Internal Audit Report

Pavement Management – Data Quality

June 30, 2023

SOUTH CAROLINA OFFICE OF THE STATE AUDITOR

1. Executive Summary

Objective

Management's objective for the Pavement Management activity is to collect and report accurate, timely, repeatable pavement condition data. Our objective is to provide assurance that internal controls are adequately designed and operating effectively to manage risks that may hinder the achievement of Management's objectives.

Background

Pavement Management is an activity within Road Data Services, which operates as part of the Office of Intermodal Planning. The Pavement Management activity is a set of carefully defined processes for the collection, analyzing, and reporting of surface distresses experienced by the Interstate, Primary, and Secondary road systems within South Carolina.

Pavement data collection is split between the South Carolina Department of Transportation (SCDOT) Pavement Management unit and a third-party vendor. The vendor is responsible for collecting data annually for all roads funded by federal aid, which consists of all interstate, all primary, and some secondary roads. The remaining pavement data (all non-federally funded secondary roads) is collected biennially by SCDOT Pavement Management equipment operators, who are organized into three regions across the state.

In 2018, Pavement Management procured vans equipped with state-of-the-art road collection tools and tracking devices that significantly changed the pavement condition data collection process. Shortly after the changes were implemented, Internal Audit Services performed an audit of Pavement Management that was limited to an assessment of the design adequacy of the activity's internal controls. This current audit was performed as a follow-up to the 2018-2019 audit to assess the operating effectiveness of the activity's internal controls.

Conclusion

In our opinion, controls are partially adequate in design and operating effectiveness for reducing some risks within the Agency's risk appetite. Risk exposure is determined to be Medium.

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Authorization

The South Carolina Office of the State Auditor established the Internal Audit Services division (IAS) pursuant to SC Code Section 57-1-360 as revised by Act 275 of the 2016 legislative session. IAS is an independent, objective assurance and consulting function designed to add value and improve the operations of the South Carolina Department of Transportation (SCDOT). IAS helps SCDOT to achieve its objectives by bringing a systematic, disciplined approach to evaluating the effectiveness of risk management, internal control, and governance processes and by advising on best practices.

Statement of Independence

To ensure independence, IAS reports administratively and functionally to the State Auditor while working collaboratively with SCDOT leadership in developing an audit plan that appropriately aligns with SCDOT's mission and business objectives and reflects business risks and other priorities.

Report Distribution

This report is intended for the information and use of the SCDOT Commission, SCDOT leadership, the Chairman of the Senate Transportation Committee, the Chairman of the Senate Finance Committee, the Chairman of the House of Representatives Education and Public Works Committee, and the Chairman of the House of Representatives Ways and Means Committee. However, this report is a matter of public record and its distribution is not limited.

Acknowledgment

We wish to thank members of management and staff in Pavement Management for their cooperation in assessing risks and developing actions to improve internal controls and enhance operating performance.

SOUTH CAROLINA OFFICE OF THE STATE AUDITOR
1401 Main Street, Suite 1200 • Columbia, SC 29201

3. Internal Auditor's Report

June 30, 2023

Ms. Christy A. Hall, Secretary of Transportation
and
Members of the Commission
South Carolina Department of Transportation
Columbia, South Carolina

We have completed risk and control assessment of the South Carolina Department of Transportation's (SCDOT's) Pavement Management activity. The objective of this assessment was to contribute to the improvement of risk management by evaluating SCDOT's exposure to risks and the controls designed by Management to manage those risks. Our engagement included two aspects:

- Facilitation of Management's assessment of risks associated with the Pavement Management activity.
- Independent assessment of the design and effectiveness of internal controls to determine whether those controls effectively manage the identified risks to an acceptable level.

We planned and performed the engagement with due professional care in order to obtain sufficient, appropriate evidence to provide a reasonable basis for our observations and recommendations. Our observations, recommendations, and management's action plans were discussed with management.

George L. Kennedy, III, CPA
State Auditor

4. Engagement Overview

Background

Pavement Management is an activity within Road Data Services, which operates as part of the Office of Intermodal Planning. The Pavement Management activity is a set of carefully defined processes for the collection, analyzing, and reporting of surface distresses experienced by the Interstate, Primary, and Secondary road systems within South Carolina.

