surprisingly, which staff person administered this assessment is associated with a more consistent, and larger, effect on customer outcomes as chart location. It is difficult, for at least two reasons, to attribute this variation to differences in the types of customers a given staff person processed. In the first instance, age and previously-identified vision limitations (limited-term licenses and long-standing conditions) are both included in the model and their statistical effects controlled for. Hence, the variation among technicians in the likelihood of their customers' failing the Pelli-Robson contrast sensitivity assessment is *net* of any differences in the type of customers they saw (i.e., in the average age of customers seen by one technician versus another, or in whether or not a technician spent most of their time processing customers with limited-term licenses). Secondly, the automated ticketing system currently in use at most CA DMV field offices (the "Que" system, which was in use at all six of the pilot offices) routes customers to staff terminals on the basis of *transaction type* rather than *customer type*. 3-Tier

customers were, by definition, conducting basic Class C license renewal transactions; they therefore were included in a single transaction type. As a result, customers conducting license renewal transactions were routed on a *quasi-randomizing* basis to any technician designated in the Que as processing license renewal transactions. Even if some customers were flagged as requiring extra assistance due to some kind of disability (a "J-ticket"), this variable was found to have no statistically significant effect on customer outcomes. It is also difficult to attribute staff variation in fail rates to the location in which they worked. Staff are not usually tied to specific work stations, at least not at five of the six pilot field offices. The data used for this analysis reveal that among those who processed at least 10 customers, staff worked at an average 4.5 different locations over the course of the pilot and in four of the offices no technician worked at fewer than two locations. Staff thus moved from terminal to terminal and chart to chart, and any effects that we see related to staff variation in fail rate on this assessment cannot be easily attributed to the location at which they worked.

The implications of these findings for potential statewide implementation of any elements of the 3-Tier Process Analysis are discussed at more length in the conclusions. In addition, the severe methodological limitations inherent to the method used for imputing chart location are discussed at more length. Here it is worth noting simply that the data regarding chart location are subject to both random and non-random error and, therefore, the effect size, significance level, and the direction of effect of chart location on customer outcomes on this assessment may be biased or otherwise inaccurately specified. The same reservations regarding data quality are not, however, required for the findings discussed here regarding the effects of other variables.

Customer Acceptance of 3TAS

At the conclusion of the field office portion of the 3-Tier Pilot, R&D administered a short survey to a stratified random sample (n=5,777) of customers who had completed their license renewal applications. This survey asked customers six questions regarding (i) the ease of the 3-Tier process as a whole, as well as (ii) the ease of the instructions for each assessment test, (iii) the reasonableness of wait times in the field offices, (iv) the courtesy of DMV staff, (v) the fairness of the 3-Tier process, and finally (vi) whether or not the program would improve traffic safety. The response rate was at the low end of generally accepted standards for mail-type surveys (49%); stratification design and non-response weights were thus applied to the results. See Module #3 of the Appendix to this report for a full discussion of the methodology and findings from the survey.

3-Tier customers had, on the whole, positive attitudes towards 3TAS; between three-quarters and nine-tenths (78-92%) of respondents agreed or strongly agreed with positively-phrased questions about their experiences during the pilot. A majority of customers (52%) strongly agreed that DMV staff treated them with courtesy and respect; for each of the other five questions, majorities of respondents checked "agree."

Table 51 displays the results of a binary logistic regression predicting the probability that a respondent would respond by disagreeing (or disagreeing strongly) with one of 6 positively phrase statements about 3TAS. In other words, the table displays the probability that a customer perceived their experience of the 3-Tier process in a *negative* way.

Table 51

Binary Logistic Regression Results Predicting Odds Ratios of Answering "Disagree" or "Disagree Strongly" for Six Questions on Attitudes Towards 3-Tier

	Model #1: Time[a]	Model #2: Ease	Model #3: Instructions	Model #4: Courtesy	Model #5: Fairness	Model #6: Safety[b]
Assessment Level, Tier 2[c]	1.414*	2.406**	3.082**	1.289	2.089**	1.946**
Assessment Level, Tier 3[c]	4.334**	9.245**	9.211**	4.518**	6.773**	3.742**
2 or more crashes in prior 3 years	2.797**	0.988	0.857	4.353**	2.598**	2.240**
1 or more "points" in prior 3 years	1.490**	1.063	1.242*	0.984	1.213	1.169[d]
Gender (male = 1)	1.041	0.953	0.799**	1.113	1.175	---
Senior (65+ = 1)	0.472**	1.295[d]	1.197	0.485**	0.981	0.837[d]
Constant	0.079**	0.039**	0.057**	0.048**	0.065**	0.143**
-2 Log Likelihood	3166.140	2512.441	2781.599	2229.204	3717.106	4557.121
Nagelkerke R^2	0.069	0.104	0.106	0.065	0.080	0.043

Note: All models incorporate sampling design and non-response weights.
[a] This model has a poor goodness-of-fit, as indicated by its Hosmer-Lemeshow statistic ($p < 0.05$).
[b] Gender was omitted in order to ensure acceptable goodness-of-fit, as indicated by the Hosmer-Lemeshow statistic.
[c] Tier 1 is the omitted reference category
[d] These predicted odds ratios approach significance (<.10).
* Significant at the 0.05 level
**Significant at the 0.01 level

In the logistic regression analysis, it was determined that customers who experienced enhanced levels of assessment (Tier 2 or Tier 3 of the process) were substantially more likely to view the process negatively. In addition, respondents with poor driving records (as indicated by having two or more crashes, or at least one traffic conviction, in the prior three years) were somewhat more likely to view the process negatively. Because this survey involved a cross-sectional (rather than longitudinal) design, it is not possible to determine precisely the direction of causality in these instances. It may be the case that enhanced competency assessment produces negative customer affect; or in other words, participation in Tier 2 or Tier 3 of the 3-Tier system may reduce the likelihood of customer acceptance of assessment of driving skill. On the other hand, it may also be the case that customers with poor driving records view competency assessment in general with skepticism, regardless of the form it takes. Hence, it may be that customers with poor driving records regard any system of competency assessment negatively, especially a system which might result in the restriction or even loss of the driving privilege. The first possibility suggests that 3TAS may be altered to reduce customer anxiety and fear at Tier 2 or Tier 3; the second possibility suggests that some (small) portion of the driving public will always regard with skepticism any license renewal system that assesses driving skill. These two possibilities cannot be distinguished with this evidence.

To the degree that respondent age correlates with attitudes towards 3-Tier, senior drivers (those aged 65+) held more positive views of 3TAS, other effects held constant. Specifically, seniors were more likely to hold positive views about 3-Tier's effects on customer service, as measured either by time spent in the field office or by the courtesy of DMV staff. On other questions, however, it does not appear that age has a consistent relationship with attitudes towards the pilot, as the predicted odds ratios do not achieve standard levels of statistical significance. In other words, according to the data collected on this survey, senior drivers were no more (nor less) likely than other types of drivers to view the 3-Tier process and its component assessment tests as being fair, as improving traffic safety, or as being easy to understand.

Other variables, including respondent's gender, had no statistically significant relationship to attitudes toward 3TAS. Neither did the office at which a customer started their application; this latter variable was dropped from the analysis for the sake of brevity. Its exclusion from the equations does not alter the main findings in any substantive way.

Estimation of the Costs to Implement 3TAS Statewide

As an integral part of the utilization-focused nature of this report, it was judged necessary to develop estimates of the potential cost of statewide implementation of 3TAS. The following section starts with a description of the guidelines and assumptions which inform the development of these estimates, and includes a discussion of some of the limitations of these guidelines and assumptions. The remainder of the section then describes (a) the estimation of the number of customers affected by 3-Tier procedures, including adjustments for the extension of the assessment tests to all languages, enrollment of holders of Class C&M licenses (i.e., licensed motorcycle users), and customers lost in the pilot due to migration, erroneous processing, or lagging applications, (b) the estimation of the time added by 3TAS to each basic Class C license renewal transaction, and (c) the combination of (a) and (b) to estimate the combined impact on staff workload, and finally (d) the start-up costs of purchasing new materials, training of staff, initial quality control, and database programming.

GUIDELINES AND ASSUMPTIONS

In estimating the amount of time added to transactions under 3TAS, the author draws upon data for the pilot months of July through October (for processing times at the initial counter) and for August through October (for drive tests). These will be referred to as “mature” months in the sense that many of the initial quality control concerns had been addressed by that point in the pilot; furthermore, staff were (by report) relatively used to the processes and procedures during those months, and so relatively more efficient in their processing than at the beginning. Any added time associated with transitional start-up (May and June) and termination (November and December) of the pilot does not accurately capture the stable, ongoing, time associated running 3TAS; furthermore, costs specifically associated with purchasing of equipment, training of new staff, and initial quality-control monitoring are estimated elsewhere.

Since the mature months of the pilot constitute only a fraction of a year, it was necessary to judge whether seasonality of customer flows would affect the estimates. The mean number of driver license customers processed each month in the six pilot offices during the mature period was 92,553. The mean number of customers processed each month in the six pilot offices during the other 8 months of 2007 was 91,059. As these figures are within 2% of each other, the mature months of the pilot were assumed to be reasonably representative of normal field office workload for driver license transactions.

As piloted, 3TAS was carried out largely using hardcopy forms to record data, which were then scanned to an electronic server for secure storage of sensitive personal information before being converted to a database format amenable to quantitative analysis. This hardcopy-based system was used primarily due to the limited time and resources available to develop and organize the 3-Tier Pilot; it was not possible to create an electronic data recording and storage system specifically for the six offices used for the pilot. Because any adoption of 3-Tier Assessment System procedures is likely to require an electronic data recording and storage system, all estimates of added time associated with 3TAS are based upon the time associated with using a computer-based data collection and storage system. Included as well are estimates of what it might cost to create such an electronic data collection system, primarily by re-programming whatever system CA DMV has in place at the time of a statewide rollout of the 3-Tier System.

As a general matter, all calculations of the added processing time associated with 3TAS, as well as calculations of the associated costs, are predicated on certain policy and procedural changes—discussed elsewhere in this report—recommended for adoption to assure the practical success of statewide implementation. These recommended changes in turn may require additional training and/or modification of current CA DMV processes and procedures. The need for these changes was determined on the basis of the qualitative interviews and surveys, and the quantitative data that constitute the bulk of the process analysis.

Estimates of the amount of time added to processing are generally rounded to the nearest minute. While this reduces, to some extent, the precision of the estimates, this reduction reflects certain realistic limitations in the reliability of the measurements used to create these estimates. This also generally allows for a more realistic approximation of the individual variability that exists among staff and management who would carry out 3TAS, should it adopted for statewide implementation.

ESTIMATION OF TOTAL NUMBER OF CUSTOMERS PROCESSED

Table 52 displays the total number of customers processed using 3-Tier procedures during the pilot. Included are those customers who were erroneously processed (with certain exceptions), or who failed to complete their applications by the end of the pilot program (December 31, 2007). Although these customers have missing data in other respects, they do represent additional demands on staff time and processing efficiency. They are therefore included here for the purposes of estimating the potential costs of a statewide rollout of 3TAS.

Table 52

Customer Flows (Pilot Cohort Only), by Month, in the Pilot Offices

Month of Enrollment	Correctly processed customers	Erroneously processed customers[a]	Lagging customers	Driver Safety referrals to field office	Total customers served by pilot field offices
July	2101	110	105	24	2340
August	2378	121	137	38	2674
September	2071	114	139	15	2339
October	2470	193	216	24	2903
Mean (*SD*)	2255 (199)	135 (39)	149 (47)	25 (10)	2564 (276)

[a] Excludes customers with commercial licenses, motorcycle licenses, original applicants, those who were not required to take the written test, or who elected to take the written test in oral format, audio format, or in a language other than English.

Table 53

Customer Flows, by Month, in the Pilot Offices According to the

Driver License Issuance Activities Report

Month of enrollment	TTC				Total 3-Tier customers	Proportion of all DL transactions that are 3-Tier
	DLA[a]	DLD[b]	DLC[c]	Total DL transactions		
July	12,905	3,917	1,338	18,160	2340	12.89%
August	13,330	3,822	1,297	18,449	2674	14.49%
September	11,751	2,873	1,059	15,683	2339	14.91%
October	12,179	3,712	1,128	17,019	2903	17.06%
Mean (*SD*)	12,541 (709)	3581 (479)	1,206 (133)	17,328 (1,258)	2564 (275.57)	14.84% (1.72%)

[a] This includes both original and renewal license applicants for all license classes, and any application for a change of license class.
[b] This includes duplicate license applicants (e.g., requesting a new photo, or replacing a lost or stolen license).
[c] This includes name changes as well as changes or corrections which do not require the payment of a fee.

Table 53 displays the total number of customers processed for driver license-type transactions in the 6 pilot field offices under the various Transaction Type Codes (TTCs) used to track business activities for CA DMV's Driver License Issuance Activities Report. If 3TAS is adopted for

statewide implementation, these TTCs are expected to include all customers that would be eligible for 3-Tier processing.

However, these TTCs will also include a number of customers who will remain ineligible for 3-Tier processing—for instance original license applicants. Thus, the rightmost column of the table contains a calculation of the average proportion of all driver license customers processed in the field offices who were eligible for assessment according to 3-Tier System procedures. This figure is simply the cumulative total of customers processed under these 3 TTCs divided by the total number of customers processed using 3-Tier procedures (displayed in Table 52). For the remainder of this analysis, this average proportion (rounded upward to 15%) will be used—subject to adjustments for changes in the criteria regarding eligibility that were used in the pilot but will likely to be discarded in the event of statewide implement.

It is expected, according to applicable state and federal laws as well as departmental policy, that 3TAS, if it is adopted for statewide implementation, would include all otherwise-eligible customers regardless of language spoken. For reasons essentially having to do expense, the pilot (both baseline pilot cohorts) excluded customers electing to take the written test in audio format, oral format, or in a language other than English. Any estimate of the number of customers likely to be affected by the implementation of 3TAS must therefore include an adjustment for the extension of the program to all formats (oral, audio, and languages other than English) in which DMV administers license renewal transactions.

The most recent statewide survey that included questions regarding language use was the California Health Interview Survey (California Health Interview Survey, 2007), conducted by the UCLA Center for Health Policy Research. The results of that survey indicate that approximately 19% of the population of the state (18 years of age or older) speaks English less than “very well” (i.e., “well,” “not well,” or “not at all”). This is essentially the same as the proportion reported in the US Census 2008 American Community Survey (ACS), which found that 19% of Californians (5 years of age or older) in 2007 spoke English less than “very well.” For Sacramento County (the closest equivalent to the pilot area), the California Health Interview Survey reported that 11% of those aged 18 or older spoke English less than “very well.” This is similar to the proportion reported in the 2007 ACS, which found that 11.4% of respondents aged 5 or older spoke English less than “very well” in the Sacramento Combined Statistical Area (which includes a substantially wider area than just the county). These independent sources of data are roughly in line with the figures reported elsewhere in this report (see pp. 180-181, below) regarding DMV’s own internal surveys own customer language use. Taking these

proportions and applying them to the numbers displayed in Tables 52 and 53 then suggests that any estimate of the number of customers likely to be affected by 3TAS should be increased by approximately 23% statewide, and 12% for the pilot offices (19%/81% = 23% increase statewide, while 11%/89% = 12% for Sacramento County/Combined Statistical Area). This estimate includes no component for those customers electing to take the test in an audio or oral format. Due to the rarity of these formats, it is not expected that this would substantially alter the figures presented here.

It is also expected that 3TAS, if it is adopted for statewide implementation, may include holders of motorcycle licenses. Unfortunately, no direct measure is easily available from CA DMV records of the total number of Class C license holders who also hold a motorcycle license. The following estimates are therefore based upon the known distribution of motorcycle licenses among Class C (non-commercial), Class A (commercial), and Class B (commercial) license holders. As of January 1, 2008, a total of 23,628,581 individuals statewide held Class A, Class B, or Class C licenses. Of that total, 2% were Class A, 1% were Class B, and the remainder Class C licenses. For Sacramento County, 909,599 individuals held Class A, B, or C licenses, distributed in a similar manner (Class A = 2%, while Class B = 1%, with the remainder Class C). Also as of that date, 1,160,587 individuals statewide (including 48,239 within Sacramento County) held motorcycle licenses (Class M) along with a Class A, Class B, or Class C license.[30] For the sake of parsimony, it will be assumed that those holding combination licenses (Class A+M, Class B+M, and Class C&M) are distributed in proportion to the overall number of Class A (2%), Class B (1%) and Class C (97%) licenses. This leads to the calculation that approximately 4.8% of Class C license holders statewide also hold a motorcycle endorsement: (1,160,587/23,628,581)*0.97 = 0.0476. Similarly, 5.1% of Class C license holders in Sacramento County also hold a motorcycle endorsement: (48,239/909,599)*0.97 = 0.0514.

Customers taking the written test in languages other than English having already been accounted for, the estimate of the proportion of customers holding motorcycle endorsements should also be adjusted for language use, to avoid double-counting. The author assumes that motorcycle licenses are distributed within the population in roughly the same proportion across languages; as there is no data on this matter available at the present time, this is the most parsimonious

[30] A very small number (1,279 statewide, including 33 individuals within Sacramento County) hold only a motorcycle (Class M) license.

assumption for the purposes of the question at hand.[31] This would mean that 80% of motorcycle licenses statewide, and 89% of motorcycle licenses in the Sacramento area, are held by customers taking the written knowledge test in English. This would mean, further, that 3.8% (0.048*0.80) of all Class C license holders in the state of California also hold a motorcycle endorsement and chose to take their written renewal test in English. For Sacramento, the proportion is 4.6% (0.051*0.89). This represents an increase of about 4% statewide, and 5% in Sacramento County, in the percentage of customers subject to 3-Tier assessments, when customers with a combination Class C (non-commercial) and Class M (motorcycle) are included. Combined with the figures stated above (regarding language), this means that the number of customers likely to be subject to 3TAS should be increased by 27% statewide (23% for language + 4% for motorcycle users) and by 17% in the Sacramento area (12% for language + 5% for motorcycle users).

In sum, approximately 19% (15% + 15%*27%) of non-commercial license renewal transactions in CA DMV field offices are expected to involve 3-Tier Assessment System procedures, if customers are enrolled regardless of language and regardless of whether they hold a motorcycle license, but all other criteria remaining the same.

ESTIMATION OF ADDED TIME PER TRANSACTION

CA DMV maintains copious and detailed records regarding the efficiency of customer processing and changes to average wait times in the field offices. CA DMV's own internal data regarding wait times and processing efficiency were not used in the current analysis, however, primarily because no substantial change to in customer wait times was observed during the pilot period. This was likely a product of the fact that only 15% of all driver license transactions during the pilot period were processed using 3TAS. That no increase in customer wait times was observed does not mean, however, that 3TAS did not require additional staff time in comparison to standard license renewal processing, nor does it mean that the implementation of 3TAS statewide would have no operational impact on CA DMV field office workload. Alternative methods for calculating the impact of 3-Tier Assessment System procedures on customer processing efficiency were therefore developed.

[31] It may be that motorcycle users are more likely to speak English "very well" in comparison to the general population. If this is the case, then the calculations presented in the main body of the text represent a very slight deflation—on the order of 1% or less—of the proportion of the population likely to be subject to 3-Tier assessments in the event of statewide implementation.

Added time due to Tier 1 assessment tests

In order to estimate the amount of time added to basic Class C license renewal transactions by 3TAS procedures, it was first necessary to estimate the amount of time it takes to process such a customer under current (non 3-Tier) procedures. In March 2008 (approximately 3 months after the conclusion of the pilot), R&D staff conducted stop-watch timing of customer processing in two of the pilot field offices: Sacramento-Broadway, and Folsom. The mean times for each portion of a basic Class C license renewal transaction without an associated drive test, according to current (non 3-Tier) CA DMV procedure, are presented in Table 54. All times are rounded to the nearest minute. The estimates of time taken for each segment of a renewal process were the same in both offices. Only those customers who were "3-Tier eligible" were observed. Each segment of the process was observed separately with multiple customers, rather than by following unique individual customers through the entire process. Thus, each segment of the process has a different *N* of observations.

Table 54

Current (Non 3-Tier) Processing Times for a 3-Tier Eligible Customers (Nearest Minute)

	"Start Here" window	Initial counter		Video Capture Station (VCS)	Total Tier 1 equivalent processing time	Corrections counter	
		With Snellen chart	With Optec 1000			Distribution of test	Correction of test, etc.[a]
Minutes	1	4	7	1	6 or 9	1	2
N	231	217	19	237	N/A	6	92

[a] This includes hand-correcting the written renewal test, updating an application with the test results, and issuing any documents (e.g., the interim or temporary license).

Because about 10% of customers required assessment of their visual acuity with the Optec 1000, there exists a range of times for current (non 3-Tier) processing. Using a weighted average based on this figure yields the following estimate: (0.10 X 9 minutes) + (0.90 X 6 minutes) = 6.3 minutes. Adding an additional 30 seconds (0.5 minutes) of staff time for the transitions before, between, and after tasks yields a rounded estimate of 7 minutes of processing for those tasks that are parallel to the Tier 1 procedures of 3TAS.

At around the same time as the stop-watching exercise, R&D distributed a short survey among those staff who had participated in the pilot, regarding their recollection of the difference in the amount of time it took to process a customer using 3-Tier procedures as opposed to under current

(non 3-Tier) procedures. Specifically, staff were asked how much additional time each Tier 1 assessment took, as against parallel non 3-Tier procedures. These estimates were, of necessity, based upon staff recollection some months after the pilot. While staffs' memories of the amount of time it took to process 3-Tier customers may thus have been imprecise, this method yielded relatively consistent estimates across staff, suggesting that at the very least staff had a relatively common perception of the amount of time it took to process customers. These estimates were compared with stopwatch timing conducted by one of the office managers (at Sacramento-Broadway) during the early months of the pilot, which yielded figures roughly similar to those presented below. The estimates of the added time for the Tier 1 assessments are given in Table 55. According to the data displayed in Table 55, the 3-Tier process involved a doubling of the amount of the time used to process a basic class C license renewal, from 7 minutes to 14 minutes.

