D.4.2
MAINTENANCE MANAGEMENT PLAN
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER A: GENERAL INFORMATION</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.1 Purpose of Plan</td>
<td>3</td>
</tr>
<tr>
<td>A.2 Definitions</td>
<td>4</td>
</tr>
<tr>
<td>A.3 References and Standards</td>
<td>6</td>
</tr>
<tr>
<td>A.4 Systems and Procedures</td>
<td>13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHAPTER B: PLAN SPECIFIC INFORMATION</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>B.1 Roles and Responsibilities</td>
<td>14</td>
</tr>
<tr>
<td>B.2 Equipment</td>
<td>17</td>
</tr>
<tr>
<td>B.3 Plan Specific Procedures</td>
<td>18</td>
</tr>
<tr>
<td>APPENDIX 1 - Extent of Network</td>
<td>57</td>
</tr>
<tr>
<td>APPENDIX 2 - Performance Measurement</td>
<td>58</td>
</tr>
<tr>
<td>APPENDIX 3 - Example Inspection Records</td>
<td>59</td>
</tr>
<tr>
<td>APPENDIX 4 - Approach to Maintenance and Operation of ITS, TCS and BOS</td>
<td>62</td>
</tr>
</tbody>
</table>
CHAPTER A: GENERAL INFORMATION

A.1 Purpose of Plan

This Maintenance Management Plan (MMP) is consistent with the general maintenance obligations described in the Technical Provisions of the CDA and defines the process and procedures for the maintenance of the Project for the Term of the Agreement. This MMP includes performance requirements, measurement procedures, and threshold values at which maintenance is required for each physical element of the project. Inspection procedures and frequencies, and subsequent maintenance to address noted deficiencies of the physical elements are also included. The MMP identifies response times to mitigate hazards, permanently remedy, and permanently repair defects.
## A.2 Definitions

### A.2.1 MMP SPECIFIC DEFINITIONS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspections</td>
<td>Walked or driven assessments of the project road undertaken at predetermined frequencies</td>
</tr>
<tr>
<td>Testing</td>
<td>Cyclic or site specific technical measurement of the project road to ascertain, residual life, roughness, skid resistance, ride quality or specification compliance.</td>
</tr>
<tr>
<td>Paved Areas</td>
<td>Roadway, pavement, ramps, and hardened refuges and crossovers.</td>
</tr>
<tr>
<td>Drainage Asset</td>
<td>Project road infrastructure designed to manage clearance of storm water run off and prevent pollution of water courses.</td>
</tr>
<tr>
<td>Geotechnical Asset</td>
<td>Project road infrastructure of earthwork cutting or embankment between roadway and adjacent landowner boundary.</td>
</tr>
<tr>
<td>Road Restrain Systems</td>
<td>Concrete or Steel safety barriers or structural parapets designed to improve safety and safeguard vehicles accidentally departing from the roadway.</td>
</tr>
<tr>
<td>Soft Estate</td>
<td>Grassed or planted environmental asset adjacent to the roadway.</td>
</tr>
<tr>
<td>Injurious Weeds</td>
<td>Self established weed growth within the soft estate, recognized as capable of causing personal injury or irritation when handled.</td>
</tr>
</tbody>
</table>

### A.2.2 ROADWAY TECHNICAL DEFINITIONS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Roads</td>
<td>Those roadways located on the SH121 that are closed to the general public and are intended only for use by maintenance, inspection or utility traffic. These are low-type pavements constructed of gravel, grindings, or earth.</td>
</tr>
<tr>
<td>Asphalt</td>
<td>A brown to black solid material, soluble in gasoline or naphtha.</td>
</tr>
<tr>
<td>Bleeding</td>
<td>An area where the Asphalt mix is too rich, causing the Asphalt material to ooze to the surface in puddles and leaving a slick and slippery area.</td>
</tr>
<tr>
<td>Bridge</td>
<td>A structure consisting of single or multiple spans more than 20 feet in length that provides a means of transit for vehicles and/or pedestrians above the land, water surface, roadway, rail road or other obstruction.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Debris</td>
<td>Litter, rubbish, vegetation, rocks, dead animals, spilled materials, brush or other items which are not part of or which impede drainage.</td>
</tr>
<tr>
<td>Litter</td>
<td>Trash, Debris, waste, refuse, accident and construction residue.</td>
</tr>
<tr>
<td>Heave or Settle</td>
<td>Displacement of rigid type pavement by a combination of vertical and horizontal stresses due to expansion or contraction of the Subgrade. When Heave or Settlement in a concrete pavement is caused by pavement expansion from excessive heat, it is also commonly referred to as a pavement blowup.</td>
</tr>
<tr>
<td>Mainline</td>
<td>The portion of the multi-lane SH121 traveled way extending from Shoulder line to Shoulder line or from curb line to curb line.</td>
</tr>
<tr>
<td>Pothole</td>
<td>An area where a piece of pavement has broken free and been removed, leaving a hole.</td>
</tr>
<tr>
<td>Ramp</td>
<td>The portion of the traveled way that provides access between the Mainline and the local street network, extending from Shoulder line to Shoulder line or from curb line to curb line.</td>
</tr>
<tr>
<td>Raveling</td>
<td>The progressive loosening of the material in the courses of a road as aggregates separate from the Asphalt binding material.</td>
</tr>
<tr>
<td>Resurfacing</td>
<td>Placing of one or more new layers of material on an existing pavement surface.</td>
</tr>
<tr>
<td>Rutted and Shoved Pavement</td>
<td>Deformations in which the surface of the pavement has worn into longitudinal ruts due to repetitive passes of vehicle tires, or transverse corrugations due to vehicle deceleration and acceleration.</td>
</tr>
<tr>
<td>Shoulder</td>
<td>The portion of the roadway extending from edge of the Mainline or Ramp pavement to the unpaved top of earth embankment, or to the base of a barrier wall.</td>
</tr>
<tr>
<td>Subbase</td>
<td>An auxiliary course to furnish needed stability, usually due to poor Subgrade.</td>
</tr>
<tr>
<td>Subgrade</td>
<td>That portion of the roadbed on which pavement, surfacing, base, Subbase, or a layer of any other material which may be specified, is to be placed.</td>
</tr>
<tr>
<td>Wedge and Level</td>
<td>Pavement surface treatment which consists of milling off approximately 1 ¼ “ of surface and replacing it with new Asphalt surface material. This process is used to extend the life of relatively sound pavements that are beginning to show minor to moderate surface distresses.</td>
</tr>
</tbody>
</table>
A.3 References and Standards

**Technical Standards**

<table>
<thead>
<tr>
<th>Category</th>
<th>Manual/Manual Page/Manual Link</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road Maintenance Standards</td>
<td>TxDOT Maintenance Management Manual: ftp://ftp.dot.state.tx.us/pub/txdott-info/gsd/manuals/mmt.pdf</td>
<td>Section 2.2 (Definitions of Maintenance) defines standards; Section 2.3 provides guidance on developing maintenance plans; Chapter 5 defines Activities Requiring Permits</td>
</tr>
<tr>
<td></td>
<td>TxDOT Maintenance Operations Manual: ftp://ftp.dot.state.tx.us/pub/txdott-info/gsd/manuals/ope.pdf</td>
<td>Chapters 1 and 2 provide guidance on routine maintenance activities and maintenance operations for pavement and roadside; Chapters 4 and 5 detail traffic and emergency management operations; Section 2.3 details vegetation management</td>
</tr>
<tr>
<td>Pavement surface characteristics</td>
<td>TxDOT Pavement Design Manual: ftp://ftp.dot.state.tx.us/pub/txdott-info/gsd/manuals/pdm.pdf</td>
<td>Chapter 2 provides Asphalt Cement Concrete design guidelines; Chapter 3 provides Portland Cement Concrete design guidelines; includes methods for new construction, reconstruction, and rehabilitation</td>
</tr>
<tr>
<td>Road markings</td>
<td>2006 Texas MUTCD: <a href="http://www.dot.state.tx.us/trf/mutcd2006.htm">http://www.dot.state.tx.us/trf/mutcd2006.htm</a></td>
<td>Part 3 provides pavement markings standards, guidelines, and drawings</td>
</tr>
<tr>
<td>Topic</td>
<td>Reference</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------------</td>
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</tr>
<tr>
<td>Road signs, drainage, fences</td>
<td>Signs and Markings Manual: ftp://ftp.dot.state.tx.us/pub/txdotor-info/gsd/manuals/smk.pdf</td>
<td>On-line version provides TOC only; references print version to be obtained from TxDOT; Chapter 7 does provide detailed information on Guide Signs and references the Texas MUTCD</td>
</tr>
<tr>
<td></td>
<td>TxDOT Sign Crew Field Book (referenced in Book 3): Available for purchase from TxDOT or the Texas Transportation Institute</td>
<td>Provides sign placement information in a manner that coordinates regulatory, warning, and guide signs and promotes statewide consistency</td>
</tr>
<tr>
<td></td>
<td>Urban Freeway Signing and the Freeway Signing Handbook (referenced in Book 3): Available for purchase from TxDOT or the Texas Transportation Institute</td>
<td>Provides TxDOT staff and design consultants with information beyond that contained in the Texas MUTCD or the TxDOT Traffic Control Standard Sheets so that freeway signing can be designed and installed in a more uniform manner</td>
</tr>
<tr>
<td></td>
<td>2006 Texas MUTCD: <a href="http://www.dot.state.tx.us/trf/mutcd2006.htm">http://www.dot.state.tx.us/trf/mutcd2006.htm</a></td>
<td>Part 2 provides function/design characteristics and standards for signs; 2J provides specifications for toll road signing; Part 3 provides pavement markings</td>
</tr>
<tr>
<td><strong>Maintenance Management Plan</strong></td>
<td><strong>AASHTO Roadside Design Guide</strong></td>
<td>Presents information on the latest state-of-the-practice in roadside safety and procedures to determine a recommended minimum clear zone on tangent sections of roadway with variable side slopes and adjustments for horizontal curvature; focus of this guide is on safety treatments that minimize the likelihood of serious injuries when a driver runs off the road</td>
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</tr>
<tr>
<td><strong>AASHTO Green Book</strong></td>
<td>Provides sight distance requirements; use as secondary reference to the TxDOT Roadway Design Manual</td>
<td></td>
</tr>
<tr>
<td><strong>TxDOT ROW Beautification Manual:</strong> ftp://ftp.dot.state.tx.us/pub/txdot-info/gsd/manuals/bet.pdf</td>
<td>Includes standard for toll plaza lighting (Chapter 4, Section 9, Illumination).</td>
<td></td>
</tr>
<tr>
<td><strong>AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals</strong></td>
<td>Provides criteria for structural support, breakaway, and safety</td>
<td></td>
</tr>
<tr>
<td><strong>AASHTO Roadway Lighting Design Guide (referenced in Book 3): Available for purchase from AASHTO</strong></td>
<td>Provides a general overview of lighting systems and recommends minimum levels of quality</td>
<td></td>
</tr>
<tr>
<td><strong>Landscaping</strong></td>
<td><strong>TxDOT ROW Beautification Manual:</strong> ftp://ftp.dot.state.tx.us/pub/txdot-info/gsd/manuals/bet.pdf</td>
<td>Manual provides the current information and operating practices for acquisition of right of way for transportation projects, property management relating to right of way, and the highway beautification program</td>
</tr>
<tr>
<td>Section</td>
<td>Description</td>
<td>Details</td>
</tr>
<tr>
<td>---------</td>
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</tr>
<tr>
<td>AASHTO Roadside Design Guide</td>
<td>Presents information on the latest state-of-the-practice in roadside safety and procedures to determine a recommended minimum clear zone on tangent sections of roadway with variable side slopes and adjustments for horizontal curvature; focus of this guide is on safety treatments that minimize the likelihood of serious injuries when a driver runs off the road</td>
<td></td>
</tr>
<tr>
<td>Cleaning</td>
<td>Chapter 1 provides definitions and general requirements for routine, preventative, and major clean-up operations; Chapter 7 provides general procedures for emergency clean-up and haz-mat spills</td>
<td><a href="">ftp://ftp.dot.state.tx.us/pub/txdot-info/gsd/manuals/mmt.pdf</a></td>
</tr>
<tr>
<td>TxDOT ROW Manual, Books I and II</td>
<td>Referenced in CDA Book 3; various volumes of ROW Manual are available on TxDOT’s Manuals website; however, no specific volumes relating directly to surveying were found</td>
<td><a href="http://www.dot.state.tx.us/services/general_services/manuals.htm">http://www.dot.state.tx.us/services/general_services/manuals.htm</a></td>
</tr>
<tr>
<td>Hand Back Requirements for Highways</td>
<td>Specific requirements for handback are defined in Book 2A Section 19.3 Handback Requirements; Table 19.3.4-1 provides Residual Life requirements including residual life at handback, useful life at handback, inspection requirements, and residual life methodology requirements. Book 2B Section 19.3 provides and overview of these handback requirements and a summary Table of Residual Life Requirements for handback.</td>
<td><a href="http://www.fhwa.dot.gov/ppp/toc.htm">http://www.fhwa.dot.gov/ppp/toc.htm</a> (one stipulation for warranty following handback)</td>
</tr>
</tbody>
</table>
### Environmental Protection Standards / Legislation