The data collected by Pavement Management can be viewed agency-wide in the Integrated Transportation System (ITMS) and is used by management to make reliable, cost-effective decisions concerning the maintenance and preservation of South Carolina's pavement network. In order to comply with federal regulations, Pavement Management also submits an annual report of pavement data to the Federal Highway Administration (FHWA) for the Highway Performance Monitoring System (HPMS).

Pavement data collection is split between the South Carolina Department of Transportation (SCDOT) Pavement Management unit and a third-party vendor. The vendor is responsible for collecting data annually for all roads funded by federal aid, which consists of all interstate, all primary, and some secondary roads. The remaining pavement data (all non-federally funded secondary roads) is collected biennially by SCDOT Pavement Management equipment operators, who are organized into three regions across the state.

In 2018, Pavement Management procured vans equipped with state-of-the-art road collection tools and tracking devices that significantly changed the process for collecting pavement condition data. Shortly after the changes were implemented, Internal Audit Services performed an audit of Pavement Management that was limited to an assessment of the design adequacy of the activity's internal controls. This current audit was performed as a follow-up to the 2018-2019 audit to assess the operating effectiveness of the activity's internal controls.

Objective

Management's objective for the Pavement Management activity is to collect and report accurate, timely, repeatable pavement condition data.

Our objective is to provide assurance that internal controls are adequately designed and operating effectively to manage risks that may hinder the achievement of Management's objectives for the Pavement Management activity.

Scope

The Pavement Management activity is comprised of six processes involving multiple stakeholders as follows:

1. In-House Data Collection
2. Vendor Data Collection
3. Process/Upload Data
4. Process/Upload Images
5. Federal Data Reporting
6. HPMA Data Updates

Our scope included processes 1-3 above (In-House Data Collection, Vendor Data Collection, and Process/Upload Data) for calendar year 2021 pavement data that was collected and processed during the period of January 4, 2021 – February 16, 2022.

Methodology

For the processes included in the engagement scope, we performed the following procedures:

1. We facilitated Management's completion of a process outline that documents the steps in the process and the individuals responsible for those steps.
2. We facilitated Management's completion of a risk and control matrix used to:
    a. identify risks which threaten process objectives,
    b. score the risks as to their consequence and likelihood of occurrence using the risk scoring matrix in Appendix B,
    c. determine if controls are adequately designed to manage the risks to within the Agency's risk appetite, and
    d. propose design improvements to controls when risks are not managed to within the Agency's risk appetite.
3. We evaluated Management's assessment to determine if it was reasonable and comprehensive.
4. We tested controls intended to manage risks with inherent risk scores of 9 and above [scale of 1 (low) to 25 (high)] to determine if controls are designed adequately and operating effectively. Our testing included inquiry, observation, and inspection of documentation to determine if controls are operating effectively.
5. We developed observations for controls determined to be inadequate in design and/or ineffective in operation.
6. We collaborated with management to develop action plans to improve control design and/or operating effectiveness for the identified control deficiencies.

5. Conclusion

Pavement Management Controls

In our opinion, controls are partially adequate in design and operating effectiveness for reducing some risks within the Agency's risk appetite. Risk exposure is determined to be Medium. Our recommendations to improve control design and/or operating effectiveness are described in the Observations section.

Development of Management Action Plans

We facilitated Management's development of action plans for each observation and performance opportunity to improve control design and operating effectiveness with practical, cost-effective solutions. These improvements, if effectively implemented, are expected to reduce the overall risk exposure to an acceptable level (i.e. within the Agency's risk appetite).

We will follow up with Management on the implementation of the proposed actions on an ongoing basis and provide SCDOT leadership with periodic reports on the status of management action plans and whether those actions are effectively and timely implemented to reduce risk exposure to an acceptable level.