Table 55

Estimated Time Added to Processing for Tier 1 Tasks (to Nearest 15 Seconds)

Added task	Added time
Memory recall test	30 seconds
Physical observation (upper body)	15 seconds
Administration of the Pelli-Robson chart	1 minute
Physical observation (lower body) including walking	2 minutes, 15 seconds
VCS	1 minute
Additional keying time	1 minute
Transition time between tasks[a]	1 minute
Total added time	7 minutes

[a] Transition time includes such matters as: waiting for customers to walk up to the initial counter, providing documents, putting documents away, answering questions and conversing with a customer regarding specific assessment tasks, and waiting for customers to gather their materials at the end of a transaction but prior to calling the next customer. Technicians also had to find forms, pens, line-date stamps, and other supplies. There were more tasks, and thus more transition time, during 3-Tier than during the current (non 3-Tier) license renewal process.

The suggestions for making the physical observation protocol more efficient are considered in further detail in the next sub-section ("Minimizing impact on processing efficiency"). Here it bears noting that it is expected that the suggestions made by staff would result in having multiple technicians observe customers separately (at the Start Here station, at the initial counter, and

possibly at the VCS), to counterbalance the elimination of consistent observation by one technician (as occurred in the pilot). Suggestions made by staff would also likely increase (slightly) the amount of keying time necessary to accurately record data on these observations. Finally, staff suggestions would likely eliminate some of the time associated with processing at the VCS. The revised estimates of added time for Tier 1 estimates, based on staff suggestions regarding how to improve processing, are included in Table 56.

It is therefore expected that the processing at Tier 1 will take approximately 12 minutes of Motor Vehicle Field Representative (MVFR)-level staff time per 3-Tier customer, of which 5 minutes is additive to current processing for the purposes of costing.

Added time due to Tier 2 assessments

In regards to the Tier 2 assessments, it is assumed that the administration of the written test took no additional time under 3-Tier Assessment System procedures. In the administration of the PRT, observation by R&D, and responses by staff to the survey together indicated that the PRT took approximately 7 minutes of staff time to administer, plus an additional 30 seconds for the purposes of recording data. During the mature period of the pilot, an average of 475 PRTs were administered each month over all 6 pilot offices. However, as noted above (see Table 40, p. 101), an additional 104 customers should have taken the PRT; 82 of these occurred during the mature

Table 56

Estimated Time Added to Processing for Tier 1 Tasks, Revised According to Staff Suggestions (to Nearest 15 Seconds)

Added task	Added time
Memory recall test	30 seconds
Physical observation (upper body)	15 seconds
Administration of the Pelli-Robson chart	1 minute
Physical observation (lower body) without walking	30 seconds
Additional keying time	1 minute, 15 seconds
Transition time between tasks[a]	1 minute
Total added time	5 minutes

[a] Transition time is unaffected by the efficiency gains suggested by staff, primarily because it consists largely of waiting upon the customer.

months of the pilot, bringing the total number of PRTs that were, or ought to have been, administered, to 495 per mature month of the pilot. Multiplying this by the average time taken (7 minutes and 30 seconds) yields 3713 minutes of technician time per month to administer the PRT. On average, 2564 customers enrolled in 3-Tier in an average month (see Table 52 above, p. 142). Therefore, for the purposes of the estimation of efficiency of processing and costing, each PRT will be considered to have taken an average of 1.4 minutes of MVFR-level staff time per 3-Tier customer. This will be rounded upward to 1.5 minutes for the purposes of costing.

Added time due to Tier 3 (excluding the drive test)

There were a number of components of Tier 3 that added to the time necessary to process a customer transaction. This included a formal pre-drive test interview and the educational intervention.

The pre-drive test interviews were conducted by the 3-Tier Manager I prior to the first drive test for which a renewal customer was scheduled (the time required to schedule a drive test for a Driver Safety referral customer is discussed below). Pre-drive test interviews were given, on average, to 118 customers during each mature month in the 6 pilot offices. Each interview was estimated (by staff) to last approximately 15 minutes, plus an additional 2 minutes for data entry specifically associated with this task. Together, this cumulates to 2006 minutes of DMV Manager I time each month for this task. Since 2564 3-Tier customers enrolled in the field offices each mature month, the pre-drive test interview took an average of 0.8 minutes per customer. This will be rounded upward for the purposes of costing to an estimate of 1 minute of additional DMV Manager I time required for the pre-drive test interview for each 3-Tier renewal customer.

Due to the maladministration of the educational intervention, it is somewhat difficult to estimate the number of educational intervention interviews that were actually conducted. However, it is possible to estimate the number of interviews that *should have been* conducted under the original design of the project. During the mature months of the pilot, an average of 157 customers should have received the educational intervention, whether for contrast sensitivity or for perceptual speed limitations. Each intervention was estimated (by staff) to last approximately 12 minutes, plus 1 minute for data-entry specifically associated with this task. Taken together, this means that the total amount of DMV Manager I time taken by this task cumulated to 2,041 minutes. Since 2,564 customers enrolled in the field offices each mature month, the educational intervention took an average of 0.8 minutes per customer. This will be rounded upward for the purposes of

costing to an estimate of 1 minute of additional DMV Manager I time required for the educational intervention for each 3-Tier renewal customer.

Added time due to 3-Tier processing associated with the SDPE drive test

The calculation of the additional time associated with 3-Tier processing for the drive test was accomplished through comparison of the drive tests given during the baseline and pilot periods, as well as the calculation of the "pure" effect of additional drives generated by the 3-Tier process. Although baseline customers were somewhat different from pilot period customers, this is not anticipated to have had any substantial or significant effect on the length of the average drive test.

During the baseline period, drive tests were given to three classes of drivers: customers renewing a standard (5-year) term license who failed the visual acuity standard despite referral to a vision specialist (and, presumably, vision correction such as a prescription for new lenses), customers renewing a limited-term license in their fee-due year, and referrals from Driver Safety. The number of drives given during baseline, along with the average time taken per type of drive test (visual acuity failure, limited-term license holder, and Driver Safety referral), are displayed in Table 57. The number of SDPE drive tests given is the cumulated total of drive test attempts (first, second or third), regardless of outcome. Only one Area Driving Performance Evaluation (ADPE) was administered during the baseline period: it took 90 minutes.

Table 57

Number of SDPE Drive Tests Given, and Average Time Taken (Baseline Cohort)

Type of SDPE drive test customer	*N* of SDPE drive tests given	Mean length in minutes[a]	Total minutes of SDPE drive test time
Driver Safety referral	234	33	7,666
Limited-term renewal	47	30	1,430
Failed visual acuity standard	13	32	415
Total	294	N/A	9,511[b]

[a] The effective *N* to determine the mean length of each type of drive test is slightly smaller than the number of drive tests actually given, due to missing data. The effective *N* for Driver Safety referrals is 221, for limited-term renewals it is 45. There was no missing data for drive tests involving customers who failed the visual acuity standard. The mean length of drive tests is weighted across attempt (first, second, or third).

[b] This figure sums the figures in the column above. It thus effectively weights for the number of drive tests multiplied by the different mean drive-test time for each type of customer.

Each of these types of customer was given slightly different types of SDPE drive tests, per current CA DMV policy. As a general matter, the cognitive assessment components of the SDPE (the destination task, multiple directions task, and divided attention task) are only given to those Driver Safety cases who have been referred for a drive test because of a diagnosis of a driving-relevant cognitive limitation (such as dementia). This likely explains the slightly longer average time taken to administer drive tests to Driver Safety referral customers. The difference in mean drive test time between the limited-term customers and those who failed the visual acuity standard is most likely an indirect product of the fact that limited-term customers were somewhat more likely to fail the drive test. In those cases where a customer makes a disqualifying error (such as a dangerous maneuver), the examiner may cut short the drive test and instruct the driver to return to the office by the shortest, safest route available. A relatively higher proportion of limited-term type drive tests were cut short, as compared to drive tests given to customers whose drive test was required due to failing the visual acuity standard.

During pilot period, drive tests were administered to both Driver Safety referrals and limited-term renewal customers. In addition, a substantial number of customers were required to take a drive test because of a failure on one or more of the screening tests (including the visual acuity standard) that constituted the 3-Assessment System. The number of SDPE drive tests given during pilot period, with the mean duration in minutes, is given in Table 58.

As noted elsewhere in this report (see Table 40, p. 101), a substantial number of customers were erroneously processed during the pilot, and relicensed without a required drive test. These lost drive tests are included in Table 58 for the purposes of estimating the potential costs of a statewide rollout. In the calculation of the total minutes of drive test time that should have been administered (the augmented totals), the mean length of the drive test is assumed to be the same as calculated for drive tests actually given.

The average length of an SDPE during pilot period was 4-5 minutes longer than an SDPE during the baseline period. This is likely due to the fact that all the cognitive components of the SDPE (destination task, divided attention task, and multiple directions task) were supposed to be administered, regardless of the reason triggering the required drive test (Driver Safety referral, limited-term renewal, or regular-term renewal). It may also be a result of the more detailed post-drive discussion which generally occurred during pilot period. In cases of failure, the examiners were trained to discuss the nature of the errors committed during the test, and to encourage customers to practice with a friend or family member, or to take professional training. Examiners

were also trained, under 3-Tier procedures, to discuss with customers the ADPE where such an exam might be appropriate to the driver's circumstances.

The additional workload associated with 3-Tier processing for SDPE drive tests is the sum of two factors. First, there is the additional amount of time required to conduct an SDPE under 3-Tier procedures, as compared to similar drives administered during baseline. Secondly, there is the time required to conduct the additional drives required by 3TAS, which have no comparable parallel during baseline.

Table 58

Number of SDPE Drive Tests Given, and Average Time Taken, with Augmentation for Erroneous Processing and Lagging Applications (Pilot Cohort)

Type of drive test customer	Number of drive tests given	Weighted mean length, in minutes[a]	Total minutes of drive test time
Driver Safety referral	142	37	5,254
Limited-term renewal	246	36	8,856
Failed visual acuity	35	39	1,365
3-Tier generated	451	37	16,687
Drive tests lost due to erroneous processing[b]	275	37	10,175
Drive tests lost due to lagging applications[c]	186	37	6,882
Total #1 (pilot drives)	874	N/A	32,162[d]
Total #2 (pilot + errors)	1149	N/A	42,337
Total #3 (pilot + errors + lagging)	1335	N/A	49,219

[a] The effective *N* to determine the mean length of each type of drive test is slightly smaller than the number of drive tests actually given, due to missing data. The effective *N* for Driver Safety referrals is 117, for limited-term renewals it is 237, for visual acuity fails it is 32, and for 3-Tier generated drive tests it is 425. The mean length of drive tests is weighted across attempt (first, second, or third), and rounded to the nearest whole minute.

[b] This includes the 225 customers who were licensed without being given a drive test required under 3-Tier procedures. It assumes a 20% fail rate for the 2nd and 3rd attempts at the SDPE.

[c] This includes an estimated 150 customers who were required to take a drive test under 3-Tier procedures, but delayed completing their application until after the end of the pilot. It assumes a 20% fail rate for the 2nd and 3rd attempts at the SDPE.

[d] This figure sums the total number of minutes among the different types of pilot customers, and so is effectively weighted for the number of drive tests multiplied by the different mean drive-test time for each type of customer.

For most customers there was generally a period of a few weeks between the time they were enrolled in the pilot, and the date of their first drive test. For customers who failed the visual acuity assessment, for instance, this time might be spent in taking care of the DL62 referral process; for customers who were required to take a drive test because of failure on one or more 3-Tier Assessment System tests (e.g., extreme failing on the PRT, or failing the written test 3 or more times), this time might be spent practicing their driving in preparation for the on-road test. In any case, this gap between the date of enrollment and the scheduling of the first drive test means that the month of July had substantially fewer drive tests (58) than the months of August, September, and October (94-122). For the purposes of costing, therefore, the average number of drive tests generated per month during pilot cohort (regardless of source) will be taken for the months of August, September, and October. The augmented totals, however, will be derived by taking the total number of drives estimated to have been lost due to erroneous processing (275) or lagging applications (186) divided by the full five months of the project (July-October). Table 59 displays the added time per category of drive test, the average number of drive tests administered per month during pilot period, and the total number of minutes of added time. If a customer was referred to Driver Safety from one of the field offices, they are included in the row of 3-Tier generated drive tests. Based on Total #3 of Table 59, 3TAS generated 123 hours and 30 minutes per month of additional drive test examiner time as compared to current processing. However, this excludes otherwise eligible customers who had motorcycle endorsements, who elected to take the renewal test in a language other than English, or who took the renewal test in a non-written format.

Added time due to 3-Tier processing associated with the ADPE drive test

Table 60 displays the number of ADPE drive tests given, and the mean length of these tests. The length of the test includes the time spent the examiner spent traveling to and from a customer's house, the time spent greeting and discussing the route with the customer, and the time spent on the actual drive test itself. Due to missing data, these three sub-components of the ADPE (travel time, greeting time, and drive time) cannot be separately estimated. Although the mean length of the ADPE differs somewhat according to customer type (Driver Safety Referral, limited-term renewal, or 3-Tier generated), these differences may simply be a product of (a) small sample size, or (b) inherently large variation in the length of this type of test.

The calculation of added time from the ADPE would, in parallel to the calculations presented above for the SDPE test, be the sum of two factors: first, any difference in processing time between baseline and pilot, and second, any difference in the number of drive tests of this type

administered during baseline and pilot. Only a handful of ADPEs were administered during either baseline (1, which took 90 minutes) or pilot period (19, with an average length of 103 minutes). It will therefore be assumed that any difference between the mean time to administer

Table 59

Added SDPE Drive Test Time During the 3-Tier Pilot

Type of SDPE drive test customer	Average *N* of tests per mature month[a]	Added time (pilot mean – baseline mean)[b]	Total additional minutes per month
Driver Safety referral	31	4 minutes	124
Limited-term renewal	53	6 minutes	318
Failed visual acuity standard	8	7 minutes	56
3-Tier generated	100	36 minutes	3,600
Erroneously-processed customers	55	36 minutes	1,980
Lagging customers	37	36 minutes	1,332
Total #1 (pilot drives only)	192	N/A	4,098
Total #2 (pilot + errors)	247	N/A	6,078
Total #3 (pilot + errors + lagging)	284	N/A	7,410

[a] Combines first, second, and third attempts for the months of August, September, and October. Rounded to whole drives.
[b] Calculated to the nearest whole minute. Added times for 3-Tier generated, erroneously processed, and lagging customers do not subtract for baseline mean.

Table 60

Number of ADPE Drive Tests Given, and Average Total Time Taken (Pilot Cohort)

Type of ADPE drive test customer	*N* of ADPE drive tests given	Mean length, in minutes[a]	Total minutes of ADPE drive test time
Driver Safety referral	5	105	525
Limited-term renewal	7	99	693
3-Tier generated	7	110	770
Total	19	103	1988[b]

[a] The effective *N* to determine the mean length of each type of drive test customer is different from the number of ADPE drive tests given, due to missing data.
[b] This figure sums the total number of minutes among the different types of pilot customers, and so is effectively weighted for the number of drive tests multiplied by the different mean drive-test time for each type of customer.

the ADPE using 3-Tier procedures and the expected mean time according to current FOD estimates (two hours, or 120 minutes) is the result of random fluctuation, and will not affect costing.

Given the substantial differences in the demographic characteristics of the baseline and pilot cohorts it is not clear whether the difference in the number of ADPEs administered is a result of 3TAS, or some other factor (such as the 14 year difference in the mean age distribution; see Table 44, p. 107). Furthermore, according to the staff interviews (see Module #2 of the Appendix to this report) those who took the ADPE during the pilot may well have taken this type of drive test regardless of the existence of 3TAS. It will therefore be assumed that no excess ADPEs (over normal processing) were administered as a result of 3TAS.

In sum, the administration of the ADPE during the 3-Tier Pilot does not appear to have added in any substantial way to staff workload. Therefore, it will be assumed that the administration of the ADPE during a statewide rollout of 3TAS will not involve a substantial increase to staff workload *as compared with current processes and procedures*.

Added time due to 3-Tier processing associated with Driver Safety processing

About 1% of the customers who participated in the pilot cohort did so as the result of a referral to the Sacramento Driver Safety Office (DSO). While this had a significant operational impact on that specific office, in terms of sheer quantity of customers the participation of Driver Safety in the 3-Tier Pilot is dwarfed by the involvement of FOD.

In order to estimate the time added to customer processing of Driver Safety referrals, Hearing Officers were surveyed just after the completion of the pilot regarding the amount of time (in their estimation) that was added to processing by 3-Tier Assessment System protocols. The data collected during these surveys indicated that 3-Tier processing added approximately 11 minutes to processing. However, much of this added time consisted of elements of the process that were pilot-specific, and not anticipated to be adopted for statewide implementation (e.g., the Driving Habits Survey, filling out the hardcopy form of the 3-Tier Tracking Sheet, as well as some quality-control measures specific to Driver Safety). In addition, other aspects of 3-Tier processing of Driver Safety customers will be eliminated if the automation of 3-Tier data collection incorporates Driver Safety at the time of statewide implementation. What remains is the scope of driving questions used to determine which kind of drive test (SDPE or ADPE) is most appropriate for a customer's specific driving needs; according to the surveys conducted of

Hearing Officers this took approximately 3 minutes to complete. During an average mature month, Driver Safety processed 36 3-Tier customers, of whom 33 were scheduled for drive tests; multiplied by the average additional time taken, this represents 108 additional minutes of processing time.

ESTIMATION OF ADDITIONAL STAFF NECESSARY

Assuming staff-proposed efficiencies to the Tier 1 assessment tests (e.g., the elimination of walk-time associated with the physical observation of potential lower-body limitations) as well as reprogramming of CA DMV's system of electronic data collection and archiving, 3TAS will increase the amount of time required to process individual 3-Tier eligible customers. In order to best manage this increase in added time, it is recommended that CA DMV hire staff to manage this additional workload. The number of additional staff positions recommended is based upon the total amount of additional processing time expected to result from the implementation of 3TAS. In other words, simply *in order to maintain present standards of processing efficiency* it is recommended that CA DMV hire additional staff to manage the added workload that will result from additional assessment and education of California drivers for driving-relevant limitations.

The amount of time expected to be added to processing for each step of 3TAS includes the following components:

- Tier 1 assessment tests: 5 minutes of additional MVFR time per 3-Tier customer per month.
- PRT: 1.5 minutes of additional MVFR time per 3-Tier customer per month.
- Pre-drive test interview: 1 minute of additional DMV Manager I time per 3-Tier customer per month.
- Educational intervention: 1 minute of additional DMV Manager I time per 3-Tier customer per month.
- SDPE drive test: 123 hours and 30 minutes of additional Licensing Registration Examiner (LRE) time per month.
- Driver Safety 3-Tier processing: 108 minutes of additional Driver Safety Hearing Officer time per month.

In a mature month, 2,564 customers were processed according to 3-Tier Assessment System procedures in one of the 6 pilot offices. Multiplying this to the figures given above, and dividing by the number of work hours in an average month for an employee of the State of California

(174) will therefore yield an estimate of the number of full-time equivalent positions (FTEs) required for the 6 pilot offices:

- MVFR (or other front-line staff): 6.5 minutes X 2,564 customers = 278 hours, or approximately 1.6 FTEs for the six pilot field offices.
- Manager I: 2 minutes X 2,564 customers = 85 hours, or approximately 0.5 FTEs for the six pilot field offices.
- LRE: 123.5 hours, or approximately 0.7 FTEs for the six pilot field offices.
- Driver Safety Hearing Officer: 1.8 hours, or approximately 0.01 FTEs for the DSO.

These calculations are based upon the six field offices and the single Driver Safety office used for the 3-Tier Pilot. If implemented statewide, the number of additional staff needed in any particular office will depend upon a number of factors specific to a given locale. Among other factors, the number of additional staff needed may depend upon office size, the demographic makeup of the population in the surrounding area (e.g., the mean age, or the proximity of any sizable senior communities), and seasonal variation in customer flows. As a practical matter, the number and type of additional staff will necessarily be subject to managerial discretion at the office and region level, and may in turn have to be adjusted as the program is rolled out over time.

In order to extrapolate these estimates statewide, two potential methods are available. If one assumes that the 6 pilot offices are roughly representative of all 169 CA DMV offices, it is possible to multiply the number of FTEs for the field office positions by the ratio of 169/6, or 28.2. For Driver Safety there are 12 offices, for a multiplier of 12. This would lead to the following calculations:

- MVFR (or other front-line staff): 1.6 X 28.2 = approximately 45.1 FTEs statewide.
- Manager I: 0.5 X 28.2 = approximately 14.1 FTEs statewide.
- LRE: 0.7 X 28.2 = approximately 19.7 FTEs statewide.
- Driver Safety Hearing Officer: 0.01 X 12 = approximately 0.1 FTEs statewide.

Alternatively, by taking the ratio of the total number of DL transactions processed statewide (2,268,281/month for the mature months of the pilot), over the total number of DL transactions processed in the 6 pilot offices (92,552/month for the same period), it is possible to multiply the number of FTEs by 24.5. This would lead to the following calculations:

- MVFR (or other front-line staff): 1.6 X 24.5 = approximately 39.2 FTEs statewide.
- Manager I: 0.5 X 24.5 = approximately 12.3 FTEs statewide.
- LRE: 0.7 X 24.5 = approximately 17.2 FTEs statewide.

For Driver Safety Hearing Officers, a slightly different method is required. By taking the ratio of P&M condition cases closed during the calendar year 2007 for the DSO over the total number for the state as a whole (excluding lapses of consciousness cases, which were never intended to be subject to 3-Tier processing) yields the following: 65,712/10,572 cases/year x 0.01 FTEs = approximately 0.1 FTEs statewide.

These estimates do not take into account the increase in customer load expected to result from the extension of 3TAS to all languages, as well as to holders of combination Class C and Class M (motorcycle) licenses. Applying the adjustment developed above (see pp. 145-145) yields the following estimates, with a range given for difference in the estimates developed by assuming the 6 pilot field offices (FO) are representative of the 169 offices statewide, versus taking the ratio of DL transactions (DL) as reported in the Production Statistics Detail Reports:

- MVFR (or other front-line staff): 39.2 (DL) to 45.1 (FO) FTEs X 1.27 = 49.8 (DL) to 57.3 (FO) FTEs.
- Manager I: 12.3 (DL) – 14.1 (FO) FTEs X 1.27 = 15.6 (DL) to 17.9 (FO) FTEs.
- LRE: 17.2 (DL) – 19.7 (FO) FTEs X 1.27 = 21.8 (DL) to 25.0 (FO) FTEs.
- Driver Safety Hearing Officers: 0.1 FTEs X 1.27 = 0.13 FTEs.