| **Environmental Protection Standards / Legislation** | **TxDOT Environmental Manual:** ftp://ftp.dot.state.tx.us/pub/txdot-info/gsd/manuals/env.pdf (TxDOT ENV Division) | **Chapter 1 Section 2 presents information on the federal and state laws governing environmental considerations related to all projects that TxDOT has oversight responsibilities; the authorities are grouped under the following headings:**  
- Comprehensive environmental laws, regulations and policies  
- Natural resources  
- Cultural/socio-economic resources  
- Air quality  
- Hazardous materials. |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Protection Standards / Legislation</td>
<td>ASTM E-1527 Standard Practice for Environmental Assessments, Phase 1 Environmental Assessment Practices (referenced in Book 3)</td>
<td>Imposes specific educational, certification or licensing requirements, and relevant experience requirements, upon the person overseeing environmental assessment activities.</td>
</tr>
<tr>
<td>Environmental Protection Standards / Legislation</td>
<td>ASTM E-1528 Standard Practice for Environmental Assessments: Transaction Screen Process (referenced in Book 3)</td>
<td>Defines good commercial and customary practice for conducting an environmental site assessment of a parcel of commercial real estate with respect to the range of contaminants within the scope of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and petroleum products.</td>
</tr>
<tr>
<td><strong>Toll Collection</strong></td>
<td><strong>TxDOT Tolling Concept Guide:</strong> <a href="http://www.dot.state.tx.us/publications/tta/tolling_concept.pdf">http://www.dot.state.tx.us/publications/tta/tolling_concept.pdf</a></td>
<td>Two-page flyer provides general information on TxDOT’s tolling policy and initiatives.</td>
</tr>
<tr>
<td><strong>Toll Collection</strong></td>
<td>Texas House Bill 1340 Section 362: <a href="http://www.capitol.state.tx.us/tlo/78R/billtext/HB01340H.HTM">http://www.capitol.state.tx.us/tlo/78R/billtext/HB01340H.HTM</a></td>
<td>HB 1340 Section 362 provides interoperability legislation with respect to (toll) transponder technology used in (Texas).</td>
</tr>
<tr>
<td><strong>Toll Collection</strong></td>
<td>TxTag: <a href="http://www.txtag.org/">http://www.txtag.org/</a></td>
<td>Provides integrated electronic tolling capability for all Texas toll roads; one tag to be used on all toll roads in the state.</td>
</tr>
</tbody>
</table>

### Operational Standards

| **Road Availability (lane closures for maintenance)** | **2006 Texas MUTCD:** http://www.dot.state.tx.us/trf/mutcd2006.htm | **X MUTCD Part 6 provides procedures for temporary traffic control (rehabilitation, maintenance, etc.).** |
## State Obligations

**State Obligations (safety, patrolling, emergency response)**

<table>
<thead>
<tr>
<th>Procedures for Establishing Speed Zones:</th>
<th>Provides information and procedures necessary for establishing speed zones and advisory speeds on the state highway system; required to be used by the TxDOT and cities when establishing speed zones on the state highway system.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ftp://ftp.dot.state.tx.us/pub/txdot-info/gsd/manuals/zn.pdf</td>
<td>The Texas Highway Patrol works closely with the TxDOT which acts as the pass-through agency for funding from the National Highway Transportation Safety Administration (NHTSA) for federally funded Selective Traffic Enforcement Programs (STEP). Interagency agreements between the Department and TxDOT also provide funding for statewide overtime traffic enforcement, construction work zone enforcement, and ferry operation enforcement.</td>
</tr>
<tr>
<td>State Interagency Agreements with the Texas Highway Patrol</td>
<td>Chapter 7 provides guidance for emergency response for disasters and national emergencies, the federal reimbursement programs, and oil/hazardous materials spills.</td>
</tr>
<tr>
<td>TxDOT Maintenance Operations Manual Chapter 5 - Emergency Operations: ftp://ftp.dot.state.tx.us/pub/txdot-info/gsd/manuals/ope.pdf</td>
<td>Hazard Elimination (HES) Program is part of the Highway Safety Improvement Program; basic objective of the HES Program is to reduce the number and severity of crashes.</td>
</tr>
<tr>
<td>Hazard Elimination Program: ftp://ftp.dot.state.tx.us/pub/txdot-info/gsd/manuals/taa.pdf</td>
<td>Provides procedures and practices related to environmental analysis and decision-making with TxDOT project development work; provides a guide to clearing transportation projects through the National Environmental Policy Act (NEPA) process.</td>
</tr>
</tbody>
</table>

### Environmental Standards

| TxDOT Environmental Manual: ftp://ftp.dot.state.tx.us/pub/txdot-info/gsd/manuals/env.pdf (TxDOT ENV Division) | Provides procedures and practices related to environmental analysis and decision-making with TxDOT project development work; provides a guide to clearing transportation projects through the National Environmental Policy Act (NEPA) process. |
|--------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
|                          | US Army Corps of Engineers Wetlands Delineation Manual: http://www.wetlands.com/regs/tlpg02e.htm | Provides users with guidelines and methods to determine whether an area is a wetland for purposes of Section 404 of the Clean Water Act |
|                          | TxDOT’s Guidance for the Analysis and Abatement of Highway Traffic Noise: http://www.dot.state.tx.us/env/pdf/resources/TxDOTnoise96.pdf | Provides basic guidelines for performing traffic noise analyses for TxDOT highway projects and includes a discussion of the fundamentals of sound and traffic noise, the traffic noise analysis process, and associated documentation. |
| **Air Pollution**        | TxDOT Environmental Manual: ftp://ftp.dot.state.tx.us/pub/txdot-info/gsd/manuals/env.pdf (TxDOT ENV Division) | Section 4 describes roles and responsibilities related to air quality; manual details process for all related environmental documentation; Section 8 provides content details for documentation. |
|                          | TxDOT Air Quality Guidelines: http://www.dot.state.tx.us/publications/environmental_affairs/AQGuidelines0606.pdf | Provides background information on air quality issues and terminology to clarify the air quality analysis and documentation requirements for environmental documents; guidelines include sample language which can be used when developing environmental documentation. |
## Maintenance Management Plan

### TCEQ Dallas-Fort Worth Non-attainment Area:
http://www.tceq.state.tx.us/implementation/air/sip/dfw.html

Summarizes Dallas-Fort Worth’s air quality challenges, air quality plan, and control strategies; contains links to rules, agreements and State implementation Plan (SIP) revisions.

### Vegetation

Executive Memorandum on Beneficial Landscaping and the Executive Order on Invasive Species (EO 13112):
http://www.fhwa.dot.gov/environment/020399em.htm

Issued to prevent and control the introduction and spread of invasive species

Landscape and Aesthetics manual:

Provides guidance in the selection of landscape and aesthetic design criteria for highway and street project development; provides a synthesis of current information and design practices related to development of landscape and aesthetic components for different classifications of roadway facilities.

### Required Operations and Environmental Permits

Comprehensive Development Agreement, TxDOT Statewide Open-Road Toll Collection System, Section 6.4; however, Book 2A provides comprehensive permitting information:
http://www.fhwa.dot.gov/ppp/toc.htm

Table 4.1 in Book 2A lists all environmental permit requirements and the name of the coordinating agency; Chapter 6 in Book 2A describes utility adjustment requirements and procedures.

### Insurance Standards

Comprehensive Development Agreement, TxDOT Statewide Open-Road Toll Collection System, Section 9:
http://www.fhwa.dot.gov/ppp/toc.htm

Section 9 provides the insurance coverage required for all CDA development, including requirements for commercial liability insurance, workers’ compensation insurance, and other liability insurance.
A.4 System Processes

For Systems and Procedures please refer to the Quality Management Plan which includes inter alia procedures to cover the following:

- Control of quality records
- Management reviews
- Resource allocation
- Measurement of customer satisfaction
- Control of nonconforming products and services
- Internal audits
- Continual improvement

For MMP specific procedures please refer to Section B and Appendices below
CHAPTER B: PLAN SPECIFIC INFORMATION

B.1 Roles and Responsibilities

In order to ensure that the philosophies and methodologies detailed in the Project Management Plan regarding maintenance are implemented, resources are employed in two different departments: Roadway Operations and Systems.

B.1.1 Roadway Operations Department

This department is responsible for all roadway maintenance activities (routine, preventative and major renewals). The Organizational chart as well as responsibilities and minimum requirements for key employees in this area are presented below:

<table>
<thead>
<tr>
<th>Staff</th>
<th>Minimum Requirements</th>
<th>Roles/Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadway Operations</td>
<td>10 years minimum experience in maintenance, operations, design and construction of major highways. 3 years supervisory experience.</td>
<td>Supervises the work of the Maintenance Manager, highway operations control center and traffic analysis/planning. Coordinates with Construction, Design, CFO, NTTA and state, federal and local entities and authorities. Main point of contact for access to the corridor by any other entity (city, TxDOT, Utilities) Develops Audit Inspection Regime and completes the Asset Condition Score in accordance with the Project Specific CDA Section 22.4. Acts as quality control for Technical Manager design work and oversees all new construction that occurs during the O and M phase (adding lanes), contracting.</td>
</tr>
<tr>
<td>Role</td>
<td>Experience and Skills</td>
<td>Responsibilities</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Technical Manager</td>
<td>5 years minimum experience in transportation design. 3 years minimum supervisory experience. Advanced degree and Chartered status preferred.</td>
<td>Responsible for quality and delivery of the initial construction period, specification compliance and management of early operational input to design stage. Management of capital road renewal design and construction team following initial construction phase.</td>
</tr>
<tr>
<td>Maintenance Manager</td>
<td>10 years minimum experience with state DOT, toll authority, county or city maintenance programs, 5 years minimum experience in pavement repair design, drainage design, sign design, maintenance materials, emergency weather/spills prevention planning, and managing equipment fleets.</td>
<td>Demonstrated ability to know when to call in expert specialized consultant or contractor. Coordinate with all other managers on O and M team. Responsible for ensuring that all crew and patrol members are trained in environmental compliance, recognizing category defects, and appropriate procedures for emergency incident situations. Responsible for the development of all required plans, coordination with local responsible entities.</td>
</tr>
<tr>
<td>Field Patrols</td>
<td>Experience of working in a high speed road environment.</td>
<td>Roadway Patrol will be trained in identifying environmental compliance and Category 1 defects as a back up to regular inspection and in appropriate procedures for emergency incident situations.</td>
</tr>
<tr>
<td>Control Room Operators</td>
<td>5 years experience in call center work. 3 years supervisory experience. Event monitoring and Incident response.</td>
<td>Event monitoring and Incident response. Coordinates will all local emergency/ utility/ city/county/environmental entities. 24/7 operation.</td>
</tr>
<tr>
<td>Maintenance Crews, Foremen and Labor</td>
<td>3 years highway roadway maintenance experience. Experience of working in a high speed road environment.</td>
<td>Operation, supervision and reporting of routine and cyclic maintenance regimes. Operating as 4 Foremen leading crews of 2 or 3 operatives.</td>
</tr>
<tr>
<td>Roadway Public Information Rep</td>
<td>3 years experience in Customer service disciplines and communication systems</td>
<td>Role detailed further within Communications Plan</td>
</tr>
</tbody>
</table>

Note: In addition to Core Maintenance Management roles described above, incident specific roles are also detailed within the Winter Service Plan, Incident Management Plan, and Operations Management Plan.
B.1.2 Systems Department