Observations

Observation 5.1 **Performance and Documentation of Monthly Equipment Calibrations for SCDOT Collection Vehicles**	**Risk Exposure** **Medium-Low**
Division: Pavement Management	
Control Assessed: Control 1 – Equipment Calibrations	
Control Description: Control 1 – Block tests (assesses accuracy and precision of vehicle's laser's measuring equipment) and control site verifications (assesses accuracy and repeatability of International Roughness Index (IRI) and rutting data collected by vehicle's equipment) are both performed monthly to ensure equipment is properly calibrated.	
Process Affected: (See process descriptions in Appendix A) Process 1 – In-House Data Collection	
Observation: We obtained the documentation and calculation of the control site verifications noting that none of the control site verification documentation provided to IAS clearly indicated whether the monthly verification data met the repeatability or accuracy thresholds for International Roughness Index (IRI) or rutting. Additionally, the monthly control site verifications contained improperly calculated averages that would not allow for an accurate comparison of the control run data to the baseline data. Furthermore, most of the documentation provided contained batches of monthly control site verification data in which the aggregate of those batches was compared to baselines rather than a month by month comparison. In most cases, IAS was able to perform its own calculations and determined that the repeatability and accuracy thresholds for IRI and rutting were met for each set of monthly verification data. **Recommendation 1:** We recommend that Pavement Management develop a centralized process for reviewing and monitoring the monthly equipment verification activity of all three SCDOT collection teams to ensure all monthly equipment calibrations are performed properly and at the required frequency. **Recommendation 2:** We recommend that that Pavement Management require all three collection teams to a) calculate and document the monthly equipment verifications in the same manner, b) assess each month's control site run verifications immediately after the data was collected and document each month separately, and c) clearly document whether the IRI and rutting standards for both accuracy and repeatability were met.	
Management Action Plan (MAP) 5.1a	
Pavement Management staff has reviewed and is in the process of updating the existing SCDOT Pavement Management Data Quality Management Plan. The plan will include a schedule for profiler verifications and a standardized process for reviewing and monitoring the monthly equipment verification activity. A new Pavement Management Operations Manager position was established in 2023 – this manager will review, monitor, confirm the collection, maintenance, and acceptability of the equipment verification records for all SCDOT collection teams. Management staff is in the process of reviewing and updating the existing SCDOT Pavement Management Data Quality Management Plan. The plan will include a schedule for	

profiler verifications and a standardized process for reviewing and monitoring the monthly equipment verification activity. A centralized documentation depository is also being established for ease of access. A new position of a Pavement Management Operations Manager has been established in 2023 – this manager will review, monitor, confirm the collection, maintenance, and acceptability of the equipment verification records for all SCDOT collection teams.

MAP Owner:	Pavement Management Engineer
Division:	Pavement Management
Scheduled Date:	April 30, 2024

Management Action Plan (MAP) 5.1b

The Pavement Management office now requires all team members involved in performance and validation of monthly equipment verifications to calculate and document these authentications using only the methods and checklists recommended by the supplier of SCDOT's Pavement Management profiler fleet. The Pavement Management Operations Manager is responsible for the immediate assessment of whether each control site verification calculation meets the IRI and rutting standards as determined by the vendor to conform to AASHTO standards for accuracy and repeatability before the profiler is released for data collection. The Operations Manager now stores validated control site verifications in the Road Data Services share folder by year, month and profiler identifier.

MAP Owner:	Pavement Management Engineer
Division:	Pavement Management
Scheduled Date:	Implemented During Audit

Observation 5.2
Verification of Vendor's Equipment Calibrations and Certifications

Risk Exposure: **Medium-Low**

Division: Pavement Management

Controls Assessed:
Control 1 – Verification of Vendor's Equipment Certification
Control 2 – Verification of Vendor's Equipment Calibrations

Controls Descriptions:
Control 1 – Prior to the commencement of the annual data collection cycle, Pavement Management verifies that each vehicle that will be used by the vendor to collect pavement data for SCDOT was certified to meet or exceed the applicable requirements of AASHTO R 56-14.
Control 2 – Pavement Management verifies that the vendor performed initial and monthly calibrations for each vehicle used to collect pavement data for SCDOT to ensure the vendor's collection equipment was assessed and met the accuracy and repeatability standards for International Roughness Index (IRI) and rutting data.

Process Affected: (See process descriptions in Appendix A)
Process 2 – Vendor Data Collection

Observation:
Pavement Management did not verify the vendor's equipment certifications or the vendor's

equipment calibrations for any of the vehicles used to collect data for SCDOT during 2021. IAS was able to determine that the equipment for each of these vehicles was properly certified prior to the start of data collection and, in most instances, that the control site calibrations for each of these vehicles was performed properly and at the required frequencies. However, there were two instances in which there was insufficient documentation to support that a monthly calibration was completed for all of the required control sites and one other instance in which there was insufficient documentation to support that an initial calibration was performed before the vehicle began collecting data.