In order to convert these estimates of necessary staffing to dollars, the mean salaries (and associated benefits) were taken for the 2009/2010 fiscal year. These figures are presented in Table 61.

Table 61

Estimated Monthly Cost of Additional Staff for Implementation of the 3-Tier Assessment System Statewide

Position	Monthly salary + benefits[a]	FTEs	Expected monthly cost of additional staff
MVFR	$3,598	49.8 – 57.3	$179,180 - $206,165
LRE	$4,329	21.8 – 25.0	$94,372 - $108,225
Manager I	$4,847	15.6 – 17.9	$75,613 - $86,761
Hearing Officer D	$6,028	0.13	$784
Total			$349,949 - $401,935

[a] Salaries are taken for the 2009/2010 fiscal year, and do not include reduction for furloughs that were specific to that year's fiscal emergency. Benefit rate was set at 46.762%

If implementation is judged an appropriate course of action by policy-makers and stakeholders, it will likely occur sometime after 2011 (the expected date of publication of the outcome analysis of crashes and violation rates, as predicted by 3TAS). The specific dollar amounts associated with salaries and positions will therefore differ somewhat from those presented here, depending on inflation, contract negotiations, and other factors.

TRAINING, QUALITY CONTROL, PURCHASING, AND DATA PROGRAMMING ASSOCIATED WITH START-UP

Training for any statewide rollout of 3TAS will likely build upon the training policies and procedures that were developed for the 3-Tier Pilot. Certain changes, stemming from the recommendations included in this report, are assumed in the development of the estimate of the costs of training. The primary difference that would affect training for any statewide implementation would be the adoption of an electronic system of data collection and archiving, as opposed to the hardcopy paper collection of data that occurred during the pilot. The costs associated with training are broken down by (a) development of curriculum, and (b) ongoing added costs of new training.

The estimated costs of developing new policies, procedures, and training materials are presented in Table 62.

Table 62

Estimated Cost to Develop Training Classes in 3-Tier Assessment System Procedures

Class topic	Hours to develop	Expected cost[a]
3-Tier MVFR procedures (via distance learning)	32	$1,443
PRT procedures	16	$722
3-Tier LRE procedures	128	$5,774
3-Tier Manager I procedures	128	$5,774
Administrative Manager overview	32	$1,443
Field Office Manager overview	16	$722
Driver Safety Hearing Officer procedures	28	$1,263
Driver Safety Manager overview	24	$1,083
Total	404	$18,224

[a] Assumes salary for a Training Officer (Range C) + benefits of $7,849/month.

In recent rollouts of new procedures, CA DMV has generally adopted the practice of training staff on a region-by-region basis, one region at a time. This will be assumed to occur if 3TAS is adopted for statewide implementation. The number of sessions held for any given class will necessarily depend upon the number of field offices, as well as the number of employees, in each of the eight CA DMV regions around the state. The number of classes and sessions will also likely differ from region to region depending upon geographic spread between field offices. This complicates any procedure for estimating the number of classes that will be expected for a statewide rollout.

In order to facilitate the estimation of training costs, a number of assumptions will be made. First, it will be assumed that any non-distance learning class will be taught by two Departmental Training Branch (DTB) Training Officers. Secondly, it will be assumed that the number of classes will be in proportion to the number required for the pilot. Hence, it will be assumed that all field office-related classes will be 28 times the number offered during the pilot (169 field offices statewide versus 6 pilot field offices; 169/6 = 28.2) and all Driver Safety-related classes will be 12 times the number offered during the pilot. Similarly, the number of students taking a given class will be assumed to be 28 (or 12) times the number who took the class during the pilot. Third, it is unknown at this time to what extent distance learning techniques can be extended to any or all of the classes required for statewide rollout. In the detailed estimates below, only one class (MVFR procedures) is assumed to be distributed via distance learning. In those cases were distance learning is not feasible or appropriate, DTB staff will require travel and per diem expenses associated with providing training at multiple sites across the state. These latter costs are especially difficult to estimate since the distance and time necessary to travel for any specific class session will depend upon a number of unknown factors. As a general rule of thumb, therefore, it will be assumed that travel expenses and per diem will come to $100 per trainer per session, and that travel time will be four hours per trainer per session. Fourth, for all classes except those which cover LRE procedures, it will be assumed that curriculum materials will cost $2 per participant; for LRE procedures it will be assumed that curriculum materials will cost $4 per participant (to cover the added expense of drive test score sheets, etc.). The details of the estimated expense of each class required for start-up are detailed in Table 63.

In keeping with current CA DMV practice, it is assumed that periodic retraining of staff at all levels would be required. This would most likely be carried out during Wednesday morning staff meetings on-site at individual field offices and Driver Safety Branch offices, using training tools and curricula developed by DTB and FOD. In addition, it is assumed that training in 3-Tier

Assessment System procedures would be incorporated into formal training of newly-hired staff and managers. Whether this occurs as a separate class specifically on 3-Tier processing, or whether it is incorporated into other training classes (such as, for instance, Basic Driver License Processing) is beyond the scope of these recommendations, and subject to the discretion of DTB.

Table 63

Estimated Cost of Start-Up Training for Statewide Implementation of the 3-Tier Assessment System

Class	Sessions	Students[a]	Hours		Materials	Training Officers[b]	Total
			Per session	Total			
MVFR procedures (via distance learning)	14[c]	3,528	4	56	$7,056	$5,052	$12,108
PRT procedures	56	336	2	112	$672	$41,514	$42,186
LRE procedures	56	392	16	896	$1,568	$112,246	$113,814
3-Tier Manager I procedures	28	392	16	448	$1,568	$56,216	$57,691
Administrative Manager overview	28	280	4	112	$560	$25,809	$26,369
Field Office Manager overview	28	308	2	56	$616	$20,757	$21,373
Driver Safety Hearing Officer procedures	12	228	3.5	42	$456	$10,520	$10,976
Driver Safety Manager overview	12	240	3	36	$480	$9,978	$10,458
Grand Totals	234	5,704		1758	$12,976	$282,000	$294,976

[a] Students taking a given class can include different job classifications.
[b] Assumes a salary of $5,348/month + benefits at 46.762%, plus travel and per diem of $100 per trainer per session (excluding distance learning sessions), plus travel time of 4 hours per trainer per session (excluding distance learning sessions).
[c] Assumes that half of the 28 DMV Video Conferencing/Distance Learning sites are used for each training session.

However, it is assumed that training in 3-Tier procedures will be delivered in a formal setting, rather than through informal on-the-job transmission of information. This should reduce variation in implementation of 3-Tier Assessment System procedures, as well as reduce potential misunderstanding of the purpose of specific assessment tests. Also in keeping with current CA DMV processes and procedures, it is assumed that periodic quality control will occur to ensure

uniform handing of customers. This will most likely occur in the context of more general managerial supervision of field office and Driver Safety standards and processing.

In addition to start-up training, there will be some significant one-time costs associated with implementation. In particular, new equipment necessary to conduct certain assessment tests will be required. This includes the Pelli-Robson contrast sensitivity charts, and the hardware and programming associated with the PRT. The costs for these will be estimated on the assumption that the six pilot offices are representative of the state as a whole, and that therefore the cost of statewide implementation will be approximately 28.2 times the cost of implementation for the pilot. During the pilot, each chart (including the costs of hooks and chains for hanging from office ceilings) cost $216.30, and 49 charts were used. It is therefore estimated that approximately 1,380 charts will be needed for a statewide rollout, at a total cost of $298,494.

For the Perceptual Response Time (PRT) assessment test, there were two components to the costs of implementation for the pilot: consulting fees associated with the development of customized programming of the testing software, and the purchase of computer hardware for the delivery of the testing software at each field office site. The extrapolation of costs for a statewide rollout requires slightly different assumptions for each of these components. For the consulting fees associated with programming, the incremental cost associated with providing PRT software for all field offices across the state—assuming that all computers are basically the same (i.e., not a mix of platform types such as Mac vs. PC)—would be relatively modest, perhaps in the range of $25,000. However, because the underlying algorithm for the assessment testing is proprietary, it is likely that an annual license fee would apply, based on the number of sites using the software. Traditionally, a single computer constitutes a “site” for the purposes of software licensing; however, in cases where a single office contains multiple computers, the license fee may apply at the office level, perhaps adjusted for the number of expected simultaneous users of the software. There are currently 169 CA DMV field offices; if one assumes an annual fee of $500 per site license, applied at the office level (regardless of the number of computers in a given office), this would cumulate to a statewide annual license fee of approximately $84,500. If CA DMV makes a multi-year commitment, presumably any licensing fees would be subject to negotiation. As an initial estimate, however, this figure will be adopted for the present calculations.

In addition to software, the delivery of the PRT would likely require the purchase of computer hardware. Using available current (2009) prices, Table 64 details the various hardware costs:

Table 64

Estimated Costs of Hardware Purchasing Associated with the PRT

Item	*N* of units	Approximate unit price	Total cost
Port desktop switches	169	$71.00	$11,999
Universal drive locks	564	$42.50	$23,970
Standard PCs	420	$1,100.00	$462,000
17” display screens	420	$415.00	$174,300
Electronic waste recycling fee	420	$16.00	$6,720
USB swipe reader	420	$63.00	$26,460
LaserJet (B/W) printers	169	$899.00	$151,931
Total			$857,389

CA DMV has for some years been investigating the possibility of administering the written knowledge test by computer, rather than by hardcopy paper format as is used currently. If the written knowledge test is administered by computer, it may be possible to administer the PRT on the same hardware (i.e., on the same computer). While this would necessarily entail similar programming and licensing fee costs as are detailed above, this would at the same time eliminate or reduce many of the hardware purchasing costs detailed in Table 64. However, it is unknown at the time of the preparation of this report when, or indeed if, the administration of the written knowledge test will be converted to a computer-based format.

Both the Pelli-Robson contrast sensitivity charts and the equipment (hardware and software) associated with the PRT are expected to have relatively long functional lives. Some replacement of worn or broken equipment is expected to occur periodically. It is not possible at this time to predict the functional lifespan of this equipment. Hence, it is not possible to estimate the future costs of replacement and maintenance of the equipment required for 3TAS.

The final one-time cost associated with implementation involves reprogramming the data collection and storage system CA DMV uses to collect information regarding customer transactions. As emphasized heavily by staff in the interviews and surveys (see Modules 1 and 2 of the Appendix to this report), the use of hardcopy forms for the collection of data was deemed by those who participated in the pilot to be troublesome, error-prone, and altogether unsatisfactory. Staff repeatedly emphasized to this author and others the necessity of using a

data-collection system embedded within, and consonant with, the standard processes and procedures used by CA DMV field office and Driver Safety employees. For many years now CA DMV has relied upon a computer-based system for tracking most of the data associated with driver license renewal and assessment, including the outcomes associated with various assessment tests already in use (visual acuity assessment, knowledge tests, and road tests). The most appropriate change to pilot procedures in preparation for statewide implementation, therefore, would involve reprogramming whatever system of electronic data collection and storage is in use at the time of implementation. However, the actual estimation of the costs of reprogramming is neither easy nor obvious, for many reasons. CA DMV is currently in the process of substantially revising its system of electronic data collection in the field offices, with an expected rollout date sometime in late 2010 or early 2011. Therefore any estimation of what it would cost to reprogram the current system (called the DMVA) will soon be obsolete. Moreover, the soon-to-adopted system (called EASE) has yet to be rolled out, and there are simply no procedures in place for the estimation of revisions and reprogramming after rollout. What follows, therefore, are the author's estimates based on "best-guess" back-of-the-envelope assumptions about the costs associated with conducting substantial revisions to large, complicated mainframe applications in a business/agency setting. There are many unknowns associated with the timing of any potential statewide implementation of 3TAS. Therefore, these estimates must be treated with extreme caution, as many unknown factors may affect the ultimate costs associated with reprogramming of an electronic system of data collection and storage. In particular, if the knowledge test is converted to a computer-based format, it is unknown (to this author) how that would interact with the soon-to-be adopted primary system of data collection and storage (EASE).

The author assumes that the person doing the programming will be approximately equivalent to a civil service Staff Programmer Analyst classification, earning a salary of $5,766/month (mid-range for that classification, based on currently contracted salary ranges), plus a benefit rate of 46.762%. The author further assumes that the total amount of work required to accomplish the task will total approximately 3300 programming hours, for a total cost of approximately $160,500. It is unknown to the author at this time whether the additional data collected as part of 3TAS—which will include a number of new data fields for a substantial portion of those customers renewing their driver license in any given year—will necessitate investment in the memory storage capacity of CA DMV's driver record database. Thus, the cost of any expansion of the storage capacity of CA DMV's mainframe is not included in this report.

SUMMARY OF ESTIMATED COSTS OF A STATEWIDE ROLLOUT OF 3TAS

Table 65 details the summary of all costs associated with a statewide rollout of 3TAS, based on the assumptions laid out in this report.

Table 65

Summary of Estimated Cost of a Statewide Rollout of 3TAS

Item	Amount
Start-up (one-time) costs	
Development of training materials	$18,224
Implementation of training at rollout	$294,976
Purchase of Pelli-Robson charts	$298,494
Purchase of PRT equipment and software	$882,389
Reprogramming of DMVA/EASE	$160,500
Sub-total	$1,654,583
On-going costs (converted to annual basis)	
PRT licensing fee	$84,500
New FOD personnel	$4,199,388 - $4,823,220
New Driver Safety personnel	$9,408
Sub-total	$4,293,296 - $4,917,128

As noted above, it is assumed that the costs of training new employees, subsequent to rollout of the program statewide, will be incorporated into the Department's annual training budget. It is not expected that this will substantially alter that budget. It is further assumed the costs of periodic refresher training (conducted at the field offices and Driver Safety Branch offices at Wednesday morning staff meetings) will also be incorporated into the Department's annual training budget, with no significant or substantial effect on the bottom line. Finally, it is assumed that quality control monitoring will occur as part of current managerial oversight and supervision of production standards in the field offices and Driver Safety Branch offices.

DISCUSSION AND CONCLUSIONS

The remainder of this report focuses on the substantive interpretation of findings presented in the previous section. The discussion is broken into three sub-sections: (1) methodological and data-quality concerns, and their implications for understanding the patterns in the data produced by the 3-Tier Pilot, (2) process concerns, and their implications for the overall evaluation of the 3-Tier Assessment System (3TAS) as implemented in this pilot, and finally (3) recommendations for potential future implementation of 3TAS (in whole or in part). This last sub-section builds upon the discussion in the sub-sections on methodological and process concerns, to include recommendations for preserving data quality while maintaining production efficiency and high standards for customer service.

Methodological and Data Quality Concerns

There were eight substantial threats to the methodological validity of the 3-Tier Pilot. These methodological problems vary in scope and severity. The main threats to methodological validity include:

1.) The generalizability of results based upon a non-random sample of the population;
2.) Customer migration from pilot to non-pilot offices;
3.) The various processing errors committed by staff in the implementation of the pilot;
4.) The existence of “lagging” customers who did not complete their applications by the end of the pilot period;
5.) The effect of the shift in driver license renewal terms from four years to five years on the comparability of the baseline cohort with the pilot cohort;
6.) The limitation of the pilot to customers taking the written renewal test in English;
7.) The probable variation in the administration of the memory recall assessment; and
8.) The expressed concern by some of the staff regarding perceived variation in customer outcomes on the contrast sensitivity assessment, depending on glare and shadows falling on the Pelli-Robson charts.

Each is discussed below, including the nature of the problem, the implications for the analyses contained in this report and the implications for the outcome analysis.

Generalizability of Results of the Data Produced by the Pilot

The 3-Tier Pilot incorporated a quasi-experimental method, with a purposive sampling frame. The choice of method and sampling for enrolling participants was necessary for a number of reasons, the three most important of which were (a) minimizing potential disruption of ongoing California Department of Motor Vehicles (CA DMV) field office operations and procedures, (b) minimizing potential disruption of ongoing Driver Safety Branch operations and procedures, (c) maximizing the face-validity connection between enhanced assessment of driving skill and empirically demonstrated predictors of driving competency, and (d) operating within current legal and policy directives. From a methodological perspective, this meant that the population enrolled in the pilot was not a random sample (simple or otherwise) of the population; any generalization to the driving public as a whole must therefore be severely qualified.

The quasi-experimental aspect of the pilot lay primarily in the construction of a baseline and pilot period samples separated temporally by a few months. As originally designed, whether or not a customer enrolled in the pilot was intended to be largely a product of the month of their birth (which determines the month in which a license expires). This was not anticipated to have a direct relationship to the dependent variables of concern in this study; unfortunately, this turned out not to be true. Baseline customers are substantially different from pilot customers in mean age and prior violation rates, both of which are directly related to crash risk, subsequent violation rate, and licensing outcomes. This is especially the case for 5-year renewal applicants; Driver Safety referrals and limited-term license renewals are not statistically different across cohorts. The statistical differences across cohorts will necessitate revisions to some of the statistical techniques used in the outcome analysis.

The purposive aspect of the sampling used for the project involved the choice of field and Driver Safety offices participating in the pilot. These were not randomly chosen from the universe of CA DMV field offices. It therefore follows that the drivers renewing their licenses in these field offices do not constitute a random sample of California drivers. That said, there is no *a priori* reason to believe that drivers enrolled in the pilot are significantly different from other California drivers in terms of the relationship between safe driving behavior (as will be measured by the dependent variables included in the outcome analysis) and those variables that *predict* safe driving behavior, as incorporated into 3TAS (e.g., vision conditions, cognitive health, physical conditions, etc.). In addition, there is no *a priori* reason to believe that drivers enrolled in the pilot are significantly different from other California drivers in terms of the effect of participation in the 3-Tier Pilot on subsequent driving behavior. To the extent that Sacramento-

area drivers *are* different from the population of California drivers as a whole—in terms of age, likelihood of being required to renew their license in a field office, or likelihood of being enrolled in the pilot for some other known reason (e.g., language use)—this has implications for the process analysis but not the outcome analysis. These differences have been taken into account in estimating the potential costs of a statewide rollout, as discussed above (pp. 142-145).

In comparison to the population of California drivers as a whole, those enrolled in the pilot and baseline cohorts were both older and, for quite separate reasons, more likely to have crashes and violations on their record. In all three cases (age, prior crash history, prior violation record), the characteristics of the 3-Tier Pilot and baseline cohorts were largely a product of CA DMV's license renewal policies (already in place prior to the pilot) which require all customers over the age of 70, with limited-term licenses, or with a specified number of at-fault crashes or violations on their driver record, to renew their license in a field office, rather than renewing by mail. These characteristics of the sample population likely constrain any empirically-demonstrated statistical relationships between outcomes on the various assessment tests and the primary dependent variables: post-participation crashes, violations, and licensing outcomes.

That said, the population enrolled in the 3-Tier Pilot constitutes a much broader sample of the population than has generally been included in prior studies. Each of the assessment tests used in the pilot has shown promise in prior studies that involved much narrower samples (e.g., only older drivers, or older drivers with diagnosed reportable conditions known to affect safe driving). If outcomes on these assessment tests, and participation in 3TAS more broadly, are shown in the outcome analysis to result in methods by which CA DMV can improve the safety of road and highway users, save lives, reduce violation rates, and preserve individual mobility, the non-random nature of the sampled population should be taken into account. Specifically, the reader should keep in mind that 3TAS was specifically designed to identify, assess, and educate drivers who are, by reason of age or prior driving record, more likely than other drivers to possess driving-relevant limitations in vision, cognition, or physical function.

Customer Migration

The author used multiple methods to estimate the degree to which customers "migrated" from pilot offices to non-pilot offices. If customer migration occurred in substantial numbers, and especially if those customers who migrated to non-pilot offices were substantially and significantly different from non-migrating customers (e.g., in terms of age or violation

propensity), this would potentially constitute a form of non-response bias to the findings. This would, in turn, require the estimation of (and, potentially, correction for) potential biases to the size, direction, and statistical significance of any findings from these data.

It appears from the findings discussed above (pp. 94-99) that customer migration was quite uncommon. When measured in terms of the raw count of customer flows into pilot and nearby offices during the months just prior to, during, and just after the pilot, the data suggest that customer migration, if it existed at all, occurred rarely enough that it did not substantially effect the overall size of customer flows into the pilot offices. When measured in terms of the total number of customers switching from one office to another (i.e., starting an application at one office, then completing the application somewhere else), the data suggest that customer migration did occur, but rarely. However, the overall rate of customer migration does not appear to have been affected by the pilot, *per se*: an approximately equal number of customers switched *to* pilot offices as switched *from* pilot offices, and the overall rate of office-switching was basically consistent over time (i.e., between the pilot period and the period just after the pilot).[32] In comparing specifically-identified customers who dropped out of the pilot and completed their applications elsewhere (<1% of the total pilot cohort), the data suggest that these individuals likely switched offices for reasons other than, or at most in addition to, the extra assessment associated with the pilot (see Table 39 above, p. 98). It is true, however, that those individuals who switched offices were both younger (by approximately 6 years) and substantially more likely to have recent violations on their record; hence they are statistically somewhat different from the general pilot cohort (see Table 38 above, p. 97). In sum, customer migration was not a substantial source of potential non-response bias; however it did occur among a small number of customers with significantly different driving records. In conjunction with other forms of customer non-compliance (discussed in the next two subsections, on erroneously-processed customers and lagging applicants), these findings have implications for both the process and the outcome analyses.

For the process analysis, the existence of a small number of migrating customers underscores the need for an adequate system of record-keeping for the purposes of data control and quality. Customer migration from one field office to another is simply part of conducting business with a dynamic, mobile population. CA DMV customers are not required to use any particular field office (indeed, to the extent possible, customers are encouraged to conduct their transactions by

[32] The rate of office-switching was higher in the baseline period than in the pilot period. This is likely related to other oddities of the baseline cohort, discussed in the subsection on the effect of the shift in the license renewal term on baseline period data.

mail or internet, to save time and money). Many individuals use offices near their home, or their place of work, or some other locality for any number of idiosyncratic reasons having very little to do with licensing assessment. Because CA DMV does not require non-commercial license holders to visit a specific field office[33], any adoption of 3TAS statewide should occur along with adoption of some system of electronic record-keeping of 3-Tier data, to facilitate the accuracy and completeness of data collected on customers who visit more than one office in the course of completing their transaction(s). This might be directly accomplished through reprogramming of whatever system for electronic data collection and storage is in use in CA DMV field offices (currently the DMVA). This suggestion is discussed at further length in the sub-section on recommendations for potential future implementation (pp. 199-201).