This department is responsible for all systems maintenance activities (routine, preventative and major renewals). The Organizational Chart as well as responsibilities and minimum requirements for key employees in this area are presented below:

<table>
<thead>
<tr>
<th>Staff</th>
<th>Minimum Requirements</th>
<th>Roles/Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field systems Manager</td>
<td>5 years of experience in maintenance of ITS field systems in the transportation industry.</td>
<td>Ensuring that the response times for repair of the field systems are met through and adequate management of the available resources, including the performance of the programmed maintenance activities. Additionally, this position needs to make possible to meet the accuracy and availability levels required by TxDOT for the Toll Collection System.</td>
</tr>
<tr>
<td>Back Office Systems Manager</td>
<td>5 years of experience in operation and maintenance in back office systems in the transportation or financial industry.</td>
<td>Ensuring that the control centre is up and running on a 24/7 basis and that the information flows between the field elements, the control centre and external third parties (NTTA and other regional TMCs, basically) are permanent and fluid.</td>
</tr>
<tr>
<td>Field Systems Crews</td>
<td>3 years systems maintenance experience. Experience of working in a high speed road environment.</td>
<td>Performs the necessary field works to maintain all field equipment (Video Cameras, ETC antennas, Weather Stations, DMS, Communications...).</td>
</tr>
<tr>
<td>Hardware &amp; Software group</td>
<td>3 years of experience in database applications. IT degree preferred.</td>
<td>Give support to all the applications and hardware installed at the administration building, including the servers for ITS and TCS and everything related to the Back Office System. It's envisaged to have on board for this purpose at least two databases administrators, one GUI technician and one hardware technician.</td>
</tr>
<tr>
<td>Office IT Help Desk</td>
<td>3 years of experience in standard business applications IT support</td>
<td>Supports regular office IT queries. Acts as the Developer's extranet administrator.</td>
</tr>
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</table>
## B.2 Equipment

<table>
<thead>
<tr>
<th>Type</th>
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<tr>
<td>Supervisor’s Pick up</td>
<td>3</td>
</tr>
<tr>
<td>Standard Pick up</td>
<td>5</td>
</tr>
<tr>
<td>Anti Icing Spreader</td>
<td>7</td>
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<table>
<thead>
<tr>
<th>Type</th>
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<tbody>
<tr>
<td>Backhoe / Loader</td>
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</tr>
<tr>
<td>Crash Trucks</td>
<td>3</td>
</tr>
<tr>
<td>Arrow Signs</td>
<td>6</td>
</tr>
<tr>
<td>Sign Trailers</td>
<td>3</td>
</tr>
<tr>
<td>Mowers</td>
<td>2</td>
</tr>
</tbody>
</table>
B.3 Plan Specific Procedures

Figure 1 shows the inspection regimes and defect management process extending into defect clustering and development of reactive maintenance through experienced asset management to ensure the most appropriate and cost effective intervention levels, driving a robust program of renewal maintenance.
**B.3.1 Inspections**

Traditional practice for recording the condition of different parts of the network has included various types of inspections to achieve this with programmes of routine inspections. However, these are not the only ways of...
achieving the objectives. The following Sub-Sections describe how the application of these inspections has been successful in the past. When appropriate, specific information is provided for each Technical Area.

Inspections will audit effectiveness of routine and cyclic maintenance strategies and intervention timescales which will be programmed in accordance with TxDOT Road Maintenance Standards and TxDOT Maintenance Management Manual. Sites where increased levels of maintenance or increased frequency of maintenance visits are required will be identified through inspection and our maintenance programme adjusted accordingly.

All inspections should be co-ordinated, as fully as possible, with the inspections of items in the highway as a whole, or in the case of covers, gratings, frames and boxes with the cleaning out of highway gullies, catchpits and interceptors. Wet weather inspections should be undertaken at locations causing concern even if a dry weather inspection has been undertaken.

Inspections should be carried out with hand-held Data Collection Devices (DCD), using standard data capture programs that include check-lists setting out the various defects to be noted. The data should be downloaded into the database management system when the inspection has been completed. This system utilizes Graphical Positioning System hardware to accurately locate defects and repair instructions, whilst providing a robust audit trail of inspection regimes in defence of claims against maintenance standards.

Sample Routine Inspection forms are shown at Appendix 3.

B.3.1.1 Detailed Inspections

Detailed Inspections are generally to identify defects in all Technical Areas except structures and tunnels. For structures, General and Principal Inspections are used. Arrangements for Detailed Inspections should seek to minimise disruption to traffic whilst providing adequate access for proper inspections and maintaining a safe working environment for the inspectors.

Wherever possible, Inspections that require lane closures should be carried out when closures are in operation for other maintenance work. Where separate lane closures are necessary, inspections should be undertaken in off-peak periods and consideration given to night-time working or mobile lane closures to keep delays to road users to a minimum and reduce the risk of accidents.

Detailed Inspections for defects in and along the edges of dual 3-lane carriageways, or wider, should be carried out from the hard shoulder or grass verge/nearside lane. The condition of the carriageway surface, Delineators and Road Markings in all lanes should also be observed from the edge of the carriageway together with gullies, kerbing and edges adjacent to the nearside verge and central reservation.

Using lane closures in place for other purposes, previous experience has shown that a Detailed Inspection can be carried out from the central reserve, with the offside lane coned off. This Inspection can cover all items within and adjacent to the central reserve. Additionally, the centre and offside lanes of the carriageway, as well as the Road Markings and Delineators between the lanes, should be inspected.

The Detailed Inspection record should include details of the manner of Inspection (e.g. offside lane closure or hard shoulder), the weather conditions and any other unusual features of the inspection. Nil returns should be recorded in the database.

B.3.1.2 General Inspections

General Inspections comprise a thorough visual inspection of representative parts of structures forms part of the Long-Stop Condition assessment and are carried out at the frequencies provided in the Performance Requirement Tables. No General Inspection is necessary when a Principal Inspection is being carried out.
These inspections will be undertaken by maintenance crew foremen at no more that 2 yearly intervals on each structure and inspection data drive the maintenance renewal program. It is envisaged that these inspections will be carried out without the need for roadway occupation or traffic management.

B.3.1.3 Principal Inspections

Principal Inspections comprise a close and detailed examination of all accessible parts of structures. Principal Inspections of structures forms part of the Long-Stop Condition assessment and are carried out at the frequencies provided in the Performance Requirement Tables.

These inspections will be undertaken by maintenance crew foremen, supported by a structural engineer, at no more that 6 yearly intervals, on each structure and inspection data drive the maintenance renewal program. It is envisaged that these inspections will need roadway occupation and traffic management to carry out a more thorough structural inspection.

B.3.1.4 Special Inspections

Special Inspections comprise a close examination of a particular area or defect of special concern and are carried out as required. These inspections will be undertaken by maintenance crew foremen, supported by a structural engineer and inspection data drive the maintenance renewal program.

B.3.1.5 Weekly Safety Inspections

Safety Inspections are regular visual inspections designed to identify the presence of Category 1 defects and are carried out by 2 trained personnel operating together from a slow moving vehicle. In particular circumstances (e.g. footbridges and at complex road junctions) inspection personnel may need to proceed on foot either to confirm suspected faults or to complete the Inspection. It may be appropriate to undertake Safety Inspections at off-peak times or at night in order to minimise the traffic disruption and maximise the safety of both the inspectors and the public.

Safety Inspection data should be loaded into the management database including those showing a nil return. Safety Inspection records include details of the weather conditions, road surface condition and any unusual features of the method of inspection.

Reports and complaints received from other sources should be similarly recorded on the database and retained together with details of specific inspections and actions taken.

It is advised that Data Capture Devices are used for the collection of the condition information and the automatic transfer of the information into the records database.
B.3.1.6 Daily Safety Patrols

The function of Safety Patrols is to supplement Safety Inspections by providing a structured, more frequent surveillance of the road network to identify obvious hazards (Category 1 defects).

A Safety Patrol should normally be carried out by an inspector in a vehicle travelling slowly at prevailing traffic speeds, without disrupting the traffic flow. At particular sites it may be appropriate for Safety Patrols to be undertaken on foot.

A record should be made of all Safety Patrols undertaken, including the date, the inspector, the method, and the time that each section of the road was patrolled.

The Patrols should be at periods appropriate to the Road Category and local circumstances. At junctions it will generally be unnecessary to patrol the main carriageway and all the associated ramps, but at more complex interchanges it may be necessary to cover only some of the link roads. A schedule of the link roads and ramps to receive Safety Patrols shall be agreed with the Maintenance Manager.
B.3.2 Information Management

B.3.2.1 Records

Valuable information may be gained from records of repairs. For example, a high incidence of repairs at a location can highlight the need to consider a more widespread treatment.

A database enables trends to be examined that may indicate the need for increased maintenance funding (e.g. levels of valid claims against the Developer or the proportion of the budget spent on reactive maintenance compared with planned maintenance).

Records of assessments, planned actions and actions taken should be used for benchmarking, efficiency and legal defence. In all cases, records of inspections, defects and intended repairs, including nil returns, are essential. They are necessary to demonstrate that the Highway Authority has taken reasonable measures in maintaining the highway, in defence against any claim.

Records provide information on past performance on which future decisions may be made, evidence that acceptable standards are achieved and information for future costing. In many cases, keeping adequate records is a statutory requirement and represents verification of compliance with legal obligations for testing and maintenance. Retaining test records, up to date manuals, drawings etc. are essential requirements for effective maintenance management and the safe operation of the network. Records will be generated by different parts of the operations and maintenance organisation and procedures should be developed to make the information readily accessible.

Management procedures should ensure that records are retained in an appropriate archive for the necessary period, such that they remain secure, accessible and retrievable. The Information Management System forms part of the Quality Management System and should be used for analysis of the records collected and the production of summaries of the information at appropriate levels of detail. Statistical, logistical and financial analyses of the records enable the performance of engineering assets to be assessed. On a site-specific basis, the analyses may indicate significant trends in performance, which may be related to changes in operational and maintenance strategies, or the potential for, and timing of, equipment failures.

B.3.2.2 Testing

Specialist pavement surveys will be undertaken by a specialized testing sub consultant.

High speed road monitor and Deflection (FWD)

A traffic speed, high definition pavement video survey will be undertaken on an annual basis, throughout the network, to identify areas of pavement deformity and vertical differential between roadway slabs. Areas of identified defect will be examined further for deflection under a standard falling weight (FWD) within an extended programme of testing. Results will drive the ongoing development of the maintenance renewal program.

Skid Resistance

A locked wheel skid resistance survey (SCRM) will be undertaken on an annual basis, throughout the network, to identify areas of vehicle stopping deficiency. Results will drive the ongoing development of the maintenance renewal program.

International Roughness Index (IRI)
The IRI survey will be carried out on an annual basis, throughout the network, to identify areas of pavement irregularity to both wheel track rut depth and longitudinal ride quality. Results will drive the ongoing development of the maintenance renewal program.
B.3.3 Paved Areas

To meet the requirement for sustainable travel and accessibility and to this end one of the objectives is to provide safer and more acceptable facilities for pedestrians, cyclists and other vulnerable road users

B.3.3.1 Carriageways

Conditions that are likely to prevent the achievement of the Performance Requirements are:

B.3.3.2 All Carriageways

- Difference in level between items (such as covers, gratings, frames and boxes) and the abutting carriageway, or differential levels between different components.

- Parallel gullies and other gratings in carriageways, which have gaps parallel to the normal line of movement of pedal and motor cycles.

- Overgrown vegetation that is causing a hazard by encroaching on sight lines.

B.3.3.3 Flexible surfacing

- Localised cracking or breaking up (including edge deterioration) confined to a discrete area of the carriageway, or around a reinstated trench or patch and not associated with structural maintenance activities. This includes cracking or breaking up around ironwork, a difference in the level of a reinstated trench or patch with the surrounding carriageway and potholes.

- Depressions.

- Fretting, or loss of material from the carriageway surface, or around a reinstated trench or patch

- Open or excessive surfacing joints.

B.3.3.4 Concrete surfacing

- Spalling at joints and cracks, opening of longitudinal joints, failure of sealed cracks, vertical movement resulting in stepping at a joint or crack and also cracking.

- Dynamic movement under traffic at joints and cracks caused by lack of support from the sub-base or lack of, or ineffective, load transfer dowels or tie bars at joints. Dynamic movement may also be associated with mud pumping, the usual signs of which are muddy stains on the surface of the slab.