Recommendation:

We recommend that Pavement Management develop processes for a) verifying annually that the equipment for each of the vendor's vehicles that will be used to collect data for SCDOT is properly certified before the vendor starts its annual data collection and b) reviewing and monitoring the initial and monthly equipment calibration activity of all vendor collection vehicles used to collect data for SCDOT to ensure all equipment calibrations are performed properly and at the required frequency.

Management Action Plan (MAP) 5.2a

Beginning in 2023 – SCDOT Pavement Management office has reestablished the requirement for the vendor to supply all profiler certifications prior to start of data collection. In addition, the contractor is now required to provide each pavement data collection van's monthly site verifications sending those with each data delivery. With recent Pavement Management office restructuring, our Operations Manager now confirms and documents the acceptability of vendor certifications and verifications.

MAP Owner:	Pavement Management Engineer
Division:	Pavement Management
Scheduled Date:	Implemented During Audit

Observation 5.3 Quality Control Review Sampling and Documentation	Risk Exposure Medium

Division: Pavement Management

Controls Assessed:
Control 1 – Quality Control (QC) Reviews

Controls Descriptions:
Control 1 – Once data has been uploaded into the Highway Pavement Management Application (HPMA), Pavement Management performs QC Reviews on a sample of pavement data.

Processes Affected: (See process descriptions in Appendix A)
Process 1 – In-House Data Collection
Process 2 – Vendor Data Collection
Process 3 – Process/Upload Data

Observation:

2021 Non-Federal Aid Pavement Data
Pavement Management was only able to provide documentation to support a review of a partial population of 2021 pavement data for non-federal aid secondary roadways once it was uploaded into HPMA prior to inclusion for reporting as required by the department's Quality Management Plan. The review of the partial population did not include clear documentation for each selected item.

This data is collected directly by SCDOT and used for reporting internally.

(See further comments regarding documentation of data anomalies and irregularities below.)

2021 Federal Aid Pavement Data
Pavement Management provided documentation to support a review of the full population of federal-aid pavement data collected by the vendor as required by the department's Quality Management Plan.

This data is used for reporting internally and externally to FHWA.

(See further comments regarding documentation of data anomalies and irregularities below.)

Documentation of Data Anomalies and Irregularities

Pavement Management was unable to provide any documentation to support that items highlighted as anomalies and irregularities for 2021 pavement management data including both datasets above were adequately explained or addressed prior to finalizing the data in HPMA as required by the department's Quality Management Plan.

Based on the department's Quality Management Plan, the review should result in a list of irregularities and anomalies for the following reviews based on the Quality Management Plan:

A statistical comparison of current versus historical distress data for each route.
Condition log plots of Pavement Quality Index data are generated in HPMA for all interstates, primary roads, and a sample of secondary roads.
A data completeness check

Evidence of a formal, systematic review of the accuracy and completeness of data should result in the documentation of variances or irregularities in data. These items should be compiled in an organized fashion and result in an inquiry of variances or irregularities until the irregularity is adequately explained or addressed through the recollection of data. Such items should be sufficiently documented.

Note that the observation is focused on the final step in the quality control of pavement data. Quality control is performed throughout the process from the collection of data and the processing of data through to the final review of data after loading pavement data into HPMA.

During our audit, we observed that Pavement Management did update and improve its process for documentation for the 2022 data cycle as compared to the 2021 cycle noted herein.

Recommendation 1:

We recommend that Pavement Management develop a policy or procedure that clearly specifies how QC Reviews should be documented.

Recommendation 2:

We recommend that Pavement Management develop a policy or procedure that delineates a systematic approach to sampling pavement data for QC Reviews.

Recommendation 3:

We recommend that a secondary, high-level review of the QC Reviews be performed and documented by the Pavement Management Engineer or equivalent to ensure the QC Reviews are properly executed and sufficiently documented.

Management Action Plan (MAP) 5.3a

Pavement Management staff has reviewed and is in the process of updating the existing SCDOT policy and procedures for the documentation of Pavement data QC review process. This documentation will be available as a part of SCDOT Pavement Management Data Quality Management Plan by the end of April 2024.