For the outcome analysis, the number of migrating customers (71) was quite small in comparison to the total number of pilot cohort customers (10,999). Although these cases were rare, they are statistically different from the overall pilot cohort sample, both in terms of age and prior violation record. In conjunction with other instances of likely participant non-compliance (erroneously-processed customers, lagging applications), it is possible that these cases might constitute a potential source of bias to the analysis of 3-Tier's effect on crashes, violation rates, and licensing outcomes. To estimate, and if possible control for, this potential source of bias, these customers will be incorporated into a sub-analysis of the outcome report. This will allow for continued tracking of their post-participation driving records, and hence comparison with the main sample of pilot cohort participants. This will further allow for sensitivity analyses to be performed, to estimate the size, direction, and significance of any bias to the main findings.

Effects of Errors in Processing of 3-Tier Customers

The third methodological concern relates to the cumulative number of erroneously-processed customers (see Table 40, above, p. 101). These errors generally fall into one of three categories: the enrollment of non 3-Tier eligible customers, missing documents or data, and improperly administered 3-Tier procedures. The cases falling into each of these three categories were excluded from the main body of the process analysis, and will similarly be excluded from the main body of the outcome analysis. Each of these categories of error has somewhat different implications for the methodological validity of the data retained for analysis in the process and outcome reports.

[33] Commercial license holders are encouraged to visit Commercial Driver License (CDL) Drive Test Facilities, or a sub-set of traditional CA DMV field offices specifically designated to conduct any behind-the-wheel driving tests required of these customers.

ENROLLMENT OF NON 3-TIER ELIGIBLE CUSTOMERS

In the first instance there were 118 customers who were enrolled in the 3-Tier Pilot but, for various reasons, ought not to have been. While this added to the customer load in a marginal way, this represents approximately 1% of the total number of customers processed during the pilot. This likely had very little effect on the various process measures discussed in this report. Because these customers in general have quite different driving habits and risk exposure—especially motorcycle, commercial, and original applicants—all have been excluded from the dataset and will not be included in the outcome analysis. The participation of these customers in the pilot will therefore have no impact on the estimates of 3-Tier's impact on crashes, violation rates, or licensing outcomes.

MISSING DOCUMENTS OR DATA

The second type of erroneously-processed customer included those with missing documents or data that could not be imputed from other sources. There were a number of sub-populations among this group of customers: those who completed their applications at a non 3-Tier office (the so-called "migrating" customers); those whose written test results are unknown; those whose vision referral status is unknown; those for whom drive test outcomes are unknown and unreconstructable; and finally those for whom documentation regarding their Driver Safety referral is missing and/or unreconstructable. The remaining cases of missing documents and data (Tier 1 score sheet missing, Pelli-Robson contrast sensitivity assessment results not recorded, and name/DL mismatches) represent only a dozen individuals and are therefore at best a marginal source of error. Taken as a whole, these cases constitute a small, but nevertheless important source of bias to both the process and the outcome analyses.

For the process analysis, the amount of missing (and unimputable) data is small (with one exception), and therefore has relatively little impact on the customer flows and outcomes discussed in this report. For most analyses in this report, the amount of missing data is less than 10% (e.g., missing Driver Safety referral information, missing drive test score sheets, or missing information regarding the number of written tests). The one exception lies in the number of customers with missing data regarding their vision referral status (i.e., a missing DL62). These represent a potentially diverse set of circumstances. In some cases these constitute truly erroneous processing on the part of staff: this includes those customers who extreme failed on the contrast sensitivity assessment but were not referred to a vision specialist for professional evaluation. In other cases, however, the customer may have been issued a DL62 but the results of

that professional evaluation went unrecorded. Among these, some customers may have received a new optical prescription that allowed them to pass the department's visual acuity standard (a relatively common outcome, and one that does not require keeping a copy of the DL62 on file), while others may have received a diagnosis of vision that was not correctable to DMV's minimum standard (which may result in requiring a drive test), or they may have received a diagnosis of a progressive medical condition affecting vision (which may also result in requiring a drive test, and typically requires keeping a copy on file at CA DMV Headquarters). Because the DL62 form is missing for these 81 cases, these quite different process outcomes are indistinguishable: (1) a truly erroneously-processed customer who received no referral even though the procedures of 3TAS required it, (2) a correctly-processed customer whose license was renewed with a vision restriction but who was not required to take a drive test, and (3) a customer who may or may not have been processed correctly, but who was required by CA DMV policies and procedures to take a drive test. While it is probable that the largest proportion of these 81 missing DL62 customers fall into the second category (i.e., they were prescribed new lenses, and so were issued a restricted license without having to take a drive test), the precise disposition of customer outcomes cannot be imputed reliably from the data at hand. Furthermore, this represents a loss of up to 20% of the DL62s that were (or should have been) issued over the course of the pilot.[34] Thus, the operational impact of 3TAS on DMV field offices is, in this specific regard, potentially underestimated. To the extent possible, corrections for these data losses are incorporated into the estimates of the potential cost of statewide implementation. The amount of missing data also underscores the necessity of a system for accurate data collection and record-keeping; this might be accomplished through revisions or reprogramming of the electronic system of data collection in use in the DMV field offices (currently the DMVA).

For the outcome analysis, the loss of these data represents a slightly different problem. As noted in Table 41 (p. 103, above), erroneously-processed customers have somewhat different age profiles and prior violation counts in comparison to the rest of the pilot cohort. They thus constitute a potential source of bias to the outcome analysis. This is particularly true for that sub-group of the pilot cohort who may have vision limitations that potentially effect driving. Because up to 20% of the customers who were (or should have been) issued a DL62 are missing key information regarding the nature and severity of their vision limitation, they must be excluded from the analysis. This has the potential to alter the size, direction, and statistical significance of any correlations determined to exist between 3-Tier assessment outcomes related to vision

[34] Slightly more than three hundred (307) correctly-processed customers had DL62s, as opposed to 81 who had missing data in this regard: 307/388 = 79%.

conditions and subsequent driving behavior. To the extent possible, sensitivity analyses will be performed to estimate this potential source of bias to the findings in the outcome report.

IMPROPER ADMINISTRATION OF 3-TIER PROCEDURES

The third type of erroneously-processed customer involved the 300+ customers who were, in one way or another, not processed according to the training protocols developed for the pilot. If one includes errors in the administration of the educational intervention, this adds several hundred additional customers to this total. These customers missed one (or more) Tier 2 or Tier 3 assessment tests, or were given them when their individual circumstances did not require it. There were three main types of processing errors: maladministration of the educational intervention, customers who missed taking the PRT, and customers who were re-licensed without an on-road drive test. Each of these types of errors represents a relatively substantial threat to the methodological validity of the pilot, though each has somewhat different implications for the process and outcome analyses. A handful of customers (7) were given a drive test unnecessarily, or given the wrong type of drive test; these likely constitute only a marginal source of error and potential bias to the findings.

Just under 800 individuals received the experimental educational intervention materials developed to enlighten customers as to methods of compensation for potential limitations in contrast sensitivity or perceptual speed. According to the data collected during the pilot, one-third of these individuals (271/785) received these materials when they shouldn't have, and an additional, smaller, number (217) should have received the materials but did not. However, these figures are somewhat speculative as there exists additional evidence that the receipt of educational materials was not always accurately recorded (see Module 2 of the Appendix to this report). In other words, there may exist a substantial number of both Type I (false positive) and Type II (false negative) errors in the data regarding the educational intervention. Hence, there is substantial doubt both as to who actually received the educational intervention and as regards how many errors were committed in the administration of this component of the pilot.

From a process perspective, in those cases where customers received educational intervention when this was not called for, it added to the amount of time that the 3-Tier Manager I spent with a given customer. By contrast, where customers did not receive the educational materials when they should have, less staff time was spent on these customers than was required according to pilot training and procedures. In either case, the over- or under-distribution of the educational intervention may have impacted the efficiency of customer processing in the field offices more

generally, though this second-order effect was probably small. These errors should have had no impact on the movement of customers from one tier to the next, as the educational materials did not themselves constitute an assessment trigger.

More generally, the maladministration of the educational intervention materials suggests that relying upon individual judgment to ensure the accuracy of a randomizing experimental protocol is impractical and inadvisable in a busy agency environment. CA DMV field office staff are subject to multiple, complex, task demands during the course of a given day; this is all the more true given the importance of maximizing production efficiency, minimizing wait times, and delivering excellent customer service. Without an automatic, or forcing, mechanism for the delivery of a randomizing experimental protocol, human judgment tends to enter in to the process and, for good or for ill, produce non-random effects.

Staff did report anecdotally that customers who received the materials were more likely to succeed in passing their on-road drive tests. It is certainly true that the fail rate on the Supplemental Driving Performance Evaluation (SDPE) during the 3-Tier Pilot was substantially lower—especially for Driver Safety referral and limited-term customers—than has generally been reported for referral drive tests (Hagge, 1994, Hagge, 1995, Masten, 1998a, Masten, 1998c). However, these comparisons must be made with some caution, as the sample population studied in earlier reports consisted largely of Driver Safety referral cases, rather than limited-term license holders. Even with referral customers the comparison is imperfect, as the 3-Tier Pilot included only a small subset of all Driver Safety cases referred to the pilot field offices for a drive test. It is therefore not at all clear if the fail rate for drive tests administered during 3-Tier was in fact lower than “normal,” however defined. More to the point, any correlation between the drive-test fail rate of 3-Tier participants and the educational intervention is impossible to estimate given that there exists substantial doubt as to the accuracy of the data regarding which customers actually received the educational intervention materials, or, for that matter, the drive test preparation materials also given out during the pilot. Even if the administration of the educational materials was associated with a higher chance of passing the on-road test, it is entirely possible that this was a product of some version of the Hawthorne effect (the extended conversation with the 3-Tier Manager I, the mere fact of participation in a new pilot study, the fact that customers received extra attention and personalized customer service, etc.), rather than the quality or content of the educational material itself. In sum, the maladministration of the educational intervention materials nullifies any efforts to estimate the effects of the education on driver behavior *even when properly administered*. Because there is too much doubt about the

quality of the data regarding who received the education and who did not, it is simply impossible to estimate any potential effect of these materials on crashes, violations, and licensing outcomes. This means, quite simply, that this section of the outcome analysis must remain unexamined for lack of appropriate data. As a corollary, it must be acknowledged that the educational intervention materials may constitute a potential source of unestimated and uncontrollable bias to the findings in the outcome analysis.

Slightly more than 100 individuals did not take the Perceptual Response Test (PRT) even though required to do so according to pilot procedures. About half of these were customers who failed the written test twice, while the other half had somewhat failed one of the Tier 1 assessment tests. These may represent rather pure examples of staff failure to follow 3-Tier procedures: many of these customers were issued their license on the same day as their initial application, suggesting that customers were not themselves attempting to avoid enhanced assessment. Compared to the total number of PRT tests administered (over 2200), this represents a rather small amount of error; and yet, the differences between those who took the PRT and those who were (incorrectly) not assessed using the PRT are significant. Correctly processed PRT takers were, on average, 6 years older than incorrectly processed customers (69.50 years versus 59.54 years, significant at the <0.01 level, equal variances not assumed). They were also quite a bit more likely to have accumulated negligent operator points on their record in the prior 3 years (0.59 points versus 0.16 points, significant at the <0.01 level, equal variances not assumed). This type of erroneously-processed customer was also more likely to be male than comparable pilot-cohort PRT-takers, however the difference does not rise to standard levels of statistical significance.

Although the differences between these two groups in age and prior violation propensity are significant, this represents a relatively small source of bias to the process analysis. The administration of the PRT generally took up only a small amount of staff time given that it was a self-administered test delivered via computer. The fact that these customers were processed more quickly than was required according to pilot protocols is therefore unlikely to have had a substantial effect on the efficiency with which customers were processed during the pilot. The loss of these data also represents only a small number of cases of people who ought to have advanced to Tier 3. Those who took the PRT generally failed or somewhat failed 10%-15% of the time. Hence, perhaps a dozen individuals among this group might have been required to take a drive test, had they been properly processed.

For the outcome analysis, it is possible that taking (or not taking) the PRT had some effect on customers' awareness of their own driving-relevant limitations, and by extension on their propensity to drive more safely. Given the number of cases (<5% of all PRT takers) this is unlikely to change any findings in the outcome analysis in a substantial way. However, sensitivity analyses will be performed to estimate the potential effects of the loss of these data.

Finally, there are the 222 customers who should have taken an on-road drive test but did not. In about half of these cases the customer failed the written test 3 or more times. For the remaining cases the customer either extreme failed on the PRT or received a score of 2 or more on the Tier 1 assessments. This represents a substantial loss of data to certain components of the current analysis. If processed properly, these cases would have increased the overall number of renewal-customer drive tests by 30-40%. This would have had a sizeable impact on the operational workload of the 3-Tier Manager Is and Licensing Registration Examiners. It may also have had an effect, though likely quite small, on the number of customers exiting the pilot with suspended or revoked licenses. Due to the substantial difference between the number of drive tests that should have been conducted, and the actual number of drive tests conducted during the pilot, the estimates of the potential costs of statewide implementation have been adjusted to account for this methodological bias in pilot implementation.

For the outcome analysis, these data losses present substantial methodological problems. One of the central hypotheses of 3-Tier is that assessment of potential driving-relevant limitations, in concert with education regarding how to compensate for those limitations, leads to changes in driving behavior. In a word, participation in Tiers 2 and 3 of 3TAS is anticipated to have a salutary effect on crashes, violations, and driver mobility. The customers who should have taken an on-road drive test (but did not) by definition also did not receive the bulk of the hypothesized intervention and education benefits of participation in Tier 3. If it were the case that these erroneously processed customers were no different from other Tier 3 customers in terms of background characteristics (age, gender, and prior violations), then they would simply represent random error. It would then be possible in the outcome analysis to conduct a sub-comparison of this population with those who were correctly processed. This, unfortunately, is not the case. Comparing these erroneously-processed customers with their closest equivalent among the correctly-processed pilot cohort (5-year renewal applicants) reveals that they are, in fact significant different in a number of areas: they are almost 11 years younger (61.40 years versus 72.36 years, significant at the <0.01 level, equal variances not assumed), and more likely to have accumulated negligent operators points in the prior 3 years (0.41 points versus 0.17 points,

significant at the <0.01 level, equal variances not assumed). They are also more likely to be male, though this difference does not rise to standard levels of statistical significance. Age and prior violation rate are, separately and in combination, predictive of subsequent (post-pilot) driving behavior. It will therefore be somewhat difficult to estimate the effects of proper 3-Tier processing on driving behavior, as (a) there exist substantial numbers of erroneously-processed drive-test customers, and (b) erroneous processing in these cases is empirically correlated with the primary dependent variables of interest in the outcome analysis. Given the magnitude and direction of the differences between correctly- and erroneously-processed drive-test customers, it is clearly necessary to reserve this group for later analysis. To the extent possible, the outcome report will include an estimation of the degree of bias to the findings generated by the improper re-licensure of substantial numbers of customers without first requiring on on-road test of driving skill.

Effects of Bias Introduced by Customers with Lagging Applications

Several hundred customers (683) did not complete their license renewal during the pilot. Because these customers have substantial amounts of missing data, it is not really possible to link specific assessment tests, or even tiers, with ceased participation. It is therefore difficult to gauge the degree to which lagging applications are a product of something about 3TAS itself, or some other (non-pilot related) set of factors. Regardless of whether these customers delayed their renewal because of something about the pilot or for some other reason, these individuals *do* represent a potential source of bias to both the process findings and the outcome analysis.

While 685 customers is somewhat small compared to the total number of customers with completed applications (slightly less than 11,000), approximately 227 customers within this group were required to take a drive test according to the procedures in place for 3TAS. Had all of them continued to participate in the pilot, this sub-group would have raised the number of first drive test attempts by something like one quarter to one third over what was actually recorded during the pilot. In addition, some of those customers who ceased participation at Tiers 1 and 2 may also have required an on-road test of driving skill (such as the approximately 125 instances where applicants failed the visual acuity assessment, or the 67 applicants who failed their second attempt at the written test). In combination, those who delayed the completion of their license renewal application represent a substantial underestimation of the number of on-road drive tests that may result from a potential statewide rollout of 3TAS. Unfortunately, the precise degree of underestimation is somewhat difficult to quantify. A sizeable proportion of the lagging applicants (53%) were not licensed within 12 months of their participation in the pilot. This

suggests that for whatever reason, at least some customers may not complete their license renewal applications for at least a year, if ever. As a rough estimate, it may be supposed that the count of 3TAS-generated first drive test attempts is underestimated by at least 150: this assumes that approximately 50% of those customers who were required to take a drive test eventually completed their applications, and that an additional 20-30 customers who ceased participation at Tier 1 or Tier 2 would eventually have been required to take a drive test. A correction for this potential underestimation is built into the estimates of the potential costs of a statewide rollout of 3TAS.

The absence of these customers from the pilot may also constitute a source of bias to the outcome analysis, and in particular the estimation of 3-Tier's affect on licensing actions that affect driver mobility. As noted in Table 42 (p. 105), 63 customers among the lagging applicants had suspended or revoked licenses twelve months after the completion of the pilot. Many of these appear to be the result of negligent operator points, failure-to-pay or failure-to-appear violations. This is nearly three times the number of suspensions and revocations (23 in total) administered under the pilot for failure to pass the on-road drive test. Regardless of the reasons for the licensing action, this constitutes a substantial difference in the number of customers who have lost the driving privilege. Perhaps more striking yet is the number of customers—362, or over 50% of the lagging applicants—who failed to renew their license *at all*. While some of these customers may have moved out of state, rather more appear to have made the ultimate move toward self-restriction and stopped driving altogether. It is not clear whether these customers made this decision *because* of the enhanced assessment regimen associated with 3-Tier, or for reasons unrelated to their participation in the pilot. And yet they surely represent an important segment of precisely that population of drivers 3-Tier is designed to identify, assess, and educate. To the extent possible, the licensing outcomes of these customers will continue to be tracked in the outcome report, for comparison to 3-Tier participants with completed applications.

It follows that the pool of lagging applicants also represents a potentially significant source of bias to any outcome measures of traffic safety. As noted in Table 43 (p. 105), while lagging applicants had approximately the same age profile (a mean age of approximately 55 years) as other pilot cohort customers, they were at the same time substantially and significantly more likely to be female, and significantly more likely to have accumulated negligent operator points on their records in the prior 3 years. Both of these variables (gender and prior violation record) are known to be correlated with the primary outcome measures of concern to the 3-Tier Pilot:

crashes and subsequent violation record. Therefore, in this particular case the pattern of non-response—in the form of customers delaying their relicensure—is correlated with the dependent variables of the outcome analysis and therefore constitutes a potential source of bias. As a methodological matter, sensitivity analyses will be performed to estimate the parameters of this potential bias to the findings in the outcome report.

Effect of Shift in License Renewal Term on Baseline Period Data

The baseline period—September 2006 through January 2007—was chosen originally for methodological reasons. It was assumed that collecting data on drivers licensed under current (non 3-Tier) procedures, but who likely lived in the same area and who drove under largely the same conditions (temporally and geographically), would approximate a control group for the purposes of comparing licensing outcomes, crashes and violations. In particular, it was decided to collect baseline data *prior* to the pilot (as opposed to afterwards) to avoid as much as practicable the existence of customers in both samples—such as the lagging customers discussed in the previous sub-section. Unfortunately, it was not determined until sometime later that the baseline period coincided almost exactly with a periodic "trough" in the number of customers renewing their licenses in CA DMV field offices. Not only were substantially fewer customers identified during baseline, but it appears that baseline-period customers are demographically somewhat different from pilot-period customers in terms of their age profile, gender, and prior violation record.

The difference in gross customer volumes between baseline and pilot period primarily has implications for the estimation of 3-Tier's effects on processing efficiency, on customer wait times in the offices, and therefore for costing. Because the baseline period was so substantially different in number of customers processed, all costing estimates are based upon data collected during the pilot cohort period (e.g., estimates of added keying time for 3-Tier Assessment System-generated data), or upon data drawn from statewide estimates of in-office license renewal transactions during the pilot cohort period (e.g., the proportion of all license renewal transactions that are expected to be 3-Tier eligible). As the pilot occurred during an otherwise-normal period of customer volumes in the field offices, these estimates are assumed to be in all essential respects reliable for the purposes of the process analysis.

The difference in demographic characteristics between baseline and pilot customers has serious implications for the utility of the baseline data as a comparison/control group. Although Driver Safety referrals and limited-term license renewal customers are statistically similar across

cohorts, 5-year license renewal applicants in the baseline cohort are substantially and significantly younger (by approximately 14 years) than similar drivers in the pilot cohort, significantly more likely to be male, and substantially and significantly more likely to have accumulated negligent operator points on their driver record in the prior 3 years (a mean of 0.98 points for the baseline cohort, in comparison to a mean of 0.35 points for the pilot cohort). The magnitude of these differences likely indicate broad differences not just in the types of drivers included in each sample, but also in the sort of driving in which these individuals engage. This suggests further that these two samples of drivers possess somewhat different risk exposure for violations and crashes. Therefore, these differences will likely affect the size, direction, and statistical significance of any findings in the outcome report that are based upon comparisons of baseline- and pilot-period customers. To some extent it may be possible to statistically control for these existing differences in age, gender, and prior violation record; certainly sensitivity tests will be included in the outcome analysis to estimate the degree of bias in any findings based upon comparisons between the baseline and pilot cohorts. Of course, these differences will have no bearing upon findings based more narrowly on the outcomes of the pilot cohort alone—whether between assessment tiers or between standard-term license renewal applicants, limited-term renewals, and Driver Safety referrals.