- Vertical movement of slabs, observed in the form of settlement of the slab.

- Crazing or scaling of surface, and a loss of texture.

- Failed repairs, such as failure of overbanding or sealed cracks.
Particular attention should be paid to potholes and other localised carriageway defects on carriageways since these may often constitute an immediate or imminent hazard. Such localised carriageway defects should be dealt with so as to protect road users and minimise user delays.

Routine and structural maintenance activities that are similar in nature should be differentiated. It is usual, before carrying out surface dressing or resurfacing, to ensure that the underlying road structure is sound. This often requires repairs to potholes, rutting, open joints, etc., that would otherwise be carried out as routine activities if no renewal work is planned.

The repair of defects reported from inspections may be absorbed into renewal works already due to be carried out in the planned maintenance programme. However, renewal works will usually be contained within the planned maintenance programme, determined on the basis of overall Facility priorities. When these schemes are deferred, routine maintenance repairs may be needed separately and at relatively short notice.
**B.3.4 Footways and cycle tracks**

Conditions that are likely to prevent the achievement of the Performance Requirements are:

**B.3.4.1 Footways and cycle tracks**

- Unevenness, including ridges, projections, sharp edges (trips), cracks and gaps. Block profiles, which include ridges, projections, sharp edges (trips) with a difference in level, cracks and gaps. Also slab rocking that creates a hazardous upstand.

- Potholes, loss of material or small areas of depression that are creating or are likely to create hazard.

- Local cracking of the asphalt surface confined to a discrete area or extensive cracking affecting the major part of a footway/cycle track. Fretting (loss of material leaving the coarse aggregate proud of the matrix or causing loss of coarse aggregate). Failed patch with adjacent cracking, loss of material from an existing area of patching, and difference in level and depressions that are creating hazard.

- Trench reinstatement and adjacent cracking, loss of material (fretting) from a reinstated trench, and difference in level, (which applies when a trench has subsided or has been left proud following reinstatement and includes ridges, projections, sharp edges (trips), cracks and gaps and also depressions. A temporary reinstatement with an upstand or depression associated with temporary reinstatement that poses a risk to users.

- Hazards such as fallen trees, unsafe signing, lighting or guarding of excavations, unsafe steps, persistent snow, ice or leaves, contaminants (such as oil) giving rise to slipping, a loose surface or encroachment by vegetation.

**B.3.4.2 Footways**

- Standing water, which restricts the footway width or is likely to cause pedestrians to use the adjacent carriageway. This is particularly a problem when the water freezes.

- Difference in levels between items (covers, gratings, frames and boxes) and abutting footway, or differential levels between different components.

**B.3.4.3 Cycle tracks**

- Standing water, which restricts the cycle track width or is likely to cause cyclists to use the adjacent carriageway. This is particularly a problem when the water freezes.

- Parallel gullies and other gratings in cycle tracks with wide gaps, parallel to the normal line of movement of pedal cycles.

- Difference in levels between items (such as covers, gratings, frames and boxes) and the abutting cycle track surface, or differential levels between different components.

- Footways include the walking surfaces of subways, underbridges, overbridges and pedestrian rights of way which are the responsibility of the Maintenance Manager and which may occasionally fall outside the Highway Boundary.

A cycle track is a paved facility available for persons with pedal cycles, with or without a right of way on foot, usually within the Highway Boundary.
Defects on footways and cycle tracks affect safety, maintenance and serviceability. Compensation claims may result from defects that have not been repaired. Therefore, a pro-active rather than a re-active approach is needed, to identify defects before they become hazardous.

Particular consideration should be given to defects, such as trips, which may constitute an immediate danger to pedestrians and/or cyclists. It should be noted that some hazards are likely to be seasonal.

Damage to the footways may be caused by vehicle over-riding, particularly at road junctions where the footway may be immediately adjacent to the carriageway edge. Consideration should then be given the provision of high strength in-situ concrete margins behind the kerb or locally at road junction radii. Alternatively, consideration should be given to carrying out an improvement scheme to alleviate the problem in which case a report and proposal for action should be made to the Maintenance Manager.

Pre-cast concrete footway slabs that have superficial cracks only should not be replaced as a routine maintenance operation unless there is a need to reset the slab because of other defects.
B.3.5  **Covers, gratings, frames and boxes**

Conditions that are likely to prevent the achievement of the Performance Requirements are:

- Covers or gratings that constitute an immediate hazard, particularly by a relative movement under load. In urban areas, rocking covers or gratings causing noise should be identified as defect with a high priority for treatment.

- Cracked or broken items which may be in danger of collapse and thus liable to cause a hazard.

- Worn covers are a hazard for pedal and motor-cycles from skidding in wet conditions.

- Missing items are likely to constitute a hazard.

Covers situated in verges that are traversed by pedestrians should not be ignored, as they may pose a hazard. It may often be difficult to decide whether a cracked or broken item is in real danger of collapse. If in doubt, should be replaced, irrespective of its position.

Defects in covers and gratings may pose particular danger to pedal and motor-cycle users. It should be remembered that occupancy of road by these road users will not always be limited to the nearside lane. The potential hazards to such users in other lanes should also be given consideration.

Rocking gratings or covers with only small movement under load may nevertheless be a nuisance in urban areas because of the intrusive noise they make. If complaints are received, they should be corrected.

When inspecting the gratings of gullies and other similar surface water catchment items, the opportunity should be taken to check that the item is functioning satisfactorily and is not partially or wholly blocked.
B.3.6 Kerbs, edgings and pre-formed channels

Conditions that are likely to prevent the achievement of the Performance Requirements are:

- Vertical and horizontal projections.
- Loose / rocking / damaged kerbs and/or damaged, edgings and pre-formed channels of all types which are creating or are likely to create a hazard or lead to loss of support or protection.
- Poor local alignment of pre-formed channels which could give rise to danger or nuisance from standing water or damage to the highway structure caused by water penetration.
- Missing kerbs, edgings and pre-formed channels of all types

Although kerbs, edgings and pre-formed channels, tend to be stable by their nature and construction specification, hazardous conditions can develop quickly when either individual kerbs, or short lengths, are damaged or moved out of alignment by heavy vehicles, or by local subsidence. Frequent damage by heavy vehicles may suggest the need for local re-alignment or a more robust treatment. Short lengths of kerb serving gullies or grips should not be overlooked.
B.3.7 Drainage

Adequate drainage facilities must be present and operate correctly to:

- Avoid the accumulation of water on the trafficked surfaces of the highway that reduces the safety of the road user.
- Adequately drain the road pavement structure to reduce maintenance liabilities and help realise the design life of the road.
- Avoid disruption to the traffic flow and caused by flooding.
- Prevent nuisance to adjoining landowners caused by flooding.
- Avoid polluted effluent, from the highway drainage facilities, being directed indiscriminately into watercourses.

Conditions that are likely to prevent the achievement of the Performance Requirements are:

- Full or partial blockage
- Standing water
- Detritus/refuse/weed growth/roots are all likely to reduce flow, damage the structure and may appear unsightly.
- Cracking/deformation/alignment of components of the drainage system adversely affecting the structural or hydraulic performance or durability of components of the system.
- Complete structural failure of components of the drainage system.
- Removal of material in the invert (scour) adversely affecting the hydraulic or structural performance or durability of components of the system.
- Removal of material in sides/banks/walls/bunds by erosion
- Complete or partial blocking of filter material.
- Displacement of surface filter material.
- Inadequate flow of water prevents self-cleaning.
- Surcharge of water not contained within the drainage system.
- Inadequate facilities for the removal of water from the balancing pond.
- Failure or incorrect operation of equipment associated with outfall regulating device pump/slunce/tidal flap/headwall/apron/penstock.
- Damage to grassed surface water channels (e.g. by vehicle overrun).
- Loose, rocking, ridges, projections, sharp edges (trips), cracks and gaps that result in an element of the linear drainage system projecting.
• Flooding of the highway, adjoining property or services caused by the inadequate provision or operation of highway drainage, or other facilities.

B.3.7.1 Piped drainage systems

Records of the condition and location of the drainage network, in a standard format will greatly assist the interpretation of the likely performance and the repair of the highway drainage network. In particular, CCTV surveys of the existing drainage network have been adopted for a comprehensive record of the type and condition of drainage facilities. Ownership of the piped drainage systems should be established and indicated on the record.

Properly designed and constructed, piped drainage systems are self-cleansing and maintenance is only necessary when a blockage or another fault occurs. Those parts of a system that often give trouble (e.g. are prone to flooding) will be known or faults can be identified from safety inspections, or reports and complaints received from other sources.

Symptoms of blockage or faults that should normally prompt further investigation include: backing up and flooding at the entry points to the piped drainage system; dry outfalls; wet areas on verges; and the presence of lush vegetation.

Methods of inspection that may be suitable include:

• Inspection of the facilities during gully, manhole, catchpit and interceptor emptying and cleansing operations

• Pulling a mandrel through the pipeline which may indicate if a pipe is broken, distorted, silted up or contains roots, but cannot be relied on to distinguish between these defects;

• Video inspections that need not be restricted to parts of the network having particular drainage problems. CCTV is currently the most informative inspection method and can be used as an inventory asset condition tool. The technique can indicate a wide range of defects (e.g. cracks, blemishes, encrustation, displaced or open joints, silt build up, debris, depressed or collapsed pipe sections, and root ingress) and may be carried out in conjunction with flushing. A library of reports and video recordings containing records for a period of 12 years may be needed to provide a comprehensive record of all the drainage facilities.

• Hand-rodding is a suitable technique for gully connections or short pipe connections where a mandrel or video inspection cannot be used. This method is not very informative but should indicate blockages and silt build up.

• Flushing of pipelines is less informative than using a mandrel but provides the best method of inspection in areas of subsidence and where the use of a mandrel is not appropriate. Flushing should be by means of high volume, low-pressure water.

• Inspections at manholes, catchpits and interceptors during or immediately following a period of prolonged rainfall can provide: measurements of the depth of water within the entries of pipes, in successive manholes, catchpits or interceptors along a drain run may indicate any blockage or fault.
Flushing under pressure is not appropriate for filter drain and fin/narrow filter drainpipes. Also, structured wall thermoplastic pipes may not withstand high jetting pressures and the structural condition of much of the highway drainage network is unknown. Where the condition of any sewer or highway drain is not known, it is recommended that the maximum pressure should not exceed 19,000psi.

B.3.7.2 Gullies, Catchpits, Grit Traps, Interceptors, Soakaways and Manholes

Experience has shown that the operation and maintenance of these items is effective if they are emptied of silt and other detritus at a frequency that is sufficient that solids do not enter the drainage system. The operation of soakaways, in particular the soakage rate, may be checked against their design for satisfactory working.

Pollution may arise from gully cleaning and the decomposition of organic material in the gully sump. Material with a high Biological Oxygen Demand (BOD), washed into a watercourse from the highway drain during periods of low base flow, can result in pollution with the consequent impact on aquatic life forms. The re-use of water from the gully sump for flushing purposes may result in the pollution of downstream watercourse systems. Particular care should be taken in respect of Health and Safety for the cleaning of large diameter deep bored soakaways.

B.3.7.3 Piped grips

The importance of piped grips should not be under-estimated. They have often been added some time after construction or re-alignment of the road, at known sensitive drainage points or as an alternative to a grip to provide safer passage along soft verges for pedestrians and equestrians. The connecting pipe is usually laid close to the surface and is therefore prone to damage. This in turn may result in a blockage. A waterlogged verge is often an indication of ineffective grips.

Methods of checking the operation of piped grips include proving, by hand rodding and/or high volume low pressure flushing, or jetting with water.

B.3.7.4 Grips

Grips need to be re-cut to maintain their function fully, at a frequency established by experience. A frequency of once each year is normally necessary and is best carried out following verge cutting. Re-cutting the grips may cause excessively deep channels across the verge and these may be a safety hazard to other users of the verge (e.g. pedestrians and equestrians). In this case conversion of the grip to a piped grip or another suitable drainage system should be considered.

B.3.7.5 Ditches

Ditches can become overgrown with vegetation, silted, blocked with debris/rubbish, or the banks may be eroded, to the extent that flow is impeded. Water in the ditch is not itself harmful unless stagnation (resulting in a health hazard) or flooding occurs, or a resulting high water table adversely affects the road or other structural foundations. Water in a ditch may be a nuisance to adjacent land users.