MAP Owner:	Pavement Management Engineer
Division:	Pavement Management
Scheduled Date:	April 2024

Management Action Plan (MAP) 5.3b

A newly created Quality Assurance /Quality Control (“QA/QC”) Pavement Management team was established in 2023. The team of two employees and one additional staff member is tasked with reviewing collected data for all the routes on SCDOT highway system, identifying any missing data, and recommending error resolution. The team has begun updating and enhancing the existing QA/QC procedures. As a part of this update - Pavement Management staff is currently researching if data QA/QC sampling is going to be needed in the future. The effectiveness of the team’s QC efforts will be analyzed over the next 10 months resulting in a review strategy that will be documented in SCDOT Pavement Management Data Quality Management Plan.

MAP Owner:	Pavement Management Engineer
Division:	Pavement Management

Scheduled Date:	April 2024
Management Action Plan (MAP) 5.3c	
Pavement Management staff will conduct research to determine a sufficient sample size for the secondary review of the Pavement Data quality control results. The results of the research will be documented in SCDOT Pavement Management Data Quality Management Plan and will include procedures for the review, documentation of findings, and error resolution.	
MAP Owner:	Pavement Management Engineer
Division:	Pavement Management
Scheduled Date:	April 2024

Appendix A - Process Descriptions

Process 1 In-House Data Collection

SCDOT collects pavement condition data for all non-federally funded secondary roads internally on a biennial collection cycle (approximately half of the data is collected one year and the rest of the data is collected the following year). The data collection is split between three regional collection teams: Greenwood, Charleston, and Columbia. In-house data is collected using PathRunner vans equipped with lasers and high-definition cameras. The vans are driven by one team member along scheduled routes as the other team member operates the equipment and monitors the data/images collected in the PathRunner system. Once collection is complete, the data is uploaded into PathView II for processing.

Twice per year, each SCDOT PathRunner van is vigorously tested by a third party and certified to meet or exceed applicable AASHTO pavement data collection requirements. Additionally, collection teams perform monthly Block Tests on each van to assess the accuracy and precision of the van's laser measuring equipment and monthly control site verifications to assess whether data collected by the van's collection equipment meets Pavement Management's accuracy and repeatability standards for International Roughness Index (IRI) and rutting.

Process 2 Vendor Data Collection

SCDOT contracts a third-party vendor to collect pavement condition data for all federally-funded roads (all interstate, all primary, and some secondary roads) annually. The data is collected by the vendor using vehicles and equipment that are similar to the ones used by SCDOT. Each collection cycle, Pavement Management sends over a list of all the roads the vendor is responsible for and the data collection is typically completed in three to four months. Once all of the data is collected, the vendor performs their own preliminary data processing/formatting and delivers the data to Pavement Management, which is then uploaded directly into HPMA.

Prior to the commencement of the annual collection cycle, Pavement Management verifies that each vehicle that will be used by the vendor to collect pavement data for SCDOT was certified by a third party to meet or exceed the applicable AASHTO pavement data collection requirements. Pavement Management also verifies that the vendor performed initial and monthly calibrations for each vehicle used to collect pavement data for SCDOT to ensure the vendor's collection equipment was assessed and met the accuracy and repeatability standards for IRI and rutting in accordance with pavement data collection contract.