Effect of Limitation of Pilot to a Single Language

As designed and implemented, the 3-Tier Pilot only enrolled customers who elected to take the written renewal test in English. Although CA DMV provides the written renewal test in dozens of languages, it was not possible (given the size and scope of the original grant) to produce translations of all of the new assessment and education materials incorporated into 3TAS. This meant that a substantial number of potentially 3-Tier eligible CA DMV customers were excluded from the pilot. This population of excluded customers varied in number depending on the field office. This population was also quite diverse. According to DMV's own internal surveys regarding language use, 78-97% of customer contacts in the six pilot offices occurred in English.[35] The range of non-English languages requested differed from office to office, though in all cases the second most common language requested (after English) was Spanish (13-14% of customer contacts in the two Sacramento offices, versus 2-3% in Folsom and Vacaville). The third most common language requested was either Russian (5% of customer contacts in Carmichael and 3% in Sacramento-Broadway), or one of various East Asian or South Asian

[35] Surveys conducted in January 2008. A customer contact could include any kind of transaction, not just a license renewal.

languages (Vietnamese, Cantonese, Tagalog, or Hindi; each constituting 1% or fewer of total customer contacts). In addition to these, some customers—an unknown, but small, number—elected to take the test in a non-written format, such as person-to-person or via audio cassette.

This language exclusion had a measurable, but correctable, impact on the various process measures detailed in this report. In particular, the estimates of potential customer load, processing efficiency, impact on wait times, and subsequent costing of any statewide rollout of 3TAS have all been adjusted to include customers speaking languages other than English. Given that the California DMV is committed, by law and departmental policy, to conducting business with all of California's residents, the potential costs of implementation of 3TAS as described in this report therefore includes in its estimates the assumption that 3-Tier would apply to all in-office Class-C (non-commercial) license renewal customers, regardless of language spoken.

Aside from adjusting for overall customer load, this language exclusion may have affected other process measures, such as the proportion of customers moving to higher assessment tiers. To the degree that language use may be correlated with outcomes on the assessment tests used in the 3-Pilot, it is possible that the estimates of the proportion of customers moving to Tiers 2 or 3 are biased. Given prior published findings in these matters, however, this appears to be unlikely—though this is an under-researched area. While there exist some studies on differences across racial/ethnic groups in the kinds of driving-relevant conditions flagged by contrast sensitivity assessment (diabetes, macular degeneration, cataracts, etc.) or perceptual speed tasks (e.g., dementia disorders), this research has tended to focus on black/white racial differences rather than Anglo/Hispanic or even white/Asian ethnic and racial differences (Gurland et al., 1999; Kaufman Cooper & McGee, 1997; van Leeuwenn et al., 2003; Schwartz et al., 2004; Shadlen et al., 2006; Smith & Kington, 1997). The author knows of no studies that incorporate immigration status—which may be associated with use of languages other than English, but only for some immigrant groups and not others—as a variable in examining cross-ethnic differences in the kinds of conditions and disorders flagged by contrast sensitivity and perceptual speed assessments. Furthermore, it is difficult to draw common conclusions across these studies, given the range of conditions which 3-Tier assessment tests were designed to flag. Where these studies do draw common conclusions, they tend to show that if ethnic/racial differences in driving-relevant vision or perception conditions exist, they appear to be the result not of race/ethnicity *per se,* but of associated mean differences in education and socio-economic status. Given these findings, in combination with the range of ethnic groups potentially excluded from 3-Tier (not just Spanish, but also Russian and various Asian-origin languages), it is not at all clear that the exclusion of customers electing to take the written test in English produced any consistent bias in

the proportion of customers assessed at Tiers 2 and 3 of the 3-Tier System. Even if this exclusion did produce a bias to the findings, it is not clear what direction that bias might have taken. The same conclusion holds for any potential bias as regards licensing outcomes, violations, and crashes.

Effect of Probable Variation in the Administration of the Memory Recall Test

As reported in the staff interviews, it appears that there was some degree of variation, across staff, in the administration of the memory recall test. While some staff reported that no customers ever failed this test, others reported that up to 10% of customers failed. Given the quasi-random nature by which the automatic queuing system in CA DMV field offices assigns customers to technicians, it seems unlikely that the fail rate varied this much in actual practice (indeed, the overall fail rate, as detailed in Table 11, p. 64, was closer to 1% of all renewal customers). Furthermore, a substantial number of staff reported skepticism regarding the utility of this test for predicting safe driving as well as concerns regarding its fairness (especially to seniors). This indirectly suggests that there may exist substantial variation among staff in the implementation of this assessment. This has implications for both the process and the outcome analyses.

For the process and outcome analyses, the widespread skepticism among staff may have led to a lower fail rate on this assessment than would have occurred otherwise. This in turn may have affected the number of customers assessed at Tiers 2 and 3. For instance, given that this test was subject to a high degree of individual interpretation on the part of staff, it may be that customers who would otherwise have been assessed at Tier 3 on the basis of a Tier 1 score of 2 were "downgraded" to a Tier 1 score of 1 by omission of a failing score on the memory recall test, and as a result only assessed at Tier 2. However, there exists no baseline parameter fail rate against which to compare the fail rate found in the pilot. Furthermore, given the rarity of failure on the test (approx. 1%), there does not exist sufficient data to estimate variation across staff. Thus, while there exists essentially qualitative evidence of some bias in these data, there is no way of estimating the size (or direction) of bias to the findings presented in this report, if such a bias exists. The same conclusion holds for any potential bias to the findings presented in the outcome analysis.

Effects of Staff Concerns Regarding Robustness of the Pelli-Robson Charts

The final source of potential methodological bias lay in the concerns reported by staff of variation in outcomes on the Pelli-Robson contrast sensitivity assessment. As noted in Modules 1 and 2 of the Appendix to this report, a number of participating staff relayed to the author their concerns that outcomes on this assessment were affected by the location of the chart, time of day, presence of nearby charts (or other objects that might cast shadows), and glare from nearby windows. In other words, staff raised the possibility that customer outcomes on this assessment were not purely a product of vision health, but potentially or partially a product of testing conditions. To some degree staff appear to have been relaying concerns communicated to them by customers, though not entirely. The most common reported concern had to do with "glare" making the charts more difficult for some customers to pass the test. Other staff reported that shadows made the letters on some of the charts more difficult to read for some customers. The implication was that this affected older, rather than younger customers.

The existence of these concerns on the part of staff largely affects the process analysis. In subtle but ultimately immeasurable ways it also probably affects the outcome analysis. These concerns can be examined according to three logical questions. First, to what extent can we determine from past research whether the Pelli-Robson charts are or are not robust under different lighting conditions? Second, to what extent can we determine the robustness of these charts from data gathered during the 3-Tier Pilot? Finally, depending on whether the charts are or are not robust (i.e., whether staff concerns do or do not have some empirical basis), then what effects might this have on the process and outcome analyses?

As discussed in some detail in Module 4 of the Appendix to this report, past research on this question has found that the Pelli-Robson chart is remarkably robust under different lighting conditions (Zhang, Pelli & Robson, 1989; Rovamo, Kukkonen, Thppana & Näsänen, 1993). If there is any effect on the robustness of the test, these differences appear under luminance levels approximating those experienced outdoors. Furthermore, to the extent that high luminance levels (i.e., bright light) have any impact on the Pelli-Robson chart, it appears that they make the assessment somewhat easier to pass, absent certain health conditions affecting vision (Cox, Norman & Norman, 1999). Given that during the pilot this assessment was administered in an *indoor* office environment there is no *a priori* reason to believe that there should exist substantial differences in customer outcomes on Pelli-Robson charts based on luminance levels (whether produced by glare, shadows, time of day, or presence of nearby windows).

That said, it does appear on the basis of evidence gathered during the pilot (and presented in further detail in Module 4 of the Appendix) that there existed some, albeit small, variation in customer outcomes on the contrast sensitivity outcome associated with the location of the chart on which they were imputed to have been tested. One chart (at the Carmichael office) was found to have a statistically higher fail rate compared to other charts at the same office, and five additional charts at two additional offices (Broadway and Folsom) were found to have higher or lower fail rates (again, compared to other charts at the same office) that approached statistical significance. However, it is difficult for both methodological and substantive reasons to tie this variation to luminance levels. Not only are the data imperfect in many ways (leading to somewhat strenuous methodological limitations), but the charts with high and low passage rates were by no means the same as those specifically indentified by staff as being (in their view) problematic. Furthermore, any empirical differences between different charts appear to be smaller than the empirical differences associated with which staff processed a given application, and in many cases the effect associated with a given chart location cannot be disentangled with statistical confidence from the effect associated with the individual staff person administering the assessment.

More important than any chart- or office-level variation is the simple fact of expressed staff concern regarding the robustness of this assessment test. That staff expressed concerns suggests at the very least the need for additional training in the background and use of this assessment. For the process and outcome analyses, however, these concerns have specific methodological implications. First, there appears to have been substantial variation between staff in their implementation of this assessment; which staff person processed a customer had a stronger effect on outcomes than the chart on which a given customer was imputed to have been tested. And while some staff were “over-orthodox” in their implementation of this assessment—in the sense that they were more likely than others to fail customers—these “over-orthodox” staff processed far fewer customers than staff who were “under-orthodox” in their implementation. In other words, the variation in staff implementation of this assessment appears to have had a direct and substantial effect in reducing the number of customers assessed at Tiers 2 and 3 of the 3-Tier process. Unfortunately, given the nature of the data it is not really possible to estimate the magnitude of this effect except to say that approximately one out of every four customers was processed by a staff member who was “under-orthodox” in their implementation of the Pelli-Robson chart, while only one out of every seven customers was processed by an “over-orthodox” technician. There is no reliable way of determining what these customers’ outcomes would have been on this assessment had they been processed by different technicians. Given the

randomization built into the CA DMV field office queuing system, it is unlikely that those customers seen by "under-orthodox" staff were significantly different from other types of customers, whether by age, prior violation record, or some other factor.

This variation in staff implementation of the contrast sensitivity assessment likely has an impact on the outcome analysis. To the extent that some unknown—but probably substantial—number of customers might have been assessed at Tiers 2 and 3 but were not, they were by definition not made aware of the existence of potentially driving-relevant limitations to their vision. Only a subset of those customers who advanced to Tiers 2 and 3 were given the educational materials on contrast sensitivity, and unless a customer had some other identified limitation (in say, physical function) there would have been no opportunity to receive these materials. In other words, if participation in the advanced tiers of 3TAS has any salutary effect on safe driving behavior, these customers did not benefit from it. This may bias the estimates of 3-Tier's impact on crashes, violations, and licensing outcomes. That said, it is not clear how to estimate the size, or for that matter the direction, of this bias (if it indeed exists).

Process Concerns

Consequences of Differences Between Planning and Implementation

Quite apart from methodological concerns, a utilization-focused evaluation also requires some attention to how the implementation of the pilot may have differed from what was originally planned. This includes determining whether a piloted program had all of the originally planned components, whether those individual components functioned in the manner intended, and whether the program as a whole operated according to plan. To the degree that a program falls short of what was originally planned, this can generally be traced to one of two sources: a failure of theory, or a failure of implementation. A failure of theory arises when the ideas from which a program is derived do not have the intended effects. A failure of implementation arises when an idea is never really tested, for instance when it was implemented in an inadequate or inappropriate fashion. In either case, a full process evaluation incorporates data and analysis on the sources and consequences of any such implementation failures—especially as these may affect substantively any future decision regarding whether to adopt 3TAS (in part or in full) statewide.

In large part, the 3-Tier Pilot was implemented as planned. All essential components of 3TAS were included in the pilot, and all components functioned in a coordinated system according to plan. To the degree that there were deviations from what had been planned, these deviations primarily arose from implementation failures. In one minor case a lack of data collection may be ascribed to a theory failure: only certain components of the physical observation protocol resulted in a meaningful number of observations (see Table 7, p. 61). This does not appear to have altered the data in any substantial way; rather it appears that the physical observation protocol can be shortened somewhat to eliminate rare and/or redundant conditions. The lines reading "Lower body - obvious shaking," and "Loss of use of leg or foot," for instance, each resulted in four or fewer observations over the course of the pilot. These can probably be eliminated, or combined with other questions (e.g., "Unable to walk if not aided"). It remains true, of course, that the real test of the theoretical value of 3TAS will come with the outcome analysis.

The main implementation failures that occurred include (a) widespread variation between front-line staff in the implementation of contrast sensitivity assessment, (b) the widespread maladministration of the educational intervention materials, and (c) the misprocessing of a substantial number of customers. In regards to this last point, misprocessing had the most significant process and outcome effects in regards to those customers who otherwise ought to have taken a PRT, or who ought to have taken an on-road drive test before being issued a new license. These implementation failures, in turn, appear to derive from three different causes.

As discussed in Module 2 of the Appendix, staff reported positive customer feedback on the contrast sensitivity charts, and in general also reported that the use of the charts "fit" with standard CA DMV field office procedures. That said, staff also reported—in some cases second-hand, i.e., from customers—that the charts were more difficult to pass under conditions of bright light and glare. As discussed in further detail in Module 4, it is more likely that customers complained of glare when they had difficulty passing the assessment, and that discomfort with glare may be a layperson's shorthand way of describing incipient declines in contrast sensitivity. See Module 4 of the Appendix, or West, et al. (2003) for more details on this question. In terms of the pilot implementation, this suggests the need for better training of staff in how to interact with customers when administering the test, to avoid confusion and misunderstanding.

That the educational intervention materials were distributed quite widely, in contravention to pilot protocols, appears not to have been driven by poor training in 3-Tier procedures. Rather this

appears to derive from a commitment on the part of CA DMV staff to abide by the highest standards of customer service. The educational materials, in the experience of staff, answered customer questions and calmed anxiety about a required on-road drive-test. They were immediately useful, in other words, in filling an unanticipated need. It is true that this practice of widespread (but poorly-documented) distribution of the education materials makes impossible the task of evaluating their efficacy in improving either drive-test outcomes or post-pilot driving behavior. However, this practice also suggests that the implementation of any or all aspects of the 3-Tier process—but most especially the drive-test component of the assessment system—should come with support for the delivery of the high-quality service CA DMV has committed to providing its customers.

Finally, there is the matter of the misprocessing of substantial numbers of customers during the pilot. This also does not appear to relate to the depth or quality of training. That customers sometimes did not take the PRT, or were issued a license despite being required to take an on-road drive test under 3-Tier procedures, more likely derives from the disjuncture between 3-Tier procedures and how staff were used to dealing with "standard" (non 3-Tier) produces for the handling of in-office non-commercial license renewals. In other words, because the pilot procedures were both new and substantially different from normal office procedures, there was some slippage in the handling of customers. In the future, this may be handled either by (a) a more concerted effort to align, where possible, 3-Tier procedures with contemporary field office operations, or (b) in the case of statewide implementation, a wholesale and permanent switch from one set of procedures to another. This latter strategy leaves open the possibility of mistakes in processing during the transition period between procedural regimes.

Discussion of the Evaluation of the Pilot

There are several mechanisms incorporated into the current evaluation designed to enhance its utility. These include mechanisms for reinforcing attainment of the desired program outcome, which in this case consists of improvements to traffic safety and mobility. Specifically, to the extent that this process analysis is widely distributed and read, in concert with the 3-Tier Technical Report (Hennessy, 2009), the findings contained herein are intended to be part of a broader dialogue among traffic-safety researchers, administrators, and law enforcement agencies about how best to save lives, reduce violations, and extend mobility for those drivers who can safely drive.

Secondly, the 3-Tier Pilot included specific mechanisms for integrating data collection with program delivery and management. Principally, these mechanisms took two forms: quality control and data-monitoring by the liaison staff, and the creation of a new staff position within the field offices (the 3-Tier Manager I) with primary responsibility for data management at the office level. These two mechanisms created a substantially enhanced quality of dialogue between Research and Development Branch and the pilot field offices over the implementation of the pilot and ongoing data collection. They also constituted the principal means by which staff within FOD were deputized with the responsibility for data control.

The periodic quality control reports by the liaison staff were one of two methods by which staff and management were provided with information regarding how the success of the program would be judged. The second method involved the staff surveys and interviews, which together provided the primary means by which staff and management were brought into the process of evaluating the success of pilot implementation. The resulting analyses (as contained in Modules 1 and 2 of the Appendix to this report) have since been shared with the field office managers and Driver Safety managers in staff meetings. The principal method by which participating customers may judge the success of the 3-Tier Pilot will, of course, come with the publication of the outcome analysis.

Finally, the publication of the current process analysis is intended to align the success of the pilot with the goals of those who participated in the implementation of the program. Specifically, the incorporation of feedback from Field Office and Driver Safety staff and managers into this evaluation is meant to ensure that the adoption of 3TAS (in whole or in part, if that is warranted by the outcome analysis), should be done in a manner consistent with CA DMV's organizational mission and goals.

Discussion of the Utilization-Focused Nature of the Evaluation

For this report to be useful, it must be distributed to policy-makers in an accessible format, and include such recommendations as can be drawn in a reasonable manner from the available evidence. The report should provide such information as allows the reader to understand what occurred during the 3-Tier Pilot, the implications of the findings from the pilot, what choices regarding implementation make sense given those findings, and the implications of those various choices. Furthermore, this report should be distributed in forums where these recommendations can be reviewed by various types of stakeholders; the utilization of any aspects of this report is

an active process, the bounds of which are shaped by multiple actors. Following this latter point, this report will be distributed to the following offices, agencies and bodies: the Director of the California Department of Motor Vehicles (CA DMV), the California Office of Traffic Safety (CA OTS), and the California State Legislature. Within CA DMV, these findings will be distributed to those divisions and branches whose operations may be affected by the potential adoption of any aspects of 3TAS. This includes both FOD and LOD, as well as certain branches within those divisions. Furthermore, to the degree that this document is a publication of CA DMV, it will be made available for review by members of the public. Certain sections of the report will likely be the subject of presentations by the author at traffic safety conferences, and so made available for review by researchers and administrators in jurisdictions outside California. It is to be expected that the implications of adoption of 3TAS will differ in their impact on various stakeholders. These implications are most properly discussed elsewhere, as they are outside the scope of the current report.

The results of the analyses contained in this report are intended for use by specific primary stakeholders. These include CA OTS, CA DMV, and the divisions and branches of CA DMV. Secondarily, this report is intended to be useful to administrators of licensing agencies in other jurisdictions, traffic safety researchers, and the driving public. Given these intended users, the information contained herein is organized with the intent of facilitating understanding and interpretation of large amounts of data that must, in some areas, be analyzed using somewhat technical means. To the extent possible, the results of the analyses have therefore been organized in a manner such that readers can access the findings easily and to varying degrees of complexity. The preparation and publication of the findings in this report have also been organized with the intent of providing information to users in as timely a manner as practicable, especially given the size and scope of the data collection, cleaning and analysis required for the report. Where possible, “negative” findings and non-findings have been presented in such a manner that users may engage with, learn from, and use the results. This includes instances where no statistical relationship was found, instances of results contrary to original hypotheses, instances where analyses could not be conducted for lack of data, and instances where analyses were limited due to poor data or methodological problems. Finally, the author would note that while publication and distribution of these findings are necessary for evaluation by intended users, the dissemination of this report should be distinguished from any use of the recommendations contained herein.

The recommendations of this report, if adopted, will be used within an organizational and policy context. That organizational context includes stakeholders with varying interests, some of which

may be impacted by these recommendations. While analyzing those potential impacts is beyond the scope of this analysis, the information contained herein may be useful for these various stakeholders as information in preparing for potential implementation. This report will be circulated as widely as necessary to ensure that all potential intended users of 3TAS have the opportunity review these findings. That said, it should be understood that while all parts of this report must be made available for review, not all the parts of this report may be equally useful to all potential users. Where the author and colleagues in California DMV Research and Development Branch (R&D) make presentations to potential users, these presentations of findings will be tailored to focus on those findings most likely to be of interest to a given audience, and most likely to be of use in the event of statewide adoption of 3TAS.

The Meaning of the Findings

In assessing the meaning of the findings presented here (and in the outcome report), the reader should take into account a number of issues related to interpretation and judgment. In the first instance, there is the plain statistical significance, or lack thereof, of any findings discussed in the analyses. Statistical significance alone merely indicates simply that a given correlation between variables is unlikely to occur by chance. Any data may contain errors, of course—and data are always, by definition, at best approximate indictors of real-world processes. As with any social science endeavor, but especially one with potential application as a new program by a major public agency, these findings must be interpreted in order to have meaning.

Judgment as to whether statistically significant relationships (or their absence) have implications for the utility of a given program requires an understanding of the context in which the pilot was implemented. In this case, judgment of the meaning of the results presented in the present report also requires some attention to the content in which 3TAS may be adopted in the future. In particular, the utility of 3-Tier must be judged in the context of (a) the program's own goals of improving safety and extending safe driving years, as well as (b) CA DMV's organizational mission and goals. In both cases the most important evidence will come with the publication of the outcome analysis, and the examination of 3-Tier's effects on crash risk, violation rates, and licensing outcomes.

Program Effectiveness

From a process perspective, how effective was 3TAS, as piloted? As a general matter, the program was implemented as planned, with some important exceptions. Given the scale of the pilot the existence of these exceptions should not be surprising. The implementation of the 3-Tier Pilot did result in some unanticipated consequences. The pilot also highlighted some process strengths and weaknesses, particularly as appeared in pilot components that worked well versus those that did not.

One of the unanticipated benefits of the program appears to be the face-valid connection between the pilot as implemented (on the whole and, for the most part, in its sub-components) and its stated goals of improving traffic safety and extending individual mobility. As expressed in the interviews, many DMV staff and management understood and valued this aspect of 3-Tier's implications for enhancing CA DMV's organizational mission. It is no doubt critical to the success of the pilot that 3TAS fit with staff and management's own commitment to departmental goals and policies.

Certain components of 3-Tier may have had a more obvious connection to traffic safety than others, and this in turn appears to have had some impact on implementation. The Pelli-Robson contrast sensitivity assessment, for instance, was widely reported by staff to make sense from their perspective as a tool for assessing potential vision limitations. By report from staff, this assessment tool also made sense to customers, and for the same purpose. Similarly, the educational intervention materials appear to have been a key component (from the perspective of staff and managers) in preparing customers for the drive test, and especially in encouraging customers to manage their own safety and mobility as much as is practicable.