Cleaning out of ditches normally requires a machine excavator. Before ditch clearance is undertaken advice should be sought from specialist ecological advisers.
B.3.7.6 Filter Drains and Fin/Narrow Filter Drains

The efficiency of filter drains can be seriously impaired by the formation of a silt crust, with or without vegetation growth, on the top of the filter material, or by the accumulation of trapped silt in the lower layers. The efficiency of fin/narrow filter drains can be seriously impaired by the accumulation of trapped silt in the lower layers.

The surface condition of filter drains can be detected easily by inspection at ground level, but the deeper accumulations can only be confirmed by excavation, usually by means of trial pits. Where the filter drain performs the dual role of surface and sub-surface water collection, ponding at the surface will occur if the drains are not performing adequately. If there is no obvious surface defect, ponding will almost certainly indicate silt in the lower layer. Defects in fin/narrow filter drains are not easily detected and usually can only be confirmed by the excavation of trial pits. Pavement vibration during the passage of a heavy vehicle may indicate a water logged foundation caused by a defective fin/narrow filter drain.

It is probable that, unless there is an obvious cause for a localised defect, a length of filter drain or fin/narrow filter drain will show a consistent defect. The replacement of the filter media, by either new or cleaned existing material, will usually be carried out as part of the planned programme of maintenance works. Where alternative surface finishes have been used for filter drains, e.g. pre-coated chips, tar spray or bitumen bonded shredded tyres, an appropriate cleaning method should be chosen.

Where work is carried out on filter drains care should be taken to preserve the integrity of geotextile liners if present. Failure of fin and narrow filter drains can have a detrimental effect on the longevity of the pavement. Where the performance is not adequate, the installation of a catchpit.

B.3.7.7 Culverts

Many culverts can tolerate some silting and vegetation growth before efficiency is impaired to the point where the culvert needs clearing. Grills fitted across the ends of some culverts are however particularly prone to blockage, restricting the free flow of water through the culvert. Video inspections have been found to be suitable for determining the structural condition of culverts.

B.3.7.8 Balancing Ponds

The effectiveness of Balancing Ponds can be easily and seriously impaired. There are some common faults that have been found to significantly affect their performance:

- Blockage of the feeder pipe or ditch
- Silting in the pond causing a loss of storage capacity and an accumulation of heavy metals that may increase the risk of pollution
- Damage or erosion to the pond banks, walls or bunds
- Damage or obstruction to the pond outlet, which affects the controlled rate of discharge
- Loss or damage to vegetative treatment systems which renders pollutant removal ineffective
Pond operating systems may be quite complex and further planning is needed before maintenance starts:

- Operation and Maintenance Manuals describe procedures for the effective management of the Pond
- Balancing ponds may often become important sites for nature conservation. Prior to commencing maintenance it is advised that relevant ecological issues are addressed.
- Planned replacement of pond vegetative treatment systems (e.g. on a cyclic basis) can be planned as part of the maintenance activities.

B.3.7.9 Linear Drainage Systems

Linear drainage systems are shallow in depth and are generally at the edge of pavements, in nosings to ramps and in central reserves. These systems are prone to accumulation of silt where the flow speed is insufficient to selfclean the system. Therefore, these items may need to be emptied of silt and other detritus to avoid solids entering the drainage system. Cleaning is normally carried out by large volume, low pressure, water flushing.

Silt and other solids arising, from emptying and cleaning operations may cause pollution. Material should be disposed of in an appropriate environmentally friendly manner.

B.3.7.10 Grassed Surface Water Channels

Channels may become blocked from arisings from grass cutting of the verge. The cuttings may need to be removed around outlets and for the first 5 yards of channel upstream of the outlet. Elsewhere it is not usually necessary to remove the arisings.

Silt removal from the channel can be carried out by either water flushing or by manual or machine sweeping. Silt and other solids arising from cleaning operations may cause pollution. Material should be disposed of in an appropriate environmentally friendly manner.

Vehicle rutting may change the direction of flow of water run-off. Where extensive rutting has occurred, it may be necessary to reshape and re-seed the verge with an approved grass seed type but other options (e.g. conversion to a hardened verge) should also be considered.

B.3.7.11 Flooding

Suitable diversion routes for traffic in flood-prone areas should be established in advance and agreed with Adjacent Authorities so that a consistent system of diversions can be implemented rapidly when flooding occurs. These routes should include for the segregation of cars from vehicles with greater ground clearance that may be able to negotiate localised areas of flooding.

Monitoring of national and local weather forecasts and flood warnings can aid the initiation of preventative maintenance of drainage systems if it is considered that adverse conditions may lead to flooding or disruption of traffic.

Gullies may be blocked (e.g. by leaves) but gullies and other drainage items are often submerged and it may be difficult to confirm they are the cause of flooding. Covers may be dislodged particularly on hills where surcharging occurs. Reliable information on location and type of gullies through the availability of an up to date inventory would ease considerably the actions to undertake at the time of flooding.
Responsibilities for the maintenance and inspection of structures, drainage ditches and watercourses that interface with highway drainage systems should be established through consultation with all relevant organisations. Provision of these details to appropriate maintenance staff will aid the effective organisation of the works in advance and at the time of flooding.

Alterations or improvements to the highway drainage system may prevent carriageway flooding caused by water being shed from adjacent land. It is not appropriate in all cases just to take the matter up with the adjacent landowner and positive advance actions may be a more efficient approach to the provision of adequate drainage.
B.3.8 Geotechnical Assets

Geotechnical defect features are primarily identified as a result of routine activities, such as the identification of Category 1 defects, recording of condition of other assets, or following other reports or complaints. After making safe, the full requirements and advice for inspections, maintenance and remedial works in connection with Geotechnical Assets is undertaken. These include:

- The appointment of a Geotechnical Maintenance Liaison Engineer who will be responsible for all geotechnical matters carried out by the Developer
- Annual and Principal Inspections
- The qualifications, experience and training of the GMLE and personnel carrying out Annual and Principal inspections.
- Submitting a Geotechnical Asset Management Plan.
- Risk assessment of geotechnical features
- Certification procedures for remedial works and prevention measures.
- Advice on the maintenance of assets, including references to sources of information

Although there is a need for specialist responsibility for geotechnical matters, the merits of integrating the categorisation and certification process with those of other assets should be considered. For example, highway drainage defects are often a cause of geotechnical problems, and conversely, instability may be the cause of drainage defects. A lateral thinking approach is necessary during inspection of these items.

Principal Inspections are initially to be carried out every five years, and at a rate of at least 20% of the network per year so as to phase any necessary remedial work. Thereafter the frequency of re-inspection may be reduced or increased to reflect the risk to the network.

It is recommended that schedules of items such as ground anchoring systems and geotextiles etc. be recorded and retained, as these can be important if, during an emergency response situation (when temporary routes for emergency service personnel and vehicles, or road users themselves), are required to be created.

We will develop a list of hazards that may affect the achievement of the Performance Requirements for the Geotechnical Assets. These can be summarised as including:

- Slope instability.
- Weak and compressible strata.
- Adverse groundwater conditions.
- Scour and erosion.
- Instability and subsidence associated with dissolution features, mining and landfill.
- Attack on construction materials due to adverse ground and groundwater chemistry conditions.
- Highway drainage acting as a conduit for migration of leachate from landfill sites.
• Degradation or failure of supporting materials or structures.
• The destabilising effect of animal burrows, vegetation or the removal of vegetation.
• Changes in loading or other changes from the original design assumptions.

B.3.8.1 Failure of Geotechnical Assets

Since geotechnical defect features may also be identified as a result of routine activities, general advice on the recognition of these defect features by non-specialists is included in this Section. The identification of potential problems of cuttings and embankments is in many cases not possible from driven inspections because of vegetation and the lack of visibility of embankments from the carriageway.

Slopes at an early stage of instability, can often be recognised by bulging of the slope profile (at the bottom of the potential slip), by development of tension cracks (at the top of the potential slip) or by evidence of water seepage from incipient slip planes. The presence of lush, greener or marsh type vegetation will often serve to identify seepage areas where water is not visible on the surface. In cuttings of rock an early stage of instability might also be recognised by relative movement of blocks of rock, fallen material and fresh surfaces.

Slips are most frequently associated with clay soils, although failures in other types of material do occur. Whilst some failures, often deep-seated, occur either during or just after construction, the most frequent type of failure is at shallow depth and occurs a number of years after construction. These latter slips are usually 3 to 6 feet deep and, in some areas, constitute a considerable maintenance problem. On new embankment and cutting slopes, failure of the topsoil layer can occur if vegetation has not yet become established. Failure is usually associated with steep slopes and large thicknesses of topsoil.

Failures are more likely to occur when ground water level is high after periods of sustained rainfall and therefore most likely during the late winter, spring, or early summer periods before warm weather and associated plant growth have dried the ground out. Similarly failures may be more frequent on slopes facing west or north where there is a higher exposure to the prevailing wind direction (and rainfall) or lower plant growth respectively. Therefore particular attention should be paid to slopes during and after periods of high rainfall.

Embarkment slope failures are often detected later than failures in cuttings as the slope is below the level of the carriageway and hence less visible. Therefore particular attention should also be paid to these where possible. Drainage defects may result in excess surface run-off, scour and raised ground water levels that may cause instability. Also, distress to pavements, structures, non-vertical signs, signals, lighting columns, trees etc. may indicate instability, and those inspecting other items should report such defects.

B.3.8.2 Permanent Repair

In cases where geotechnical investigations have to be undertaken and remedial works designed and constructed, a permanent repair may take some time to complete. Therefore making safe or temporary remedies, and their monitoring, may be required.

Differentiation needs to be made between remedial measures for failed earthworks and those undertaken as preventative maintenance. Maintenance need not be ‘reactive’ (i.e. after a failure has occurred) but can be proactive. The benefits of preventative maintenance should be noted as the work may be less disruptive but more cost effective (e.g. rock ribs are cheaper and quicker to apply than the techniques used for reinstatement).
**B.3.9 Structures**

Many of the activities for Structures are minor in themselves, but failure to carry them out may lead to the deterioration of the structure, and the need for more serious and costly repair operations in the future. Generally, it is considered cost effective in whole life cost terms, to undertake timely cyclical and repair activities. These form an important component in the development of a coherent ongoing bridge management strategy. In general the structure should be maintained to a condition that gives assurance of safety and serviceability for the next 12 months unless local conditions or experience has shown more regular monitoring is required.

The cyclical activities for Structures should be regarded as those which relate to servicing rather than repair and which will usually be undertaken regularly at pre-determined intervals. Routine activities do not cover the repair or renewal of structural elements or components which have become unserviceable because of general wear and tear or have deteriorated for other reasons. Such work should be identified during the regular inspection process, and included in a planned structural maintenance programme.

A Structure Maintenance Manual should exist for all structures and should be reviewed and updated yearly. The specific requirements for the structure should be followed, along with any recommendations from the manufacturers of components used on the structure. However, manufacturer’s recommendations are often at set time intervals, rather than as a function of the duty to which the items are subjected. These may vary with time and from location to location. Therefore, with competent judgement, manufacturers’ recommendations may be varied in the light of local conditions and experience.

If there is a need to carry out frequent routine operations (e.g. drains regularly block), consideration should be given to the implementation of planned renewal maintenance works, to reduce the necessity for such frequency.

**B.3.9.1 Overbridges.**

The Developer is responsible for the maintenance of all structural elements below and including the waterproofing membrane, together with the parapet and any protective safety fence.

**B.3.9.2 Subways.**

The Developer is responsible for the maintenance of structural elements of the subway. The maintaining authority for the footway through the subway is normally responsible for all routine activities which relate to the finishings, footway surfacing and drainage and lighting. Failure to carry out regular maintenance of these items would not normally prejudice the structural integrity of the subway. However particular attention is drawn to the maintenance of drainage pumps in subways. The responsibility for such maintenance should always be clarified.

**B.3.9.3 Footbridges and cycle bridges.**

The Developer is usually responsible for all routine activities on all items on the footbridge, including those which on an overbridge would be deemed highway elements. However there may exceptionally be a special agreement with an adjacent highway authority or other party, for maintenance of the footbridge surfacing and/or lighting on the bridge. The maintenance responsibility should be clarified.
B.3.9.4 Retaining walls.