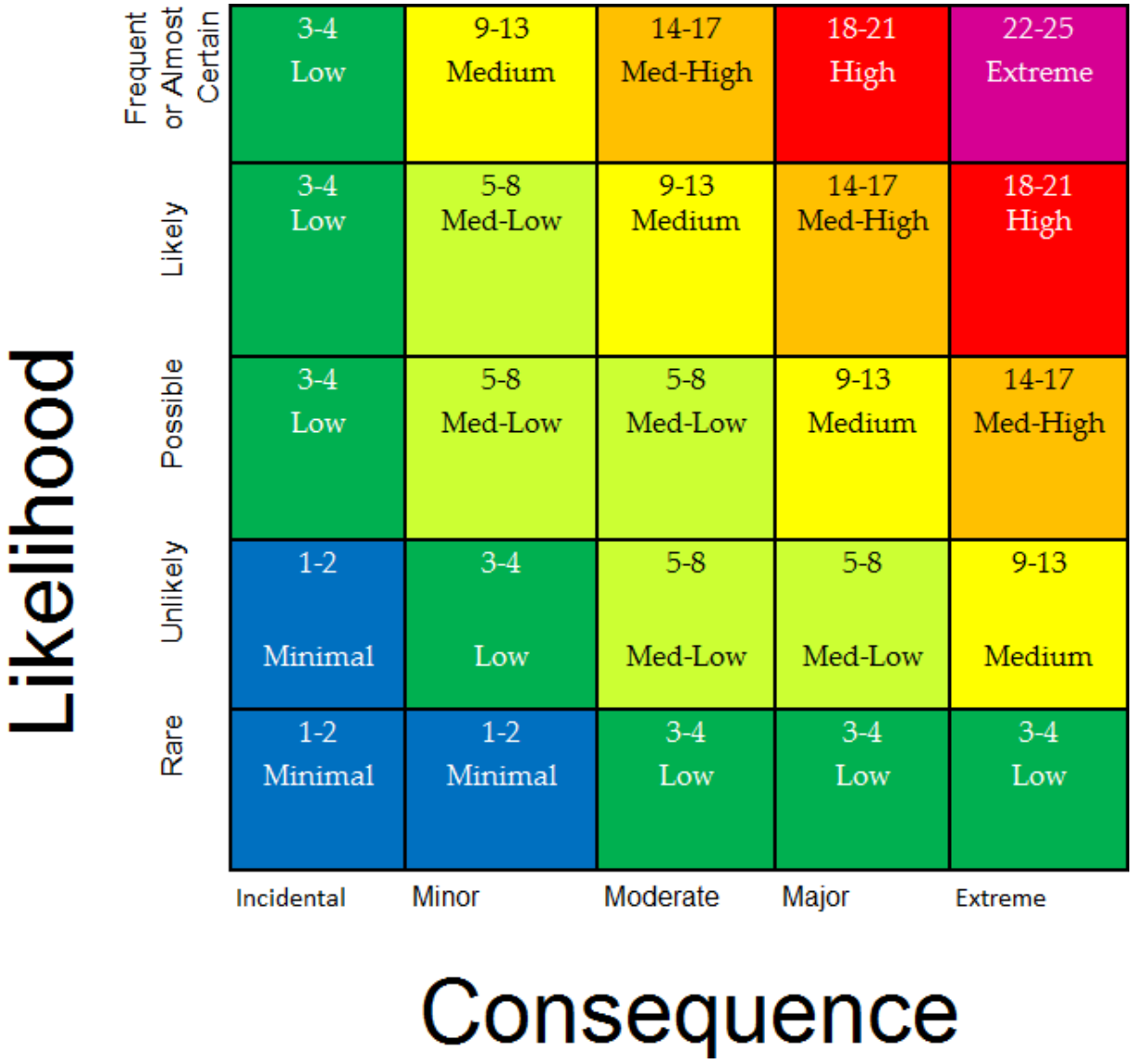
Process 3 Process and Upload Data

Pavement data that was collected internally by SCDOT is processed initially in PathView II and then formatted using Excel before it is uploaded into HPMA. The pavement data for federal-aid roads is processed and formatted by the vendor prior to delivery and then uploaded directly into HPMA by Pavement Management.

To further ensure accurate and repeatable pavement data, Pavement Management selects a sample of pavement data from HPMA and performs Quality Control Reviews of the sampled data. After all necessary Quality Control Reviews are completed, a "snapshot" is taken of the data in HPMA for that collection cycle and published to RIMS and Performance Viewer.

Appendix B - Risk Scoring Matrix

Risk significance is rated on a scale of 1 (lowest) to 25 (highest) and is the product of the risk consequence score (1 to 5) multiplied by the risk likelihood score (1 to 5). The following matrix provides a color scale corresponding to risk significance scores.



Appendix C - Risk Appetite

Risk appetite is defined as the amount of risk the Agency is willing to accept in the pursuit of its objectives. Management's goal is to manage risks to within the appetite where mitigation is cost- beneficial and practical. Management has set the Agency's risk appetite by risk type using scoring methodology consistent with the Risk Scoring Matrix shown in Appendix B. Risk appetites by risk type are as follows:

RISK TYPE	EXAMPLES	RISK APPETITE SCORE 1 = Minimal Risk 25 = Extreme Risk (See Scoring Matrix in Appendix B)
Safety	Employee and Public Well-Being	2
Ethical	Fraud, Abuse, Mismanagement, Conflict of Interest	2
Financial	Funding, Liquidity, Credit, Reporting	4
Strategic	Resources not Aligned, Unclear Objectives	4
Reputational	Unintentional Unwanted Headlines	4
Operational	Delays, Cost Overruns, Waste, Inefficiency	6
Regulatory	Non-Compliance	6
Legal	Lawsuits	10