By contrast, the utility of the PRT as an assessment tool for potential driving-relevant limitations in perception and cognition was misunderstand by a substantial number of staff—including some who were specifically trained in the administration of the this test. In the interviews staff also noted the existence of some degree of confusion and anxiety among customers about this assessment. Similarly, a sizeable number of staff reported skepticism regarding the utility of the memory recall test. Taken together, this suggests that at least some DMV staff were uncomfortable with the use of assessment tests of potential driving-relevant limitations in cognition and perception. Alternatively, staff may have been unclear as to the relationship between limitations in cognition and perception on the one hand, and safe driving on the other.

The customers who participated in the pilot also, by and large, appreciated 3-Tier's potential for improving traffic safety—at least as reported in the customer survey (see Module 1 of the Appendix). Upwards of three-quarters of customers surveyed agreed or strongly agreed with positively-phrased statements about 3-Tier's impact on wait times, staff courtesy, and whether it was easy to use, fair, and would improve traffic safety. Perhaps most strikingly, once one controls for the depth of participation in the process—which is to say, whether or not someone was assessed at Tiers 2 or 3—age has no effect on attitudes toward the 3-Tier process. If anything, older customers appear somewhat more likely to appreciate 3-Tier's positive impact on customer service, whether defined as time spent in the field office or in terms of staff courtesy and respect. In addition, older customers may be somewhat more likely to believe that 3-Tier will have a positive impact on traffic safety, though this effect is weaker and only borders on statistical significance. This suggests that as a mechanism for identifying age-related driving-relevant limitations, participating customers appreciated and understood the goals of the 3-Tier Pilot.

On the other hand, it appears that customers with violations on their record were significantly and substantially more skeptical of the value and utility of 3TAS. Drivers with prior involvement in the legal system were less likely to regard the pilot in a positive light, according to the data collected in the customer survey. This may have had some impact on the processing of customers over the course of the pilot, as those with higher-than-average violation rates are also found among (a) the "lagging" customers who delayed completion of their application until after the pilot, (b) those who had missing data on their applications (especially in terms of the written test results), and (c) those whose application was somehow mishandled (for instance, those who missed taking the PRT, or who were licensed without a drive test when one was required). To some degree then, what appears in the data as misprocessing by staff may also involve some amount of customer noncompliance by younger, more violation-prone drivers.

Another major area of misprocessing involved the administration of the educational intervention—although here it appears that this pilot component worked too well, rather than not well enough. Staff were decidedly positive in their views on the utility of these materials, especially as regards preparing drivers for an on-road test. As a tool for providing high-quality customer service the educational material may have proved so useful that staff distributed them much more widely than originally anticipated. While this means that the outcome report will contain no analysis of the effect of these materials on post-pilot driving behavior, there remain at least two process-oriented conclusions. In the first instance, the educational materials appear to

have constituted a critical component of the face-validity of 3TAS for those drivers required to take an on-road test. By providing drivers with written materials discussing the nature of their potentially driving-relevant limitation, the educational intervention reaffirmed the traffic-safety relevance of what CA DMV was asking drivers to do. Secondly, the education worked well as a customer service tool: because requiring a drive test is often a stressful experience, staff appreciated having materials on hand to answer questions and explain the testing process.

In two specific areas misprocessing may have derived from a mismatch between the requirements of 3TAS and current (non 3-Tier) processes and procedures. Where a 3-Tier customer failed the written renewal test twice, they should have taken the PRT; where they failed three or more times, they should have taken a drive test. In both of these cases, several dozen customers were processed according to *current* (non 3-Tier) procedures, which state that failing the Class C written test three times requires filing a new renewal application and consequent payment of an additional fee. Failing the written test twice results in no action under current procedures. Thus, although these customers were issued licenses erroneously according to 3-Tier procedures, they were issued licenses correctly according to current (non 3-Tier) procedures. Given the limited scope of the project, and especially its time-delimited nature as a pilot, it is not especially surprising that there occurred certain disjunctures between current (non 3-Tier) procedures and the requirements of the pilot. These disjunctures do appear to have had some impact on the methodological validity of the pilot, as discussed above. However, given the scope of the data it is not possible to determine precisely how this may have been avoided, though certain hypotheses are possible. Misprocessing of customers in general may in part have been a matter of staff turnover, and associated transmission of training in 3-Tier procedures at the field office level. Misprocessing of customers who failed the written test specifically may also have been partly related to office layout: those offices with separate testing rooms had more customers who missed taking the PRT or a drive test due to failures on the written test. It is possible that in those cases where the testing room is separate from the rest of the office that customers were issued licenses before they came to the attention of the 3-Tier Manager I; this may have true especially if the technician supervising the testing area was not adequately trained in 3-Tier procedures. These two hypotheses (adequate training versus office layout) have slightly different implications should 3TAS be adopted for statewide use. These implications are discussed at the end of this report.

Part of the context for judging how the 3-Tier Pilot worked as a process involves CA DMV's commitment to providing a consistently high level of customer service. Here the success of 3TAS as a process had potentially contradictory effects, depending on how one defines customer

service. FOD in particular has adopted a number of measures to improve customer service by increasing the efficiency of customer processing and reducing wait times in the field offices. In this respect, for those implementing the pilot at the local field office level, the utility of the program was judged largely in terms of whether or not it increased the amount of time spent with individual customers. To the degree that it increased individual processing time, that effect was judged negatively by most staff. These views were expressed most eloquently in the staff interviews: see Module 2 of the Appendix. On the other hand, to the degree that 3-Tier increased individual processing time, it appears that this also entailed a qualitative change to the interaction between customers and staff. This qualitative change involved personalized attention, the answering of questions, and more humanized face-to-face conversation. This view was also expressed by staff in the interviews, though it came up less often than concern over the likely reduction in processing efficiency and increased wait times. This degree of personalized attention may, in part, undergird the results of the customer survey (see Module 1 of the Appendix). There, respondents largely judged 3-Tier's effects on customer service in a positive light; this was especially true for older respondents, who appear to have particularly appreciated the courtesy and respect shown them by DMV field office staff. The tension between productive efficiency (as measured by low wait times) and personalized interaction between staff and customers is not resolvable via the implementation of 3TAS (indeed, this tension may be fundamental irresolvable). Nevertheless, the adoption of any aspects of 3TAS in the future will likely occur within an organizational context where production efficiency and low customer wait times are highly valued.

Finally, one of the main process criteria by which the 3-Tier Pilot should be judged is simply as a demonstration project. Many of the elements incorporated into 3TAS have shown utility in prior studies as part of small-scale projects, in clinic-type contexts, or for populations pre-identified as possessing some kind of driving-relevant limitation to their physical condition, vision, or cognition. The 3-Tier Pilot, as carried out by CA DMV in the summer and fall of 2007, has demonstrated that 3TAS can be implemented in an agency context and for a wide population of license renewal applicants. Whether the system has the intended effects on driving and mobility remains to be seen in the outcome report. Nevertheless, this system is workable and implementable as currently designed. The following sections contain suggestions for improvements to this system in preparation for potential implementation on a statewide basis.

Recommendations for Potential Future Implementation

The final subsection of this report contains recommendations about how to prepare for implementation of 3TAS statewide (in whole or in part), should that be warranted by the outcome analysis and judged by policymakers and stakeholders as an appropriate course of action. These recommendations are divided into the following areas: recommendations for minimizing any potential negative effects on processing efficiency and customer wait times in the field offices, recommendations for preventing and minimizing processing errors, changes to staff duties, and recommendations for tying 3TAS to improvements to traffic safety and good customer service.

Minimizing Impact on Processing Efficiency and Wait Times in the Field Offices

Based upon recommendations from staff, as well as on findings from this report, there are at least four substantive changes that may be made to 3TAS, as piloted, that should improve processing efficiency. These changes include: elimination of the Driving Habits Survey, consolidation of the physical observation protocol to eliminate unnecessary items, alteration of the responsibility for observing for potential physical limitations to incorporate necessary redundancy but allow for technician multi-tasking, and reprogramming of the electronic system of data collection used in the field offices to eliminate the time necessary to complete physical (i.e., paper-and-pencil) forms. Together, these changes should minimize the likely impact on wait times in CA DMV field offices, as well as any impact on the production efficiency of Driver Safety referrals.

ELIMINATION OF THE DRIVING HABITS SURVEY

One straightforward method for increasing efficiency would come with the elimination of the Driving Habits Survey. This element of 3TAS accomplished two tasks simultaneously: it served both as a method by which to collection information regarding individual driving habits, and as an opportunity for the field office technician to observe the applicant's upper body for potentially driving-relevant physical limitations (e.g., excessive shaking, loss of the use of an arm or a hand). The information regarding individual driving habits was intended primarily for use in the outcome analysis (for, among other things, estimating driving exposure). As this purpose is confined largely to the pilot, it is not necessary to collect this information on an ongoing basis in the event of statewide implementation. The second purpose of the survey (the opportunity to

observe a renewal applicant's upper body for potential limitations) may be accomplished through other means—for instance, by observing the upper body while a customer is completing the paperwork typically necessary for a renewal application (e.g., the DL44 or DL1RN forms). For Driver Safety referrals, this would result in rather pure efficiency savings, as the Driving Habits Survey was conducted in these cases purely for research purposes, and typically over the phone; information on physical function was, if appropriate to a given customer's case, provided by a health professional in the form of a confidential medical report.

CONSOLIDATION OF THE PHYSICAL OBSERVATION PROTOCOL

A second method for increasing the efficiency of 3TAS would come with the elimination of certain items in the physical observation protocol. As piloted, staff were trained to look for any of 11 items on a list of potentially driving-relevant physical limitations. Among these, 6 items produced 12 or fewer observations among the more than 10,000 customers processed in the field offices. This suggests that these items occur either so rarely that they are almost never observed among DMV renewal applicants, or (more likely) that the categories overlap in practice. It may be possible, by eliminating or combining categories, to reduce the physical observation checklist to 7 items:

- Loss of arm or hand.
- Obvious shaking or stiffness in the upper body.
- Other potential limitation in the upper body.
- Unable to walk if not aided.
- Obvious shaking or stiffness in the lower body.
- Other potential limitation in the lower body.
- Condition (upper or lower body) already on record.

OBSERVATION FOR POTENTIAL PHYSICAL LIMITATIONS BY MULTIPLE TECHNICIANS

As piloted, staff were trained to observe a customer for potential physical limitations over an extended period of time: from the moment the customer walked up to the initial counter for their renewal, through the course of the initial part of their application process, and then also while walking from the initial counter to the Video Capture Station (VCS) where their picture and thumbprint were taken, before directing the customer to the Corrections Counter where they were helped by a different technician in the written test portion of their application. Technicians

were, according to pilot protocols, required to walk with each individual customer to the VCS, observing them along the way. This involved a shift from current CA DMV field office practice, where once a customer has completed their initial transaction they typically stand in a separate line for the VCS and are processed by a different technician from the one who helped them with the initial portion of the application. The shift in procedure (walking each 3-Tier customer to the video capture station, versus directing them toward a separate line to be helped by someone else) provided an opportunity to observe potential physical limitations, but at the same time it constituted a significant amount of added time to each transaction. Perhaps more to the point, physical observation during the initial counter transaction could be combined with other tasks (e.g., helping a customer complete their application, cashiering their renewal fees, administering the visual acuity and contrast sensitivity assessments). However, walking a customer to the VCS could not be combined with other tasks. It was therefore seen, by both front-line staff and managers, as detrimental to processing efficiency. If the physical observation protocol is altered such that it is administered at two or even three different points, by different technicians, this would eliminate the time spent walking with individual customers. It would, as an additional matter, more reliably ensure that as few instances as practicable were overlooked of customers requiring further evaluation of their potential physical limitations.

The specific way in which the protocol is observed will necessarily differ to some degree from location to location, depending on office size and layout. The suggestions contained here will therefore need to be tailored by site-level field office managers for the conditions appropriate to their office. That said, it is the recommendation of this author that the physical observation protocol should be done at multiple points in the license renewal process: first, at the Start Here Window, secondly by the technician at the initial counter, perhaps also by the technician at the Video Capture Station (VCS) and finally by the technician at the Corrections Counter.

The technician at the Start Here Window is (or should be) able to observe each customer individually since there is typically one line and the technician calls each person individually to the window. If potential physical limitation in lower-body function is observed—even if it does not rise to the level of involving an assistive device—and the customer states that he or she is renewing their driver license, the technician working at the Start Here Window could then issue a J-ticket. In current (non 3-Tier) procedures, J-tickets are normally issued to customers with obvious limitations to their physical function, as evidenced by the use of assistive devices (e.g., wheelchairs, walkers, etc.). The counters that are reserved for the processing of J-ticket customers are typically somewhat lower than normal (for customers in wheelchairs) and may have chairs nearby (for customers that have difficulty standing for extended periods of time).

While this recommendation would likely have the effect of expanding somewhat the number of customers who are seen on J-tickets, it would also spread the responsibility for the identification of potential physical limitations to multiple technicians. This should reduce the likelihood that any individual customer needing evaluation would be overlooked.

The technician working at the initial counter, regardless of the type of ticket they are processing, should still observe all 3-Tier eligible Class C license renewal customers for potential limitations to the upper and lower body. Training in 3TAS procedures should continue to emphasize that observing customers as they walk up to the counter, where possible, is likely to provide the best opportunity to observe potential limitations to the lower body. The pace and gait of customers as they walk is most likely to indicate any problems arising from stiff limbs and joints, or an otherwise less-than-complete range of motion in the lower body. The filling out of a customer's application (i.e., signing their renewal application, writing a check for their fees, etc.) may, in turn, provide an opportunity for the observation of potential limitations to upper-body function. Any information regarding potential limitations could, at this point in the transaction, be entered into the electronic data collection and storage system (DMVA/EASE), as a potential indicator for further evaluation at a later point in the license renewal process (i.e., at the Corrections Counter).

The technician working the Video Capture Station (VCS) also may observe customers waiting in their line for potential limitations to lower and upper body physical function. Any information regarding potential limitations could, at this point in the transaction, be entered into DMVA/EASE as a potential indicator for further evaluation.

Finally, the technician working at the Corrections Counter may also observe customers for potential limitations to lower and upper body physical function. This technician will likely also be responsible for administration of the PRT—especially if the latter is administered on the same computer hardware as the knowledge test. They will thus necessarily be responsible for determining which customers are required to take the PRT, on the basis of information collected in customers' applications as contained in the DMVA/EASE system. Ideally, the reprogramming of the DMVA/EASE system for the collection of 3-Tier Assessment System information would contain within it certain forced-choice logic such that, if a customer is flagged at a prior point in their application (i.e., by a technician at the initial counter or at the VCS) this would require the technician at the Corrections Counter to enter the customers' test results on the PRT in order to complete their application. .

Ultimately, the value of the physical observation protocol lies less in which specific questions are included (or not), and more in its utility as a guide to the observing technician(s). By reducing and consolidating items, the physical observation protocol will take less time to apply in any individual case. At the same time, it will remain a key assessment screen for the collection of data regarding potential driving-relevant limitations. By requiring multiple points of observation (i.e., at the Start Here counter, the initial counter, the VCS station, and/or the Corrections Counter, depending on the layout of a given office), all technicians will be attuned to the observation for potential physical limitations. This will build in necessary redundancy to the process of observation while at the same time making it a normal component of customer processing. This will both reduce the likelihood that any given customer will be missed, and ensure that all customers are subjected to the same processing and observation protocols.

REPROGRAMMING OF THE DMVA/EASE SYSTEM

The majority of respondents among the staff and managers who participated in the pilot, when interviewed regarding how to change or improve 3TAS, noted that the collection of assessment-test data on customers should occur in an electronic format. Ideally, staff noted, any system for collecting customer data from assessment tests, would be embedded within the same system used to collect customer application data (currently the DMVA).

As of the date of the publication of this report, the DMVA system is currently undergoing a major reprogramming effort, with a rollout date sometime in late 2010 or early 2011. The rollout date of the new system of electronic data collection and storage (called EASE) will therefore occur before any implementation of the 3-Tier System. Hence, any reprogramming of the electronic system in use by CA DMV field offices and Driver Safety will be of EASE, and not the DMVA. This means that any recommendations made in this report about reprogramming of EASE to incorporate a 3-Tier Assessment System data-collection module will necessarily be of a somewhat general nature. The recommendations regarding reprogramming include the following: the maintenance of the look and flow of normal (non 3-Tier) data entry and processing as much as practicable, the creation of two data collection screens specifically for the collection of 3-Tier data, and the creation of a set of forced-logic decision trees to require the collection of different kinds of data depending on information entered at prior points in the application process.

As a general matter, the current (non 3-Tier) application process for a renewal application requires that a technician enter data about a customer onto a series of screens (for example, the

"Collect Application Data" screen and the "Test Results" screen). In order to keep 3TAS as parallel to non 3-Tier transactions as is feasible, it is recommended that any screens developed for the collection and storage of 3-Tier Assessment System data be as similar in their look and flow to the screens used for the completion of standard (non 3-Tier) Class C driver license renewal applications.

Within those constraints, it is further recommended that when a technician initiates an application for a customer (typically by swiping their license in a reader, or manually keying their license number), programming logic built into the data collection system itself will trigger whether or not a technician is directed to complete a 3-Tier application for a customer, or a non 3-Tier application. In other words, on the basis of stored information within a customer's permanent driver record—specifically, age, recent at-fault crash history, and recent violation record, all of which are already triggers for the requirement that a customer come into a field office in person to renew their license and take the written knowledge test—the technician will be directed by DMVA/EASE to collect 3-Tier Assessment System information as part of the license application. This will include all aspects of the Tier 1 assessment tests: memory recall (unless incorporated into the written test), upper-body physical observation, lower-body physical observation, visual acuity assessment outcome, and contrast sensitivity assessment outcome. Other information—updating an address, and the payment of required fees, for instance—will be collected at the same time, as part of the same application screens, and "passed through" to facilitate the completion of the customer's application in as efficient a manner as possible. It is further recommended that a similar forced-logic mechanism be employed at the Video Capture Station (VCS) such that the technician there would input information related to the physical observation protocol at that point in the process. More specific recommendations regarding the look and flow of these screens is beyond the scope of the present report, except to say that to the extent possible the look and flow should be as similar as practicable to non 3-Tier license application completion procedures.

The second screen would appear at the Corrections Counter, likely in parallel to what will be the equivalent of the "Test Results" screen in the license application process. This screen should include assessment data related to Tier 2 (i.e., the PRT) and Tier 3 (i.e., the educational intervention and the drive test). If possible, the 3TAS screen would appear at the time that a customer's license number is swiped or keyed in, to facilitate the completion of the transaction. On the basis of information entered previously (i.e., by technicians at the initial counter or the VCS) this screen might include fields for whether a customer is required to take the PRT or a drive test, and whether they require educational intervention regarding potential limitations to

their contrast sensitivity. If practicable, these fields could appear for particular customers on the basis of forced-logic decision tree programming (or, alternatively, this could trigger that these fields be given a value other than “waived”).

To some degree, the precise nature of the programming required will depend on factors that cannot at the present time be predicted—such as the configuration of the administration of the written test. If the knowledge test is administered by computer at some future point—as opposed to the current procedure of using hand-scored paper-and-pencil tests—it may be possible to automatically link outcomes on the knowledge test to other assessment components of 3TAS. This could relieve the technician at the Corrections Counter from some of the burden of physical data entry (not to mention reducing potential errors and variation inherent in the process of hand-scoring). It might also allow for a more reliable process of requiring a drive test in the event of a 3-time failure on the written test. Furthermore, it might be possible to administer the memory recall test via computer, in a procedure or sub-test linked to the knowledge test.

This second screen, associated with assessment outcomes for Tiers 2 and 3 of 3TAS, should be accessible to other users besides front-line technicians. If possible, it should certainly be viewable by any LRE or Manager I responsible for reviewing and recording the results of a drive test. In addition, if possible, it should be viewable by Driver Safety Hearing Officers, for the purposes of reviewing the results of drive tests scheduled by that office for 3-Tier eligible customers referred to a field office as part of a Driver Safety procedure.

All information collected (on either screen) as part of 3TAS should, if possible, be stored for at least two renewal cycles (so, up to 10 years for a full-term license, or 4 years for a limited-term renewal). This would involve a change from current processing, where data specific to a license renewal application is stored only for the most recently completed application (data associated with a driver’s permanent record, such as violations, crashes, or Driver Safety hearing outcomes, are stored on a longer-term basis, depending on the type of data as well as current law regarding the purging of old information). However, to facilitate record-keeping regarding past assessment (for, for instance, long-term but stable conditions), it will be necessary to store information for some period of time. This will provide those responsible for assessment—such as LREs and Hearing Officers—with a record of results on past tests. It will also allow for a relatively easily-accessible record of long-term but stable conditions, so that customers who have demonstrated safe driving skills need not be required to demonstrate these skills on a repeated basis.

Prevention and Minimization of Processing Errors

There are two methods available for the prevention and minimization of errors in processing: the conversion of data collection and storage to an electronic format (i.e., through re-programming of the DMVA/EASE system, as well as through automation of the knowledge test), and training of staff. Each method is useful for addressing somewhat different sources of errors in processing. The conversion of data collection from a paper-and-pencil format to an electronic format is primarily useful for speeding up processing and making the completion of a customer application as efficient as possible. It would, in particular, eliminate much of the work conducted by the 3-Tier Manager I during the pilot, including the scanning of documents to a secure server. It would also likely result in certain efficiencies in the communication of drive test information between the field offices and Driver Safety (much of this information was transmitted during the pilot via fax, a process regarded as cumbersome and time-consuming, particularly by Hearing Officers). Aside from improvements to processing efficiency, however, the conversion of data-collection to an electronic format might allow for a mechanism of forced-logic decision trees that would require certain test information be entered before completion of an application. As noted elsewhere in this report, a substantial number of customers were issued licenses without a required PRT test, and even more were issued licenses without a required drive test. These processing mistakes were, as best as can be determined, the result of human error on the part of staff, in probable combination with an entirely understandable reluctance on the part of most customers to undergo enhanced assessment testing. An electronic format for collecting assessment data may reduce such human errors, as for instance through forced-logic decision trees for requiring additional information regarding assessment outcomes.

If the written test of knowledge of the rules of the road is converted to an electronic format (administered by computer rather than by paper format), this would likely eliminate additional sources of processing errors. This should streamline the requirement that a PRT be given after failing the knowledge test twice (especially if the PRT can be administered on the same terminal as the written test), as well as the requirement that a road test be given after failing the knowledge test three times. It may also be possible to administer some version of the memory recall test on the computer, rather than in paper format as was administered during the pilot. There appears to have been a great deal of variation in the administration of this particular test: not only were there reports of substantial variation in fail rates, there was a great deal of misunderstanding about the purpose of this assessment and its relevance to safe driving. If the

test is administered by computer, this should reduce to some extent the element of human error in the administration of this assessment.