The ownership and maintenance responsibility for all retaining walls should be clarified. Where this is not the responsibility of the Maintenance Manager, the Developer should ensure that the appropriate person or organisation is aware of their responsibilities.

B.3.9.5 Cyclic Maintenance

Cyclical maintenance that may be required to meet the performance requirement is:

- Remove graffiti
- Remove undesirable vegetation, e.g. that blocks drainage, may cause structural damage or restricts access
- Remove debris, bird droppings and other detritus that blocks drainage and promotes corrosion or other deterioration
- Clear and ensure correct operation of drain holes, drainage channels and drainage systems
- Repair gap sealant to movement joints
- Check operation of flap valves and grease where required
- Check and tighten where necessary any loose nuts and bolts to expansion joints, parapet supports and gantry holding down assemblies. Replace nuts and bolts where appropriate
- Replace expansion joint gaskets where this is a specific requirement detailed in the Structure Maintenance Manual
- Remove general dirt and debris from bearings. Where appropriate, clean sliding and roller surfaces if accessible and re-grease. Follow any additional advice contained in the bearing manufacturer’s instructions in the Structure Maintenance Manual
- Ensure free flow of water through culverts
- Ensure correct operation of ancillary equipment (e.g. drainage pumps and associated sumps and pipework) and maintain certification of lifting devices
- Check (and rectify where necessary) seating of drainage gratings or covers, replace any missing or defective items
- Check, clean and replace pedestrian security measures (e.g. mirrors, handrails, non-slip surfaces)
- Check for scour damage around training works
- Check holding down assemblies
- Repair superficial defects in surface protection systems
- Ensure special finishes are clean and perform to the appropriate standards
The Structure Maintenance Manual is to contain the Routine Service Schedules.
B.3.9.6 Graffiti

The Maintenance Manager's policy is to remove obscene, blasphemous or offensive graffiti as soon as practicable after it has been observed. This graffiti is a Category 1 defect. However, discretion is required in the handling and timing of the removal of other graffiti. Where graffiti is persistent and widespread in environmentally sensitive areas, consideration can be given to alternative options, other than the frequent removal or obliteration. Possible strategies are initiatives involving local schools, stakeholder groups and the Police Authorities.

Physical measures include the use of anti-graffiti coatings, special cleaning materials, grit blasting, and the provision of alternative surfaces such as tiling, and murals. Care must be taken to ensure the compatibility of applied materials and cleaning techniques, with the structural substrate, and to avoid surface deterioration. The remedial action should not encourage further graffiti (e.g. overpainting with light coloured coatings is often seen as providing a 'new blank canvas').

B.3.9.7 Drainage

The correct operation of drains or drainage holes in a structure is essential to avoid the accumulation of water that promotes either corrosion or other deterioration. The correct operation of flap valves and other components should be checked and they should be greased where required. It is essential that weep holes and other forms of ground drain function correctly to avoid the build-up of ground water pressure and, hence, structural instability.

It is advisable to clear drainage channels after leaf fall and ensure they are working properly before the winter starts (e.g. December). Access restrictions may prevent the effective rodding of all drainage pipes and consideration should be given to the implementation of capital maintenance works to facilitate this operation.

It is advisable to clear vegetation before the growing season (e.g. April). In some areas it may be more appropriate and effective to apply a chemical spray on to the vegetation. Expert guidance on the chemicals available should be obtained.

The complexity and accessibly of below deck drainage systems will vary considerably and a maintenance interval should be agreed with the Maintenance Manager.

B.3.9.8 Cleaning

Attention should be paid to clearing debris from bearings, bearing shelves and flanges. For cleaning large expansion joints with provision for access from below the deck, low pressure water jetting should generally be used.

Bridge washing to remove contaminants is likely to be introduced for some specific bridge types. Adaptation of the specification for low pressure jetting for drains might be appropriate.
B.3.9.9 Culverts

It should be noted that many culverts can tolerate some silting and vegetation growth before efficiency is impaired to the point where the culvert should be cleared. Indeed disturbance of the natural stream bed may interfere with promoting natural conditions for fish etc. Before cleaning culverts, advice from specialist ecological advisers, may be very worthwhile.

Similarly the replacement of gap sealants is often difficult to undertake in water carrying structures. For example, the widest gaps will be found in the invert caused by longitudinal settlement and will be covered by the stream bed and water. Replacement is often only feasible during major refurbishment works.

Grills fitted across the ends of some culverts are particularly prone to blockages, restricting the free flow of water through the culvert.
B.3.10 Road Restraint Systems

Examples of aspects of condition that may affect the performance of Vehicle Restraint Systems and Pedestrian Restraint Systems are:

- Rotten wooden elements that affect the function of the Restraint System (Wooden post safety barriers must be replaced).
- Corroded metal that affects function or promotes deterioration.
- Concrete cracking, spalling or reinforcement corrosion that affects the function or promotes deterioration.
- Missing elements.
- Broken, deformed or cracked components that affect function or promote deterioration.
- Loose nuts, bolts and other components may represent a hazard or promote deterioration.
- Lack of tension - tensioned systems.
- Incorrect height.
- Excessive under growth, weeds or build up of detritus in verge or central reserve.

Site uniformity should be retained by maintaining the safety barrier system to the same physical appearance as the adjacent Systems, unless the adjacent systems are obsolete.

It is important to check for adequate and appropriate fixings and connections, such as the correct bolt types etc. Also checking the advance length of any safety barrier system provided in front of or around an obstruction is important because of the possibility that either the barrier system or obstruction might have been moved for some reason, e.g. for repair. In the process of tensioning, anchorages might need to be inspected in case they move. This can result from a change to ground conditions.

In regard to mounting height of safety barriers, the set-back distance is important (close to the carriageway, the measured height is between the carriageway surface and the beam, whereas further away from the carriageway, the measured height is between the ground surface directly beneath the barrier and the beam).

B.3.10.1 Repairs

In most cases repairs to safety barrier systems are for relatively minor vehicle impacts and comprise repairs to flattened posts and superficially damaged barriers. Although the supporting posts may be missing the barrier system remains continuous, and at approximately the correct height. Only in a few cases is the extent of the damage such that the safety barrier system is no longer continuous.
Each occurrence must be taken on its merits but, generally, damaged barrier that has the barrier lying on the ground or being no longer continuous, should be repaired immediately after the incident that has caused the damage, before the road is fully re-opened to traffic. In this case the permanent repair is carried out immediately and there is no hazard mitigation.

Consideration should therefore be given to marking central reserve safety barrier system damage by placing a single cone at the back of the hard shoulder. The risk to operatives would be greatly reduced while the safety of the road users and exposure of the Maintenance Manager to liability would be no different to the use of cones actually around the defect.
B.3.11 Road Markings and Delineators

Many road markings are used to give effect to regulatory provision; it is important that their legal status is not affected by undue wear or damage.

B.3.11.1 Road Markings

Aspects of condition that may affect the performance of Road Markings (paint or thermoplastic) and are required to be inspected are summarised as:

- Erosion
- Spread
- Discoloration and reduction in the luminance factor
- Reduction in the skid resistance of road markings
- Reduction of retro-reflective properties
- Reduction in audible or tactile characteristics when these are required

B.3.11.2 Delineators

Aspects of condition that may affect the achievement of the performance of Delineators and are required to be inspected are summarised as:

- Wear, corrosion, damage
- Loose and missing delineators and/or inserts
- Loss of or damage to retro-reflective lenses
- Sinkage
- Settlement
- Detritus on lenses
- Integrity and security of “embedded” delineator (housings)
- Loss of adhesion or breaking up of surface mounted delineators
- Misalignment with existing road markings
- Delineators that do not meet the requirements for luminous intensity
- Delineators that do not meet the requirements for reflective conspicuity.
B.3.12 Road Traffic Signs

Many signs are required to be lit and their legal status is affected if the illumination has failed. It is important that such failures are detected and rectified promptly.

Aspects of condition that may affect the performance of Road Traffic Signs are summarised as:

- Sign not visible due to dirt, graffiti, foliage or other signs and structures
- Incorrect orientation, damaged or missing
- Loss of surface/paint/legend from peeling, damage or vandalism
- Reduction in the retro-reflectivity of white sign face materials
- Degradation of coloured sign face materials
- Lamp failure, lamp on during the day, photo-electric circuit or time switch failure, electricity supply failure, no fuse, lamp dirty or output low
- Moving parts of secret and variable message signs malfunction
- Wiring deterioration, discontinuity of protective conductors, earth electrode failure, earth loop impedance failure, inadequate insulation resistance, missing drawings, condition of sealant, polarity failure, residual current device failure.
- Wiring in hazardous condition
- Access for maintenance blocked or security of the equipment breached
- Corrosion/deterioration or damage to plate, fittings, frame or post
B.3.13 Lighting

In general, lamp replacement provides safety, service and value for money. However, other aspects should be considered to ensure that overall (whole life) maintenance costs are minimised.

- Standardisation of components, where possible, should be an aim to ensure a minimum number of different components of different manufacture and types are used.
- Replacement and repair materials and equipment should have the same physical, photometric and aesthetic characteristics as existing, except where the existing is obsolete or due for replacement.
- Lights are maintained in a way that enables a continuing rapid and economic maintenance response including replacement of power factor correction capacitors.
- Lamps containing materials that can be recycled should be utilised with an aim of achieving 70% recycling. Additionally, Mercury Free Lamps should also be used where practicable.

Aspects of condition that may affect the achievement of the Performance Requirements for Lighting can be summarised as:

- Lamp failure, photoelectric circuit or time switch failure, electricity supply failure, lamp damage
- Lamp output low due to lamp being dirty, lamp ageing, voltage drop
- Lamp on during day due to photoelectric circuit or time switch failure
- Obscuring by foliage, or other signs and structures
- Incorrect orientation of the lamp due to damaged or misaligned mountings
- Wiring deterioration, discontinuity of protective conductors, earth electrode failure, earth loop impedance failure, inadequate insulation resistance, condition of sealant, polarity failure, protective current device failure, thermostat or heater failure
- Wiring in hazardous condition
- Access for maintenance blocked or security of equipment breached
- Deterioration or damage to column, brackets or other supports - corrosion, damage or missing parts that affect function or promote deterioration
B.3.13.1 Innovation

Consideration of the whole life cost of maintenance operation has been shown to lead to reduced overall costs and is the most significant aspect of improving maintenance efficiency and effectiveness and therefore best value for money. However, manufacturer development, and better specification of materials and equipment can also improve maintenance efficiency and effectiveness.

As improvements in manufacturing processes continue, these will contribute to a longer life of the Lighting Units/ Luminaires and will extend the periods between bulk changes and cyclic maintenance. The use of different wattage lamps, including lamps with an alternative light source may be considered, particularly where reductions in energy consumption and overall maintenance costs due to an increase in lamp life will lead to significant cost savings.

The equipment specification should be modified and the specification for all equipment increased to allow use of apparatus with an agreed minimum projected “whole life” which offer sustainable long term Ingress and Protection ratings, (I.P ratings), and recycling opportunities. Manufacturers should be encouraged to extend their warranties beyond the normal 12 months to the projected “whole life” of their products.
B.3.14 Soft Estate

Examples of aspects of condition that may affect the achievement of the Performance Requirements for the Soft Estate are:

- Vegetation restricting visibility along sight lines at junctions and access points and below minimum stopping distances at bends
- Vegetation obstructing the view of signs, lights, signals and marker posts
- Fire hazards
- Unsafe trees within Area Network or within falling distance of the highway boundary
- Undesired vegetation in hardened areas
- Injurious weeds
- Failure to protect named species and habitats
- Special ecological measures (e.g. deer fencing, badger tunnels and bat boxes) operate as intended
- Failure to manage planting schemes
- Failure to maintain hedgerows
- Failure to manage wetlands

B.3.14.1 Access

Access to communications equipment should be kept clear.

B.3.14.2 Trees

Trees are an important amenity feature of the roadside estate and their contribution to the environment is such that they should be retained wherever it is safe to do so. Highway trees do however have the potential to pose a threat to the safety of road users, pedestrians and to adjoining property and livestock. Any external signs of decay or deterioration should be reported for action by a qualified arboriculturist.

Arboriculturists should be employed to carry out specialist inspections and to advice on signs of ill health or damage to trees. Care should be taken to ensure the appropriate maintenance of ‘veteran trees’ (trees that are of interest biologically, aesthetically, or culturally because of their age.