Improvements to the training offered to staff may also help to reduce or prevent processing errors. In particular, training may be useful for providing background information on the purpose of specific assessment tests, and their connection to safe driving. Staff reported the existence of variation in outcomes on the contrast sensitivity assessment as a result of glare and shadows on the chart. While variation in lighting may or may not have affected customer outcomes on this assessment, it is clearly the case that staff varied in how they administered this assessment. To the degree possible, staff-level variation should be reduced to ensure uniformity of customer processing, and improvements to training may be the best available method for doing so. Training materials on this assessment might, for instance, emphasize the fact that individual perceptions of glare and shadows are, in fact, a matter of contrast sensitivity. If staff are more knowledgeable and conversant about this assessment, they should be able to better answer customer questions and concerns. Thus, both initial and refresher training materials might emphasize not just the purpose of the test (to measure contrast sensitivity), but also the traffic-safety relevance of what is being measured (perception of objects in conditions of reduced contrast, such as in conditions of darkness, glare, inclement weather, dusk and dawn, etc.).

Staff also reported widespread variation in the administration of the memory recall test, as well as skepticism regarding the purpose and traffic-safety relevance of this assessment. In addition, there were a substantial number of staff who misunderstood the purpose of the PRT. In combination, both of the testing tools used for the assessment of potential cognitive limitations were either misunderstood by staff, subject to variation in their application, or regarded with skepticism as to their utility, relevance to safety, and fairness (to, for instance, seniors). This clearly suggests the need for improvements to the training materials that cover the purpose of these assessments and their relevance to traffic safety. It also suggests that training in these assessment tests must be done in a formal manner, rather than left to less formal, on-the-job, training.

Finally, it may be useful to include within any new training a more general overview regarding how 3TAS involves a decisive shift in the approach of CA DMV toward fulfilling its organizational mission. Among other goals, CA DMV is responsible for the safety of drivers on the road. Currently, CA DMV accomplishes this mission largely through the regulation of license *origination* (i.e., testing of novice drivers) and *post-licensing control* of reckless and impaired drivers (i.e., through the Driver Safety referral process). 3TAS would shift some of the

responsibility for ensuring the safety of drivers on the road to the license *renewal* process. In particular, this shift would involve a greater proportion of field office staff—for instance, frontline staff such as MVFRs—in the active management of the fulfillment of this organizational goal. As noted in the interviews, many staff and managers who participated in the pilot were especially excited by this aspect of the program. This suggests that many, indeed probably most, of those who work at CA DMV are eager to understand their own job roles as contributing to the safety of California road users.

Changes to Staff Duties

The primary changes to staff duties if 3TAS is adopted statewide will occur to frontline counter positions (MVFR, etc.). This includes the primary responsibility for administration of the Tier 1 assessment tests: the physical observation protocol and the contrast sensitivity assessment. If the written knowledge test is not shifted to a computer-based format, frontline staff will also likely be responsible for the administration of the memory recall assessment. In addition, frontline staff will be the first point of contact for customers who have questions about the new assessment tests (though, in keeping with current field office procedures, staff may refer customers with questions to one of their managers). This will likely entail a qualitative expansion in the provision of customer service, defined as personal contact and conversation. If the recommendations contained in this report are implemented, this shift will also entail a greater degree of shared responsibility among staff for the assessment of customers for driving-relevant limitations to (in particular) physical function; this will be particularly true if the physical observation protocol is conducted at multiple points in the license renewal process. This in turn will likely result in a second-order increase in the quality, and amount, of communication between frontline staff and those in more senior positions—i.e., LREs and Manager Is—who will retain the responsibility for the scheduling and evaluation of drive tests. This should be particularly true at the beginning of project rollout, as staff at all levels become more used to the observation of potential physical limitations, and more used to communicating with customers about the purpose of new and perhaps unfamiliar assessment procedures (such as the Pelli-Robson charts and the PRT).

The changes to duties of other staff will likely be rather minimal. The expected increase in the number of drive tests may require an expansion in the number of LREs, but with no real changes to the nature of the job duties of that job classification. On a related note, it is likely that lower-level managers (Manager Is, Administrative Managers, etc.) may spend somewhat more of their

time scheduling drive tests with customers. As the project is rolled out, supervisors at all levels (especially within FOD) will likely have to oversee and manager the shift in the duties of lower-level staff. Very few changes, if any, are expected in the duties of the Driver Safety Hearing Officers.

The Link Between 3TAS and Traffic Safety

If 3TAS is adopted for statewide rollout, it is the recommendation of this author that statewide rollout be accompanied by a public information campaign that emphasizes heavily the relationship between adoption of 3TAS and improvements to public safety. In addition, training materials developed for staff should also emphasize the relationship between 3-Tier and public safety. This is clearly a major "selling point" for CA DMV staff, as evidenced in the staff interviews. It is also likely to be an important factor to members of the public—including, and perhaps especially, those who are subject to the new assessment tests. In both cases—for the external (public) audience and the internal (staff) audience—the expected number of lives saved, crashes avoided, and violations prevented are likely to be powerful offsets for any added time and annoyance associated with enhanced assessment.

Depending on the results of the outcome analysis, it may also be appropriate to emphasize in a public information campaign the relationship between 3TAS and the extension of safe driving years for drivers of all ages. The current report does not contain data necessary to speculate on whether participation in the 3-Tier Pilot in fact helped drivers stay on the road longer than they would have otherwise; this question will have to remain unexamined until the outcome analysis. If that report shows that 3TAS extends safe driving years, this may constitute an offset for any (unfounded) fears on the part of specific sub-populations regarding discriminatory treatment. This aspect of 3TAS is likely to be more important to members of the public than to CA DMV staff, though certainly this topic may be included in training materials for the purposes of providing background information (as well as for preparing staff for likely questions from customers).

The Link Between 3TAS and Customer Service

Finally, if 3TAS is adopted for statewide rollout, it is the recommendation of this author that statewide rollout be accompanied by a public information campaign that emphasizes heavily the relationship between adoption of 3TAS and improvements to customer service. This was clearly a major "selling point" for those who participated in the customer survey; respondents

appreciated CA DMV's commitment to high standards of customer service in the context of the 3-Tier Pilot. Furthermore, customers' positive perceptions of 3TAS were associated with customer service defined both as "staff courtesy and respect" and as "reasonable wait times." To the degree that 3TAS provides staff with a greater opportunity to engage in personalized contact with customers (answering questions, providing educational materials regarding safe driving), this may be a significant offset for any added time and annoyance associated with enhanced assessment. This must be balanced, however, with a commitment to processing efficiency and minimal wait times in the field offices. The results of the customer acceptance survey indicate that customers surveyed at that time were satisfied with the time spent in the field offices, and that this in turn was associated with positive regard for 3TAS.

Delivery of excellent customer service is also clearly a high priority for employees at all levels of CA DMV. Any impact of 3TAS on processing efficiency and wait times in the field offices must therefore be kept to a minimum. To the degree that 3-Tier is seen internally as having a minimal impact on processing efficiency, it is likely that the positive externalities of the assessment system in providing greater opportunities for personalized attention and customer education will be more obvious to CA DMV staff and managers.

REFERENCES

Adler, G., & Kuskowski, M. (2003). Driving habits and cessation in older men with dementia. *Alzheimer Disease and Associated Disorders, 17*, 67-71.

Adler, G., Rottunda, S., & Kuskowski, M. (1999). The impact of dementia on driving: Perceptions and changing habits. *The Clinical Gerontologist, 20*, 23-34.

Adler, G., & Silverstein, M. (2008). At-risk drivers with Alzheimer's disease: Recognition, response, and referral. *Traffic Injury Prevention, 9*, 299-303.

Alvarez, F. J., & Fierro, I. (2008). Older drivers, medical condition, medical impairment and crash risk. *Accident Analysis and Prevention, 40*, 55-60.

Anderson, S. J., & Holliday, I. E. (1995). Night driving: Effects of glare from vehicle headlights on motion perception. *Ophthalmic and Physiological Optics, 15*, 545-551.

Antsey, K. J., Wood, J., Lord, S., & Walker, J. G. (2005). Cognitive, sensory and physical factors enabling driving safety in older adults. *Clinical Psychology Review, 25*, 45-65.

Attebo, K., Mitchell, P., & Smith, W. (1996). Visual acuity and the causes of visual loss in Australia: The Blue Mountains eye study. *Ophthalmology, 103*, 357-364.

Baker, T., Falb, T., Voas, R., & Lacey, J. (2003). Older women drivers: Fatal crashes in good conditions. *Journal of Safety Research, 34*, 399-405.

Baldock, M. R. J., Mathias, J. L., McLean, A. J., & Berndt, A. (2006). Self-regulation of driving and its relationship to driving ability among older adults. *Accident Analysis and Prevention, 38*, 1038-1045.

Ball, K., Owsley, C., Stalvey, B., Roenker, D., Sloane, M., & Graves, M. (1998). Driving avoidance and functional impairment in older drivers. *Accident Analysis and Prevention, 30*, 313-322.

Ball, K. K., Roenker, D., Wadley, V. G., Edwards, J. D., Roth, D. L., McGwin, G., Raleigh, R., Joyce, J. J., Cissell, G. M., & Dube, T. (2006). Can high-risk older drivers be identified through performance-based measures in a Department of Motor Vehicles setting? *Journal of the American Geriatrics Society, 54*, 77-84.

Banister, B., & Bowling, A. (2004). Quality of life for the elderly: The transport dimension. *Transport Policy, 11*, 105-115.

Barancik, J. I., Chatterjee, B. F., Greene-Cradden, Y. C., Michenzi, E. M., Kramer, C. F., Thode, H. C., Jr., & Fife, D. (1986). Motor vehicle trauma in northeastern Ohio, I: Incidence and outcome by age, sex, and road-use category. *American Journal of Epidemiology, 123*, 846-861.

Barr, R. A. (1991). Recent changes in driving among older adults. *Human Factors, 33*, 597-600.

Bédard, M., Guyatt, G. H., Stones, M. J., & Hirdes, J. P. (2002). The independent contributions of driver, crash, and vehicle characteristics to driver fatalities. *Accident Analysis and Prevention, 34*, 717-727.

Bédard, M., Isherwood, I., Moore, E., Gibbons, C., & Lindstrom, W. (2004). Evaluation of a re-training program for older drivers. *Canadian Journal of Public Health/Revue Canadienne de Santé Publique, 95*, 295-298.

Bédard, M., Weaver, B., Dārzinš P., & Porter, M. (2008). Predicting driving performance in older adults: We are not there yet! *Traffic Injury Prevention, 9*, 336-341.

Benekohal, R. F., Michaels, R. M., Shim, E., & Resende, P. T. V. (1994). Effects of aging on older drivers' travel characteristics. *Transportation Research Record, 1438*, 91-98.

Braver, E., & Trempel, R. (2004). Are older drivers actually at higher risk of involvement in collisions resulting in deaths or non-fatal injuries among their passengers and other road users? *Injury Prevention, 10*, 27-32.

Brook, M. M., Qustad, K. A., Patterson, D. R., & Valois, T. A. (1992). Driving evaluation after traumatic brain injury. *The American Journal of Physical Medicine and Rehabilitation, 71*, 177-182.

Brown, B., & Garner, L. F. (1983). Effects of luminance on contrast sensitivity in senile macular degeneration. *American Journal of Optometry and Physiological Optics, 60*, 788-793.

California (State of) Department of Finance. (2007). *Population projections for California and its counties 2000-2050, by age, gender and race/ethnicity*. Sacramento, CA: Author.

Carr, D., Schmader, K., Bergman, C., Simon, T. C., Jackson, T. W., Haviland, S., & O'Brien, J. (1991). A multi-disciplinary approach in the evaluation of demented drivers referred to geriatric assessment centers. *Journal of the American Geriatric Society, 39*, 1132-1136.

Chapman, E. A., & Masten, S. V. (2002). *Development and evaluation of revised Class C driver license written knowledge tests* (Report No. 196). Sacramento: California Department of Motor Vehicles.

Charlton, J., Koppel, S., O'Hare, M., Andrea, D., Smith, G., Khodr, B., Langford, J., Odell, M., & Fildes, B. (2004). *Influence of chronic illness on crash involvement of motor vehicle drivers* (Report No. 213). Clayton, Australia: Monash University, Accident Research Centre.

Charlton, J. L., Oxley, J., Fildes, B., Oxley, P., & Newstead, S. (2003). Self-regulatory behaviors of older drivers. *Annual Proceedings of the Association for the Advancement of Automotive Medicine, 47*, 181-194.

Charlton, J. L., Oxley, J., Fildes, B., Oxley, P., Newstead, S., Koppel, S., & O'Hare, M. (2006). Characteristics of older drivers who adopt self-regulatory driving behaviours. *Transportation Research Part F, 9*, 517-521.

Clay, O. J., Wadley, V. G., Edwards, J. D., Roth, D. L., Roenker, D. L., & Ball, K. K. (2005). Cumulative meta-analysis of the relationship between Useful Field of View and driving performance in older adults: Current and future implications. *Optometry and Vision Science 82*, 1-8.

Cox, M. J., Norman, J. H., & Norman, P. (1999). The effect of surround luminance on measurements of contrast sensitivity. *Ophthalmic and Physiological Optics, 19,* 401-414.

Dellinger, A. M., Kresnow, M., White, D., & Sehgal, M. (2004). Risk to self versus risk to others: How do older drivers compare to others on the road? *American Journal of Preventive Medicine, 26,* 217-221.

Dellinger, A. M., Sehgal, M., Sleet, D. A., & Barrett-Connor, E. (2001). Driving cessation: What older former drivers tell us. *Journal of the American Geriatrics Society,49,* 431-435.

Di Stefano, M., & McDonald, W. (2003). Assessment of older drivers: relationships among on-road errors, medical conditions and test outcome. *Journal of Safety Research, 34,* 415-429.

Diller, E. M., Cook, L. J., Leonard, D., Reading, J. C., Deon, J. M., & Vernon, D. D. (2001). *Further analysis of drivers licensed with medical conditions in Utah* (Technical Report No. DOT HS 809 211). Springfield, VA: United States Department of Transportation.

Dobbs, B. M. (2005). *Medical conditions and driving: A review of the scientific literature (1960-2000), technical report*. Washington, DC: National Highway and Traffic Safety Administration and the Association for the Advancement of Automotive Medicine Project.

Dobbs, B. M., & Carr, D. (2005). Screening and assessment of medically at-risk drivers. *Public Policy and Aging Report, 15,* 6-12.

Dobbs, B. M., Carr, D. B., & Morris, J. C. (2002). Evaluation and management of the driver with dementia. *Neurologist, 8,* 61-70.

Donorfio, L. K. M., D'Ambrosio, L. A., Coughlin, J. F., & Mohyde, M. (2009). To drive or not to drive that *isn't* the question – the meaning of self-regulation among older drivers. *Journal of Safety Research, 40,* 221-226.

Dulisse, B. (1997). Driver age and traffic citations resulting from motor vehicle collisions. *Accident Analysis and Prevention, 29,* 779-783.

Eberhard, J. (2008). Older drivers' "high per-mile crash involvement": The implications for licensing authorities. *Traffic Injury Prevention, 9*, 284-290.

Eberhard, J., & Mitchell, C. G. B. (2009). Recent changes in driver licensing rates, fatality rates, and mobility options for older men and women in the United States and Great Britain. *Topics in Geriatric Rehabilitation, 25*, 88-98.

Eby, D., Molnar, L., Shope, J., Vivoda, J., & Fordyce, T. (2003). Improving older driver knowledge and self-awareness through self-assessment: The Driving Decisions Workbook. *Journal of Safety Research, 34*, 371-381.

Eisenhandler, S. A. (1993). The asphalt identikit: Old age and the driver's license. *International Journal of Aging and Human Development, 30*, 1-14.

Evans, L. (1988a). Older driver involvement in fatal and severe traffic crashes. *Journal of Gerontology, 43*, S186-S193.

Evans, L. (1988b). Risk of fatality from physical trauma versus sex and age. *Journal of Trauma, 28*, 368-378.

Evans, L. (1991). Age and fatality risk from similar severity impacts. *Journal of Traffic Medicine, 29*, 10-19.

Evans, L. (2000). Risks older drivers face themselves and threats they pose to other road users. *International Journal of Epidemiology, 29*, 315-322.

Fildes, B., Charlton, J., Pronk, N., Langford, J., Oxley, J., & Koppel. S. (2008). An Australasian model license reassessment procedure for identifying potentially unsafe drivers. *Traffic Injury Prevention, 9*, 350-359.

Fildes, B., Pronk, N., Langford, J., Hull, M., Frith, B., & Anderson, R. (2000). *Model license re-assessment procedure for older and disabled drivers* (Report to Austroads No AP-R 176/00). Melbourne, Australia: Monash University, Accident Research Centre.

Foley, D. J., Masaki, K. H., Ross, G. W., & White, L. R. (2000). Driving cessation in older men with incident dementia. *Journal of the American Geriatrics Society, 48*, 928-930.

Fonda, S., Wallace, R., & Herzog, A. (2001). Changes in driving patterns and worsening depressive symptoms among older adults. *Journals of Gerontology Series B: Psychological Sciences & Social Sciences, 56,* S343-S351.

Fox, G. K., Bowden, S. C., & Smith, D. S. (1998). On-road assessment of driving competence after brain impairment: Review of current practice and recommendations for a standardized examination. *Archives of Physical Medicine and Rehabilitation, 79,* 1288-1296.

Freeman, E. E., Gange, S. J., Muñoz, B., & West, S. K. (2006). Driving status and risk of entry into long-term care in older adults. *American Journal of Public Health, 96,* 1254-1259.

Freund, B., Colgrove, L. A., Burke, B. L., & McLeod R. (2005). Self-rated driving performance among elderly drivers referred for driving evaluation. *Accident Analysis and Prevention, 37,* 613-618.

Friedland, R. P., Koss, E., Kumar, A., Gaine, S., Metzler, D., Haxby, J. V., & Moore, A. (1988). Motor vehicle crashes in dementia of the Alzheimer's type. *Annals of Neurology, 24,* 782-786.

Gallo, J., Rebok, G., & Lesiker, S. (1999). The driving habits of adults aged 60 years and older. *Journal of the American Geriatrics Society, 47,* 335-341.

Galski, T., Bruni, R. L., & Ehle, H. T. (1992). Driving after cerebral damage: A model with implications for evaluation. *American Journal of Occupational Therapy, 46,* 324-332.

Gebers, M. A., & Roberts, R. A. (2004). *Characteristics of negligent operators in California* (Report No. 209). Sacramento: California Department of Motor Vehicles.

George, C. F., & Smiley, A. (1999). Sleep apnea and automobile crashes. *Sleep, 22,* 790-795.

Gilley, D. W., Wilson, R. S., Bennett, D. A., Stebbins, G. T., Bernard, B. A., Whalen, M. E., & Fox, J. H. (1991). Cessation of driving and unsafe motor vehicle operation by dementia patients. *Archives of Internal Medicine, 151,* 941-946.

Gordis, L. (1996). *Epidemiology*. Philadelphia: W. B. Saunders Company.

Grabowski, D., Campbell, C., Morrisey, M. (2004). Elderly licensure laws and motor vehicle fatalities. *Journal of the American Medical Association, 291,* 2840-2846.

Gurland, B. J., Wilder, D. E., Lantigua, R., Stern, Y., Chen, J., Killeffer, E. H. P., & Mayeux, R. (1999). Rates of dementia in three ethnoracial groups. *International Journal of Geriatric Psychiatry, 14,* 481-493.

Hagge, R. A. (1994). *The California driver performance evaluation project: An evaluation of a new driver licensing road test* (Report No. 150). Sacramento: California Department of Motor Vehicles.

Hagge, R. A. (1995). *Evaluation of California's special drive test program* (Report No. 160). Sacramento: California Department of Motor Vehicles.

Hakamies-Blomqvist, L. (1993). Fatal accidents of older drivers. *Accident Analysis and Prevention, 25,* 19-27.

Hakamies-Blomqvist, L., Johansson, K., & Lundberg, C. (1996). Medical screening of older drivers as a traffic safety measure – A comparative Finnish-Swedish evaluation study. *Journal of the American Geriatrics Society, 44,* 650-653.

Hakamies-Blomqvist, L., Raitanen, T., & O'Neil, D. (2002). Driver ageing does not cause higher accidents rates per km. *Transportation Research Part F, 5,* 271-274.

Hakamies-Blomqvist, L., & Wahlstrom, B. (1998). Why do older drivers given up driving? *Accident Analysis and Prevention, 30,* 305-312.

Hanrahan, R. B., Layde, P. M., Zhu, S., Guse, C. E., & Hargarten, S. W. (2009). The association of driver age with traffic injury severity in Wisconsin. *Traffic Injury Prevention, 10,* 361-367.

Harper, J., & Schatz, S. (1998). *The premature reduction or cessation of driving*. Chapel Hill: University of North Carolina, Highway Safety Research Center.

Harris, A. (2000). *Transport and mobility in rural Victoria* (Report No. PP 00/02). Melbourne, Australia: Royal Automobile Club of Victoria.

Harrison, A., & Ragland, D. (2003). Consequences of driving reduction or cessation for older adults. *Transportation Research Record, 1843,* 96-104.

Hennessy, D. F. (1995). *Vision testing of renewal applicants: Crashes predicted when compensation for impairment is inadequate* (Report No. 152). Sacramento: California Department of Motor Vehicles.

Hennessy, D. F., & Janke, M. K. (2005). *Clearing a road to driving fitness by better assessing driving wellness: California's three-tier driving-centered assessment system – Summary report* (Report No. 215). Sacramento: California Department of Motor Vehicles.

Hennessy, D. F., & Janke, M. K. (2009). *Clearing a road to being driving fit by better assessing driving wellness: Development of California's prospective three-tier driving centered assessment system – Technical Report* (Report No. 216). Sacramento: California Department of Motor Vehicles.

Holland, C. A., & Rabbitt, P. M. A. (1990). People's awareness of their age-related sensory and cognitive deficits and the implications for road safety. *Applied Cognitive Psychology, 6,* 217-231.