Where a hedgerow or part of a hedgerow has to be removed, it should be replaced and important hedgerows, as defined by the hedgerow regulations, should be replaced as essential mitigation. In practice, replacement of an important hedgerow may be practically impossible. The removal of a section of important hedgerow should, therefore, only be considered under exceptional circumstances and subject to expert ecological assessment.
B.3.14.3 Control of Injurious Weeds

These are likely to be widespread on the highway estate. Hand pulling is not an option for these species but they can all be effectively controlled by spot treatment with selective herbicide, or in exceptional circumstances by a carefully targeted application of an appropriate contact translocated herbicide.

These problem weeds occur on the highway estate but are much more localised. A concerted programme of translocated herbicide applications can effectively control them.

The presence of injurious weeds on highway verges can put severe constraints on engineering and maintenance operations particularly any work that involves trenching or other form of excavation. Material containing injurious weeds should not be moved within a site.


**B.3.15 Sweeping and Cleaning**

On occasions it will be necessary for emergency vehicles to drive along the hard shoulder, often at speed. It has been noted that debris on the hard shoulder, particularly metal objects can cause punctures to emergency vehicles. Therefore the use of magnetic cleaning is encouraged.

To achieve the required standards of cleanliness, the response to the accumulation of litter should be in a proactive rather than a reactive way. This can achieved by a combination of programmed scavenges, as need dictates, to establish the overall cleanliness standard, and “black spot” scavenges in locations where the highway has become heavily littered as a result of other factors such as debris from vehicles or wind blown litter. If a particular source of wind blown litter can be identified then the owners should be requested to control their site more effectively and the requests should be documented.

Weed and vegetation growth that is likely to obstruct the flow of water in channels or cause structural deterioration. Reference should also be made to the requirements for items contained in other Sections (e.g. Drainage).

Aspects of condition that may affect the provision of a clean and litter free network and amenity areas are:

- Detritus, litter, refuse, carcasses, debris, arisings and other objects.
- Growth of grass or other vegetation between the channel and kerb, which is likely to obstruct the flow of water or cause structural deterioration.
B.3.16 Fences, Walls, Screens and Environmental Barriers

There is a need to maintain a record of the purpose of fences, walls, screens and environmental barriers, so that their performance can be verified. The intended design and performance requirements may be described in the original contract documentation.

Aspects of condition that may affect the achievement of the Performance Requirements for Fences, Walls, Screens and Environmental Barriers are:

- Rotten wooden elements that affects function or promotes deterioration
- Corroded metal that affects function or promotes deterioration
- Concrete cracking, spalling or reinforcement corrosion that affects the function or promotes deterioration
- Brickwork cracking, spalling or loss or mortar that affects the function
- Missing, broken, deformed or cracked components that affect function or promote deterioration
- Loose nuts, bolts and other components may represent a hazard or promote deterioration
- Lack of tension in a strained wire fence
- Too low fence or barrier (caused by subsidence or otherwise)
- Loss of paint, galvanising or other protective system
- Effects of spray and pollutants degrading colour or transparency

The appearance of Fences, Walls, Screens and Environmental Barriers is important and any repairs or replacement sections should maintain the uniformity of their appearance, unless the existing is obsolete.

In the interests of safety, Developers are expected to use discretion in carrying out minor/temporary repairs on any part of the fence added by the landowner/occupier, where such parts are found to be defective as a result of inspection, or reports from the Police or public. Serious defects should normally be reported to the landowner/occupier with a request for them to be rectified. If the repairs need to be carried out immediately, in the interests of safety, the Developer should carry out the necessary work and make a request to the landowner/occupier for reimbursement of any substantial expenditure incurred.

Fences designed for other special purposes, such as the security of goods or the protection of traffic from sporting activities, and installed by the owners on land adjoining a motorway, remain the responsibility of the landowner/occupier, and any serious defects should be drawn to the attention of the owner/occupier.

Where there is persistent vandalism and theft, consideration should be given to replacing the existing fence with a more substantial type, e.g. replace timber post & rail with palisade.
B.3.17 Building Maintenance (Admin and Maintenance Area)

The administration and maintenance areas will be inspected on a monthly basis to identify maintenance repair and improvement needs. The inspection process will be managed by the Maintenance Manager.

Whilst we recognise the management of SH121 is a 24/7 operation, building maintenance works will be programmed around peak operational periods as to cause minimal disruption.

Inspection data will drive the annual maintenance programme of both routine cyclic maintenance and capital building maintenance and improvement. This process will allow building maintenance to be budgeted on an annual basis.

A building maintenance plan will set out periodic maintenance cycles and contain detailed layout graphics highlighting positions of site boundaries, drainage outfalls, fuel storage and fuelling points, wash down areas and waste storage.

The plan will further detail:

Security Arrangements
Discharge consents
Emergency Fire Evacuation Procedures
Spillage Protection Procedure
Waste Management
De-icing material storage
Administration
Inspection and Audit Regime
**B.3.18 Information Technology Systems**

**Ordinary Maintenance**

It is the objective of the Proposer that the Concession Company shall be independent from the vendors after a prudential learning period, in terms of IT maintenance. For this purpose, all three contracts to be signed with the ITS, TCS and Back Office integrators will include as part of the scope the provision of a 2-year extended guarantee, which shall include very exigent response times together with the obligation to perform continuous training of the Developer's IT maintenance crew.

In terms of field systems (Toll Collection System and Intelligent Transportation Systems), the following personnel structure to support maintenance has been estimated:

- The foreseen ITS field maintenance team will consist of a crew of 3 technicians, that will be on duty 16 hours from Monday to Friday and 8 hours during the weekends and holidays. During the hours not covered by this schedule, a couple of technicians will be on call in case of emergencies.
- The foreseen TCS field maintenance team will consist of two crews of 3 technicians each, which will be on duty 16 hours from Monday to Friday and 8 hours during weekends and holidays, in coincidence with the peak hours of traffic. To cover the remaining 8 hours from Monday to Friday, as well as the remaining 16 hours on weekends and holidays, another 3 technician crew will be appointed on site.

Additionally, all field maintenance technicians will be supervised by the Field Systems Manager. This will allow to coordinating the repair and inspection activities between both teams, balancing personnel needs in case of unexpected peaks.

In terms of the TMC, the maintenance support will also be provided in house, through the TMC maintenance crew, which shall include four individuals during business hours which shall give support to all the applications and hardware installed at the TMC location, including the servers for ITS and TCS and everything related to the Back Office System. It’s envisaged to have on board for this purpose at least two databases administrators, one GUI technician and one hardware technician. These four positions will be coordinated by the Back Office System manager, and the five of them will be organized in on-call shifts, in case any major problem arises during out of office hours.

Both the Field Systems Manager and the Back Office Manager will directly report to the Chief Executive Officer.

**Extraordinary Maintenance**

The guidelines to estimate the intervals between major upgrades or renewals of the system have been estimated by taking into account the advice of our vendors and advisors, plus Developer’s own experience in Toll Roadways. These are the proposed major interventions in the systems:

1) Intelligent Transportation Systems: it has been estimated that most of the hardware components of the TMC will need periodical renewals every 5 years of operation. On top of these, the whole system (including field systems and TMC hardware and software components) will be completely redesigned and rebuilt every 10 years. These 10-year operations will be tendered to the market through RFPs, leading to integrated design and build contracts with the selected provider, according to the IT department standards.

2) Toll Collection Systems:
   a. Field Systems: complete renewals of these have been scheduled every 10 years. Again, these 10-year operations will be tendered to the market through RFPs, leading to integrated design and build contracts with the selected provider, according to the IT department standards.
b. Back Office System: in this case it has been estimated that hardware components will need periodical renewals every 7 years of operation, whereas complete redesign and development of the system shall take place every 15 years. Like in the two other subsystems, these major renewals shall take place under design and build contracts awarded through RFPs.

In terms of planning of all these major maintenance operations, and due to the general planning of the deployment of systems, which must be in accordance with the construction of the different segments of the road, it has been assumed that the countdown for any of these major renewals shall start after the beginning of operations of segment 4, assuming that for TCS and ITS, the deployment of the systems in segments 3 and 4 will mean an update of the systems deployed for segments 1 and 2. For the Back Office System the countdown shall start after the beginning of operations of Phase 2, since the integration of the new functionalities included in this phase shall also mean a complete update to the system, which shall extend its lifetime.

This approach is developed in further detail at Appendix 4.
**B.3.19 Renewals works**

We will implement a storage and enquiry modular program that enables the user to use from one single computing application all the characteristic highway parameters: geometry, inventory, road surface and pavement structures, auscultation (Deflections, IRI, CRT, etc.), engineering structures and works, signs and signalling, traffic, expert management of road surfaces and pavements for their conservation, actions, etc.

**Maintenance Profile**

**Pavement**

The maintenance profile is for a 7.5-year cycle of renewals, and significant investment in year 1, to bring the existing pavements up to the required standard. This is in line with TxDOT requirements that pavements should have a design life of 20 years and be overlaid every 8 years.

**Structures**

The maintenance profile for structures is based on a strong program of inspection and renewal based on previous experience and international standards. Structures maintenance is dependent on inspections and these will be undertaken on a risk management basis. The issues in determining inspection frequencies include:

- strategic importance of a route or bridge (current and projected traffic loading may be an influence);
- risk management of known defects, e.g. environmental exposure, historical rate of deterioration for specific bridge type or component, etc;
- risk management of degradation of materials;
- events, viz. floods, bushfires, earthquakes;
- traffic crashes that may have damaged a critical structural element;
- notification from the public; and,
- availability of special equipment and/or resources

No condition surveys or structural evaluations of existing structures have been. Major treatments have been developed from discussions with structural engineers and owners of existing toll roads. Particular risks were identified for structures crossing water because of the potential impact of heavy rain and floods on structural elements. In addition, there are a number of locations that could experience long-term settlement of approach fills, therefore requiring additional work.

Deterioration from salt is expected to be low because of planned low usage and sweeping. Major planned treatments to structures include:

- Replace joints and waterproofing
- Repairs to deck
- Sub structure repairs including bearings
Other Roadway Assets

Typical frequencies for replacement or renovation of other assets, such as road markings, barriers, fencing, drainage, road signs, and lighting are shown below:

<table>
<thead>
<tr>
<th>Asset</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culverts</td>
<td>10 years</td>
</tr>
<tr>
<td>Pipe desealing</td>
<td>10 years</td>
</tr>
<tr>
<td>Concrete traffic barrier</td>
<td>20 years</td>
</tr>
<tr>
<td>Road signs</td>
<td>15 years</td>
</tr>
<tr>
<td>Road markings</td>
<td>4 years</td>
</tr>
<tr>
<td>High Mast Lighting Posts (rewiring)</td>
<td>20 years</td>
</tr>
<tr>
<td>MSE Walls</td>
<td>5 years</td>
</tr>
<tr>
<td>Noise Walls</td>
<td>8 years</td>
</tr>
</tbody>
</table>

Widenings

These major interventions are driven by the traffic capacity of the road. At certain points in time the increase in traffic will reach a threshold that will trigger the need for additional lanes. The time when this takes place depends directly on the traffic forecast model.
APPENDICES: ROAD SPECIFIC APPENDICES
State Highway 121 (SH 121) is situated in North Central Texas. It is Collin County’s principal route to the Dallas-Fort Worth International Airport, as well as an essential east-west link between US 75 in McKinney and Denton County.

The Texas Department of Transportation (TxDOT) has issued a Request for Proposals to develop, design, construct, finance, operate and maintain the SH-121 Toll Road Project through a comprehensive development agreement (Concession Agreement).

The major construction activity will take place in Collin County (Segments 3 and 4). In this section of SH 121 the Developer will improve the existing SH 121 by constructing 3 + 3 main lanes between the 3 + 3 frontage roads that are currently under construction in both sides. This will affect the last 9 miles of SH 121 from Hillcrest intersection up to the interchange with US 75.

There are 7 interchanges along this section: Colt Road, Independence Parkway, FM2478 - Custer Road (Currently under construction), Alma Drive, Stacey Road, Lake Forest Drive and Watters Road. All of them have the same typology with the main lanes crossing over the secondary roads.