Hu, P., Jones, D., Reuscher, T., Schmoyer, R., & Truett L. (2000). *Projecting fatalities in crashes involving older drivers, 2000-2025* (No. ORNL-6963). Oak Ridge, TN: Oak Ridge National Laboratory.

Hu, P., Trumble, D., Foley, D., Eberhard, J., & Wallace R. (1998). Crash risks of older drivers: A panel data analysis. *Accident Analysis and Prevention, 30,* 569-581.

Hunt, L. A., Murphy, C., Carr, D. V., Duchek, J., Buckles, V., & Morris, J. (1997). Reliability of the Washington University road test: A performance-based assessment for drivers with dementia of the Alzheimer type. *Archives of Neurology, 54,* 707-712.

Janke, M. K. (1991). Accidents, mileage, and the exaggeration of risk. *Accident Analysis and Prevention, 23,* 183-188.

Janke, M. K. (1994). *Age-related disabilities that may impair driving and their assessment*: *Literature review* (Report No. 156). Sacramento: California Department of Motor Vehicles.

Janke, M. K. (2001a). *Medical conditions and other factors in driver risk* (Report No. 190). Sacramento: California Department of Motor Vehicles.

Janke, M. K. (2001b). Assessing older drivers: Two studies. *Journal of Safety Research, 32*, 43-74.

Janke, M. K., & Eberhard, J. (1998). Assessing medically impaired older drivers in a licensing agency setting. *Accident Analysis and Prevention, 30*, 347-361.

Janke, M. K., & Hersch, S. W. (1997). *Assessing the older driver: Pilot studies* (Report No. 172). Sacramento: California Department of Motor Vehicles.

Janke, M. K., Masten, S. V., McKenzie, D. M., Gebers, M. A., & Kelsey, S. L. (2003). *Teen and Senior Drivers* (Report No. 194). Sacramento: California Department of Motor Vehicles.

Johnson, J. E. (1998). Older rural adults and the decision to stop driving: The influence of family and friends. *Journal of Community Health Nursing*, *15*, 205-216.

Johnson, J. E. (2002). Why rural elders drive against advice. *Journal of Community Health Nursing*, *19*, 237-244.

Justiss, M. D., Mann, W. C., Stab, W. B., & Velozo, C. (2006). Development of a behind-the-wheel driving performance assessment for older adults. *Topics in Geriatric Rehabilitation, 22*, 121-128.

Kantor, B., Mauger, L., Richardson, V. E., & Tschantz-Unroe, K. (2004). An analysis of an older driver evaluation program. *Journal of the American Geriatrics Society, 52*, 1326-1330.

Kaufman, J. S., Cooper, R. S., & McGee, D. L. (1997). Socioeconomic status and health in blacks and whites: The problem of residual confounding and the resiliency of race. *Epidemiology*, *8*, 621-628.

Kazniak, A. W., Keyl, P. M., & Albert, M. S. (1991). Dementia and the older driver. *Human Factors, 33*, 527-537.

Kelsey, S. L., & Janke, M. K. (2005). *Pilot educational outreach to high-risk elderly drivers* (Report No. 213). Sacramento: California Department of Motor Vehicles.

Kington, R., Reuben, D., Rogowski, J., & Lillard, L. (1994). Sociodemographic and health factors in driving patterns after 50 years of age. *American Journal of Public Health, 84*, 1327-1329.

Klavora, P., & Heslegrave, R. (2002). Senior drivers: An overview of problems and intervention strategies. *Journal of Aging and Physical Activity, 10*, 332-335.

Korner-Bitensky, N., Kua, A., von Zweck, C., & Van Benthem, K. (2009). Older driver retraining: An updated systematic review of evidence of effectiveness. *Journal of Safety Research, 40*, 105-111.

Kostyniuk, L., & Molnar, L. J. (2005). Driving self-restriction among older adults: Health, age, and sex effects. *The Gerontologist, 45*, 143.

Kostyniuk, L., Shope, J., & Molnar, L. (2000). *Reduction and cessation of driving among older drivers in Michigan: Final report* (Report No. UMTRI-2000-06). Ann Arbor: University of Michigan, Transportation Research Institute.

Kua, A., Korner-Bitensky, N., Desrosiers, J., Man-Son-Hing, M., & Marshall, S. (2007). Older driver retraining: A systematic review of evidence of effectiveness. *Journal of Safety Research, 38*, 81-90.

Lange, J. E., & McKnight, A. J. (1996). Age-based road test policy evaluation. *Transportation Research Record, 1550*, 81-87.

Langford, J. (2008). Usefulness of off-road screening tests to licensing authorities when assessing older driver fitness to drive. *Traffic Injury Prevention, 9*, 328-335.

Langford, J., Bohensky, M., Koppel, S., & Newstead, S. (2008). Do older drivers pose a risk to other road users? *Traffic Injury Prevention, 9,* 181-189.

Langford, J., Fitzharris, M., Koppel, S., & Newstead, S. (2004). Effectiveness of mandatory license testing for older drivers in reducing crash risk among urban older Australian drivers. *Traffic Injury Prevention, 5,* 326-335.

Langford, J., Fitzharris, M., Newstead, S., & Koppel, S. (2004). Some consequences of different older driver licensing procedures in Australia. *Accident Analysis and Prevention, 36,* 993-1001.

Langford, J., Methorst, R., & Hakamies-Blomqvist, L. (2006). Older drivers do not have a high crash risk – A replication of low mileage bias. *Accident Analysis and Prevention, 38,* 574-578.

Levy, D., Vernick, J., & Howard, K. (1995). Relationship between driver's license renewal policies and fatal crashes involving drivers 70 years or older. *Journal of the American Medical Association, 274,* 1026-1030.

Li, G., Braver, E. R., & Chen, L. H. (2003). Fragility versus excessive crash involvement as determinants of high death rates per vehicle-mile of travel among older drivers. *Accident Analysis and Prevention, 35,* 227-235.

Lococo, K. H., & Staplin, L. (2005). *Strategies for medical advisory boards and licensing review* (DOT HS 809 874). Washington, DC: National Highway Traffic Safety Administration, Office of Research and Traffic Records.

Lyman, S., Ferguson, S. A., Braver, E. R., & Williams, A. F. (2002). Older driver involvement in police reported crashes and fatal crashes: Trends and projections. *Injury Prevention, 8,* 116-120.

Lyman, J., McGwin, G., & Sims, R. (2001). Factors related to driving difficulty and habits in older drivers. *Accident Analysis and Prevention, 33,* 413-421.

Man-Son-Hing, M., Marshall, S. C., Molnar, F. J., & Wilson, K. G. (2007). Systematic review of driving risk and the efficacy of compensatory strategies in persons with dementia. *Journal of the American Geriatrics Society, 55*, 878-884.

Marottoli, R. A., Allore, H., Araujo, K. L. B., Iannone, L. P., Acampora, D., Gottschaulk, M., Charpentier, P., Kasl, S., & Peduzzi, P. (2007). A randomized trial of a physical conditioning program to enhance the driving performance of older persons. *Society of General Internal Medicine, 22*, 590-597.

Marottoli, R. A., Cooney, L. M., Wagner, D. R., Doucette, J., & Tinetti, M. E. (1994). Predictors of automobile crashes and mobbing violations among elderly drivers. *Annals of Internal Medicine, 121*, 842-846.

Marottoli, R., & Drickamer, M. (1993). Psychomotor ability and the elderly driver. *Clinics in Geriatric Medicine, 9*, 403-411.

Marottoli, R. A., Mendes de Leon, C. F., Glass, T. A., Williams, C. S., Cooney, L. M., Jr., & Berkman, L. F. (2000). Consequences of driving cessation: Decreased out-of-home activity levels. *Journals of Gerontology Series B: Psychological Sciences & Social Sciences, 55*, S334-S340.

Marottoli, R. A., Mendes de Leon, C. F., Glass, T. A., Williams, C. S., Cooney, L. M., Jr., Berkman, L. F., & Tinetti, M. E. (1997). Driving cessation and increased depressive symptoms: Prospective evidence from the New Haven EPESE. *Journal of the American Geriatrics Society, 45*, 202-206.

Marottoli, R. A., Ostfeld, A. M., Merril, S. S., Perlman, G. D., Foley, D. J., & Cooney, L. M., Jr. (1993). Driving cessation and changes in mileage driven among elderly individuals. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 48*, S255-S260.

Marshall, S. C. (2008). The role of reduced fitness to drive due to medical impairments in explaining crashes involving older drivers. *Traffic Injury Prevention, 9*, 291-298.

Massie, D. L., & Campbell, K. L. (1993). Analysis of accident rates by age, gender and time of day based on the 1990 Nationwide Personal Transportation Survey (Publication No. UMTRI-93-7). Ann Arbor: University of Michigan, Transportation Research Institute.

Masten, S. V. (1998a). *Evaluation of the Class C driver license written knowledge test* (Report No. 173). Sacramento: California Department of Motor Vehicles.

Masten, S. V. (1998b). *Preliminary evaluation of the referral driving performance evaluation program* (Report No. 176). Sacramento: California Department of Motor Vehicles.

Masten, S. V. (1998c). *Evaluation of the referral driving performance evaluation program – Follow-Up Report* (Report No. 177). Sacramento: California Department of Motor Vehicles.

Masten, S. V. (1999). *Evaluation of the Class C license written knowledge tests* (Report No. 182). Sacramento: California Department of Motor Vehicles.

McCoy, G. F., Johnston, R. A., & Duthie, R. B. (1989). Injury to the elderly in road traffic accidents. *Journal of Trauma, 29,* 494-497.

Meuleners, L. B., Harding, A., Lee, A. H., & Legge, M. (2006). Fragility and crash over-representation among older drivers in Western Australia. *Accident Analysis and Prevention, 38,* 1006-1010.

Molnar, L. J., & Eby, D. W. (2008). The relationship between self-regulation and driving-related abilities in older drivers: An exploratory study. *Traffic Injury Prevention, 9,* 314-319.

Molnar, F. J., Patel, A., Marshall, S., Man-Son-Hing, M., & Wilson, K. G. (2006). Clinical utility of office-based cognitive predictors of fitness to drive in persons with dementia: A systematic review. *Journal of the American Geriatrics Society, 54,* 1809-1824.

National Highway Traffic Safety Administration. (2005). *Traffic safety facts: 2005 data. Older Population* (DOT HS 810 622). Washington, DC: Author.

Newgard, C. D. (2008). Defining the “older” crash victim: The relationship between age and serious injury in motor vehicle crashes. *Accident Analysis and Prevention, 40,* 1498-1505.

O'Neill, D. (1997). Predicting and coping with the consequences of stopping driving. *Alzheimer Disease and Associated Disorders, 11*, 70-72.

Organization for Economic Cooperation and Development. (2001). *Aging and transport: Mobility needs and safety issues*. Paris: Author.

Owsley, C., Ball, K., Sloane, M. E., Roenker, D. L., & Bruni, J. R. (1991). Visual/cognitive correlates of vehicle accidents in older drivers. *Psychology and Aging, 6*, 403-415.

Owsley, C., & McGwin, G. (2004). Association between visual attention and mobility in older adults. *Journal of the American Geriatrics Society, 52*, 1901-1906.

Owsley, C., Stalvey, B. T., & Phillips, J. M. (2004). The efficacy of an educational intervention in promoting self-regulation among high-risk, visually impaired older drivers. *American Journal of Preventive Medicine, 26*, 222-229.

Owsley, C., Stalvey, B., Wells, J., & Sloane, M. (1999). Older drivers and cataract: driving habits and crash risk. *Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 54*, M203-M211.

Oxley, J. A., Charlton, J. L., Koppel, S., Scully, J., & Fildes, B. N. (2005). Crash risk of older female drivers – contributing factors. *Annual Proceedings of the Association for the Advancement of Automotive Medicine, 49*, 345-360.

Oxley, J., & Whelan, M. (2008). It cannot be all about safety: The benefits of prolonged mobility. *Traffic Injury Prevention, 9*, 367-378.

Pelli, D. G., Robson, J. G., & Wilkins, A. J. (1988). The design of a new letter chart for measuring contrast sensitivity. *Clinical Vision Sciences, 2*, 187-199.

Persson, D. (1993). The elderly driver: Deciding when to stop. *Gerontologist, 33*, 88-91.

Preusser, D. F., Williams, A. F., Ferguson, S. A., Ulmer, R. G., & Weinstein, H. B. (1998). Fatal crash risk for older drivers at intersections. *Accident Analysis and Prevention, 30*, 151-159.

Rabbitt, P. (1993). Does it all go together when it goes? The nineteenth Bartlett Memorial Lecture. *Quarterly Journal of Experimental Psychology – A, 30,* 385-484.

Rabbitt, P., Carmichael, A., Shilling, V., & Sutcliffe, P. (2002). *Age, health and driving: Longitudinally observed changes in reported general health, mileage, self-rated competence and in attitudes of older drivers*. Manchester, UK: AA Foundation for Road Safety Research.

Ragland, D., Satariano, W., & MacLeod, K. (2005). Driving cessation and increased depressive symptoms. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences 60,* 399-403.

Raitanen, T., Tormakangas, T., Mollenkopf, H., & Marcellini, F. (2004). Why do older drivers reduce driving? Findings from three European countries. *Transportation Research Part F, 6,* 81-95.

Ranney, T. A., & Hunt, L. A. (1997). Researchers and occupational therapists can help each other to better understand what makes a good driver: Two perspectives. *Work, 8,* 293-7.

Reiner, T. W., & Hagge, R. A. (2006). *Evaluation of the class C driver license written knowledge tests* (Report No. 221). Sacramento: California Department of Motor Vehicles.

Retchin, S., Cox, J., Fox, M., & Irwin, L. (1988). Performance-based measurements among elderly drivers and nondrivers. *Journal of the American Geriatric Society, 36,* 813-819.

Reuben, D., Silliman, R., & Traines, M. (1988). The aging driver: Medicine, policy and ethics. *Journal of the American Geriatrics Society, 36,* 1135-1142.

Rock, S. M. (1998). Impact from changes in Illinois drivers license renewal requirements for older drivers. *Accident Analysis and Prevention, 30,* 69-74.

Romanowicz, P. R., & Hagge, R. A. (1995). *An evaluation of the validity of California's driving performance evaluation road test* (Report No. 154). Sacramento: California Department of Motor Vehicles.

Rovamo, J., Kukkonen, H., Thppana, K., & Näsänen, R. (1993). Effects of luminance and exposure time on contrast sensitivity in spatial noise. *Vision Research, 33,* 1123-1129.

Ruechel, S., & Mann, W. C. (2005). Self-regulation of driving by older persons. *Physical and Occupational Therapy in Geriatrics, 23,* 91-101.

Ryan, G. A., Legge, M., & Rosman, D. (1998). Age-related changes in drivers' crash risk and crash type. *Accident Analysis and Prevention, 30,* 379-387.

Schwartz, B. S., Glass, T. A., Bolla, K. I., Stewart, W. F., Glass, G., Rasmussen, M., Bressler, J., Shi, W., & Bandeen-Roche, K. (2004). Disparities in cognitive functioning by race/ethnicity in the Baltimore Memory Study. *Environmental Health Perspectives, 112,* 314-320.

Shadlen, M., Siscovick, D., Fitzpatrick, A. L., Dulberg, C., Kuller, L. H., & Jackson, S. (2006). Education, cognitive test scores, and black-white differences in dementia risk. *Journal of the American Geriatrics Society, 54,* 898-905.

Simms, B. (1985). The assessment of the disabled for driving: A preliminary report. *International Rehabilitation Medicine, 7,* 187-192.

Sloane, M. E., Owsley, C., & Jackson, S. A. (1988). Aging and luminance-adaptation effects on spatial contrast sensitivity. *Journal of the Optical Society of America A: Optics and Image Science, 5,* 2181-2190.

Smith, J. P., & Kington, R. (1997). Demographic and economic correlates of health in old age. *Demography, 34,* 159-170.

Soderstrom, C. A., & Joyce, J. J. (2008). Medical review of fitness to drive in older drivers: The Maryland experience. *Traffic Injury Prevention, 9,* 342-349.

Sommer, S. M., Falkmer, T., Bekiaris, E., & Panou, M. (2004). Toward a client-centered approach to fitness-to-drive assessment of elderly drivers. *Scandinavian Journal of Occupational Therapy, 11,* 62-69.

Stalvey, B. T., & Owsley, C. (2000). Self-perceptions and current practices of high-risk older drivers: implications for driver safety interventions. *Journal of Health Psychology, 5,* 441-456.

Staplin, L., Gish, K., & Wagner, E. (2003). MaryPODS revisited: Updated crash analysis and implications for screening program implementation. *Journal of Safety Research, 34*, 389-397.

Staplin, L., Lococo, K., Gish, K., & Decina, L. (2003). *Model driver screening and evaluation program, final technical report, volume II: Maryland Pilot Older Driver Study* (Report No. DOT HS 809 583). Washington, DC: National Highway Traffic Safety Administration.

Stav, W. B., Justiss, M. D., McCarthy, D. P., Mann, W. C., & Lanford, D. N. (2008). Predictability of clinical assessments for driving performance. *Journal of Safety Research 39,* 1-7.

Stelmach, G., & Nahom, A. (1992). Cognitive-motor abilities of the elderly driver. *Human Factors, 34*, 53-65.

Stutts, J. C. (1998). Do older drivers with visual and cognitive impairments drive less? *Journal of the American Geriatrics Society, 46,* 854-861.

Stutts, J., Stewart, J., & Martell, C. (1998). Cognitive test performance and crash risk in an older driver population. *Accident Analysis and Prevention, 30,* 337-346.

Stutts, J. C., Wilkins, J. W., Reinfurt, D. W., Rodgman, E. A., & Van Heusen-Causey, S. (2001). *The premature reduction and cessation of driving by older men and women*. Chapel Hill: University of North Carolina, Highway Safety Research Center.

Taylor, B. D., & Tripodes, S. (2001). The effects of driving cessation on the elderly with dementia and their caregivers. *Accident Analysis and Prevention, 33*, 519-528.

Torpey, S. (1986). *License re-testing of older drivers*. Melbourne, Australia: Road Traffic Authority.

United States Department of Transportation. (1993). *Addressing the safety issues related to younger and older drivers*. Washington, DC: Author.

United States Department of Transportation. (2003). *Motor vehicle traffic crash fatality and injury estimates for 2002*. Washington, DC: Author.

University of California, Los Angeles, Center for Health Policy Research. (2007). *California Health Interview Survey* [computer file]. Los Angeles: Author.

Vaa, T. (2004). *Impairment, diseases, age, and their relative risks of accident involvement: Results from meta-analysis* (TØI Report 690). Oslo, Norway: Institute of Transport Economics.

van Leeuwen, R., Klaver, C. C. W., Vingerling, J. R., Hofman, A., & de Jong, P. T. V. M. (2003). Epidemiology of age-related maculopathy: A review. *European Journal of Epidemiology*, *18*, 845-854.

Vance, D. E., Roenker, D., Cissell, G., Edwards, J., Wadley, V., & Ball, K. (2006). Predictors of driving exposure and avoidance in a field study of older drivers from the state of Maryland. *Accident Analysis and Prevention, 38*, 823-831.

Vernon, D. D., Diller, E. M., Cook, L. J., Reading, J. C., Suruda, A. J., & Dean, J. M. (2002). Evaluating the crash and citation rates of Utah drivers licensed with medical conditions, 1992-1996. *Accident Analysis and Prevention, 34*, 237-246.

Viano, D. V., Culver, C. C., Evans, L., Frick, M., & Scott, R. (1990). Involvement of older drivers in multivehicle side-impact crashes. *Accident Analysis and Prevention, 22*, 177-188.

Waller, J. (1992). Research and other issues concerning effects of medical conditions on elderly drivers. *Human Factors, 34*, 3-24.

West, C. G., Gildengorin, G., Haegerstrom-Portnoy, G., Lott, L. A., Schneck, M. E., & Brabyn, J. A. (2003). Vision and driving self-restriction in older adults. *Journal of the American Geriatrics Society, 51*, 1348-1355.

Wheatley, C. J., & Di Stefano, M. (2008). Individualized assessment of driving fitness for older individuals with health, disability, and age-related concerns. *Traffic Injury Prevention, 9*, 320-327.

Williams, A. F., & Carsten, O. (1989). Driver age and crash involvement. *American Journal of Public Health, 79*, 326-327.

Windsor, T., Antsey, K., Butterworth, P., Luszcz, M., & Andrews, G. (2007). The role of perceived control in explaining depressive symptoms associated with driving cessation in a longitudinal study. *Gerontologist, 47*, 215-223.

Withaar, F. K., Brouwer, W. H., & Van Zomeren, A. H. (2000). Critical review: Fitness to drive in older drivers with cognitive impairment. *Journal of the International Neuropsychological Society, 6*, 480-490.

Wood, J., & Mallon, K. (2001). Comparison of driving performance of young and old drivers (with and without visual impairment) measured during in-traffic conditions. *Optometry and Vision Science, 78*, 343-349.

Yasuda, M., Wilson, J., & von Mering, O. (1997). Driving cessation: The perspective of senior drivers. *Educational Gerontology, 23*, 525-538.

Zhang, L., Pelli, D. G., & Robson, J. G. (1989). The effects of luminance, distance, and defocus on contrast sensitivity as measured by the Pelli-Robson chart. *Investigative Ophthalmology and Vision Science, 30*, 406.

GLOSSARY OF TERMS AND ACRONYMS

3TAS:	3-Tier Assessment System
ADPE:	Area Driving Performance Evaluation
ACS:	American Community Survey
CA DMV:	California Department of Motor Vehicles
CA OTS:	California Office of Traffic Safety
DTB:	Departmental Training Branch
DSO:	Sacramento Driver Safety Office
FOD:	Field Operations Division
LOC:	Lapse of Consciousness
LOD:	Licensing Operations Division
LRE:	Licensing Registration Examiner
MVFR:	Motor Vehicle Field Representative
P&M:	Physical and/or Mental Condition
PRT:	Perceptual Response Test
R&D:	California DMV Research and Development Branch
SDPE:	Supplemental Driving Performance Evaluation
SIP:	Special Instruction Permit
SRL:	Special Restricted License
SSN:	Social Security Number
TTC:	Transaction Type Code
VCS:	Video Capture Station