The second main construction site will be locate at the SH 121/US 75 five-level interchange (Segment 5). This new fully directional interchange will replace the existing one, which dates back to 1959. A careful study of the traffic detours and phasing will be necessary to demolish the existing structure, construct the new ones while maintaining the traffic flow.

The Developer will also have the obligation to provide finance, design and construct certain additional improvements, along each of the relevant sections, as well as the maintenance and renewal activities for the entire project.
APPENDIX 2

Performance and Measurement as TxDOT Attachment 11
# Weekly Safety Inspection Record

<table>
<thead>
<tr>
<th>Date of Inspection:</th>
<th>Location:</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT 1 Defects:</td>
<td>Action/ Comments:</td>
</tr>
</tbody>
</table>

**Maintenance Manager:**
## Site Inspection Record - Surfacing
(Random Surfacing)

<table>
<thead>
<tr>
<th>Arrival Time:</th>
<th>Departure Time:</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Location:</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Nature of Works:</th>
<th>Weather:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Works Inspected (Type of surfacing):</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Tick</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Correct area surfaced</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Finished area level</th>
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</table>

<table>
<thead>
<tr>
<th>No areas showing loss of material</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Edges level with existing carriageway</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Joints between new and existing good</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Ride quality acceptable</th>
</tr>
</thead>
</table>

### Notes/ Actions/ Comments:

<table>
<thead>
<tr>
<th>Maintenance Manager:</th>
<th>Date:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Works Approved/ Not Approved</th>
</tr>
</thead>
</table>
APPENDIX 4

Approach to Maintenance and Operations of ITS, TCS and BOS

INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

Traffic Management Center

Routine and Preventative Maintenance

- **Inspection / Testing Regimes for TMC Equipment** - The first line of defense against failure of the TMC equipment is a maintenance program through a capable maintenance organization, who will be required to respond to any inquires within 4 hours (phone) and 24 hours (on-site) respectively. Additionally, operations and support staff present in the TMC will be trained to perform minor spare part replacement activities. These activities will include replacement of lamps and filters for the videowall equipment. Failures of workstation consoles are very rare and are typically due to misuse of equipment. In order avoid this kind of failure, the operations staff will be trained properly.

The TMC equipment, including the video projection equipment and the computers and communications equipment related to the ATMS software will be purchased with a full manufacturer's warranty that includes on-site repair or replacement within 4 hours. The system operators and system administrators will be trained to initiate actions that may be needed within a shorter time frame, such as restarting applications, re-booting computers and minor reconfiguration necessary to work around failed equipment. The computer equipment proposed for this project will include sufficient redundancy to minimize or eliminate the need for a complete shut down of the system. A “cold standby” server is included to provide sufficient spare capacity, should there be an equipment failure that cannot be restored in less than 2 hours by on-site staff or 4 hours by warranty support. The performance of the TMC will be measured against the same requirements for the field ITS devices as detailed in the Technical Provisions for SH 121 - Attachment 11.

The operators and system administrators will conduct periodic inspections and system reviews as a part of a comprehensive back-up and disaster recovery process. The recommended back-up regime will include full weekly back-ups of all computers, including all databases. Daily incremental backups to assure that minimal data is lost in the case of system failure will compliment the weekly full back-up. The SOP for the TMC staff will require that computer and video wall maintenance meet or exceed manufacturer recommendations for preventative maintenance. In the case of device malfunction or failure, the ATMS software will allow the TMC staff to initiate maintenance trouble calls. Trouble calls will be documented and used to dispatch additional support when required.

The sensitive videowall equipment will be purchased with a preventative maintenance program that includes routine preventive maintenance visits, which will be scheduled in advance, to clean, inspect, align and adjust all systems and components to ensure all electronic systems are maintained to manufacturer standards.

The mechanical items such as workstation consoles will be inspected on a regular basis to ensure their continuous operation.

In order to provide for uninterrupted service of the videowall and the computer hardware in the TMC, the facility must address both the procedures to handle spare parts and replacement of the actual spare parts.

Both the TMC software and the computer hardware are designed for redundancy and disaster recovery.
The procedures to handle any requests for service of any of the video and computer hardware equipment will include the following steps:

- The operations staff detects a problem and places a service call to our installation vendor.
- The installation vendor opens a service ticket and contacts our assigned Field Engineer.
- The assigned Field Engineer technically familiar with our system calls the customer back within 4 hours to assess the problem and coordinate on-site support as required.
- Emergency on-site response shall be provided within 48 hours; routine issues will be scheduled.
- Upon completion of the service call, the service ticket is closed and a completed copy is provided to the customer electronically.
- Any spare parts used during the service call response will be sent to our installation vendor for replacement, so that within a short period of time (typically 1 week after sending) the number and type of spare parts will be restocked.

**Spare Parts** – While a lot of equipment could theoretically be stored on-site, our experiences have shown that this is not necessary. Our proposed maintenance contract with its short response times will include the provision and installation of non-TMC-stocked spare parts within a very short period of time. However, some equipment that is easily replaceable by properly trained staff is proposed to be stored on-site. The list of spare parts to be stored on-site includes:

- A set of 4 lamps (2 per videowall) – this provides for a complete set of lamps for each videowall. More lamps should not be stored because even stored lamps have a shelf-life.
- Two Filters (1 per videowall) – filters are being replaced when the lamps within a video projection cube is replaced. Filter will clog up after a period of time, but it is not necessary visible.
- One cooling fan – failure of this equipment is rare, but one should be on hand in case of failures. This equipment does not experience shelf-life limitations and can therefore be stored for a long time.
- One power supply – failure of this equipment is rare, but one should be on hand in case of failures. This equipment does not experience shelf-life limitations and can therefore be stored for a long time.
- One cooling fan – failure of this equipment is rare, but one should be on hand in case of failures. This equipment does not experience shelf-life limitations and can therefore be stored for a long time.
- Two workstation UPS units – our experience has shown that failure of this equipment is rare but not uncommon. Therefore, this type of replacement units will be provided on-site.
• **As-Builtons, Change Control & System Configuration Management** - As a cross-cutting system engineering activity, we will establish a Configuration Control Board (CCB) for the ITS command and control system comprised of TxDOT, DEVELOPER, and Telvent Farradyne staff to oversee and manage the changes throughout the life of the project. The CCB will be responsible for managing the changes in scope of work, cost, risk mitigation, schedule impacts, and overall information sharing with stakeholder participants. The Change Management system will begin at the same time that system design begins and will continue in place throughout the life of the project documenting and managing all changes related to revised functionality, maintenance or renewal. Software documentation, source code and other electronic materials will be managed with a very strong set of tools developed by Telelogic, including tools for requirements repository (DOORS) and configuration management (SYNERGY).

**Reactive Maintenance**

As described above, the workstation consoles and certain videowall equipment such as the projection engines of the video projection cubes are unlikely to fail and inclusion of 100% coverage in a maintenance contract will dramatically increase the price of the maintenance contract. However, should this type of equipment fail, it would be replaced within a reasonable time. Replacement of this equipment would fall under the ‘reactive maintenance program’. The procedures would be similar to the preventative maintenance, but be different in that competitive pricing will be obtained from different vendors to ensure a best pricing approach. The most advantageous equipment will be ordered, delivered and installed within a 1-2 week window.

In terms of reactive maintenance for software, backups of the software will be performed automatically every day and additionally once per week. The weekly backups are stored off-site to ensure that the system can be brought back online in a short period of time in case of a catastrophic failure such as a total destruction of the TMC in the case of fire. The duration of this recovery will naturally be dependent on replacement time for servers, workstations, and communications as well as other equipment such as workstation consoles and the videowall.

**Programmed Major Maintenance & Renewal**

The technical provisions for this project includes a requirement that all elements be maintained in such a fashion that upon the return or “hand-back” of the project to TxDOT, each element have a residual life of at least five years (some elements, such as structures, have a much longer residual life requirement). No specific requirements are given for the ITS equipment, TMC or related video wall and computer equipment. For technology products in particular, five years is a reasonable limit for residual life. Therefore, it is Telvent Farradyne’s proposal to replace all of the TMC electronics, including computers, network equipment, video wall projectors and related equipment every five (5) years. The cost projections for the ITS elements include this assumption.

The replacement effort would, of course, be coordinated with the TMC operations to minimize disruption to system monitoring and operations. The replacement of computers, etc., will also include any applicable upgrades to the ATMS software, operating system, databases, and related utility applications. This effort would fall under configuration management review and be subject to review and approval of the CCB. Once the new computer hardware and software is installed, an operational review and test will be conducted to verify that all functionality has been restored. Finally, the new system will be documented in as-builtons and system configuration documents as called for in the Configuration Management plan.
Corrective/ preventative and extraordinary software maintenance

The design will include a software maintenance plan identifying specific procedures to maintain the central software in its optimal state. Software maintenance issues will be logged into the asset management application. Critical issues would be initially handled by the on-site system administrator. If the issue is not resolved, off-site technicians would be contacted. The off-site technician has the ability to remotely log into the system and perform additional diagnosis. If a total failure were to occur, the vendor device software would be used to operate the devices until the central software is back on-line. Non critical issues will be logged and addressed in the next available software upgrade.

The software maintenance plan will also identify routine database backup procedures. These procedures will include on-site and off-site database backup storage procedures.

FIELD SYSTEMS

Routine and Preventative Maintenance

- **Inspection / Testing Regimes for TMC Equipment** - The ITS field equipment will be purchased with a full manufacturer’s warranty. After the warranty period, a field equipment maintenance contract will be enacted. The manufacturer's warranty and field equipment maintenance contract will be measured against the requirements for ITS field devices, as detailed in the SH 121 Technical Provisions - Attachment 11.

  Through normal operations, the TMC operators and supervisors will identify field equipment malfunctions and utilize the maintenance management software to track the malfunction and repair.

- **Spare Parts** - It is not necessary that a full complement of devices and equipment be stored on site. The ITS field maintenance contract will include provisions for the maintenance contractor to have spare parts on hand so contract imposed response times will be met. Smaller, easily replaced items will be stored at the TMC in limited quantities in case a situation occurs requiring a TMC staff person to make the repair.

- **Maintenance of Accurate As-Built Records, Records of Inspection and Maintenance Activities** - All ITS field infrastructure drawings will be in electronic format. All modifications to the design will be done using the same electronic basemaps. Change management procedures and software will be utilized to map and document changes. The result will be a continuous up-to-date set of drawings depicting the true location of all ITS field infrastructure elements.

  All ITS field infrastructure inspections and maintenance records will be stored and available electronically using the same maintenance management software used to track TMC equipment.

Reactive Maintenance

As described previously, an ITS field maintenance contract will be enacted covering both reactive and routine preventative maintenance requirements. The contract will include response times for critical (required response within hours of notification) and non-critical elements. Non-compliance in meeting the required response times would result in voiding the contract.
Programmed Major Maintenance, Renewals, & Capital Works

Provisions in the same ITS field maintenance contract described in section 4.3.2.3 will include routine, periodic maintenance activities. Types of routine maintenance activities include; cleaning CCTV camera lenses, inspecting cabinets and ground boxes for insect or rodent infestation, checking communications conductors are securely attached to the appropriate hardware component, checking servers and video switches for inappropriate wear, and maintaining up-to-date logs of all routine maintenance activities. All routine maintenance activities will be logged utilizing the same maintenance management software.

The lifecycle of electronic equipment is five to ten years. Also, new, innovative technology is likely to be available making the system more robust. While proper routine maintenance can extend the life of the field equipment, it is anticipated the field hardware would be replaced. A systematic approach will be utilized to program future enhancements, upgrades and system redesign. The “ITS Field Infrastructure Maintenance and Replacement Plan” will identify future system upgrades and replacement schedules allowing proper planning and programming of funds.

When system hardware has reached its design life or technology has advanced making the hardware obsolete, a complete system re-design would be required. Major upgrades or equipment replacement will be programmed well in advance. The first step in re-designing the system would be to develop a network replacement plan. This plan will identify the procedures and limitations to minimize system downtime and not disrupt TMC operations.

ITS Field Infrastructure Spare Parts List

The system support equipment recommended for this design is provided in the following tables. This list is the list of parts to be on hand. Other equipment is not necessary to keep in inventory.

CCTV Equipment
- Support Structures
- Pole Mounted Cabinet
- MPEG 4 Encoder w/Data
- Fast Ethernet Switch
- CCTV Camera
- CCTV Field Equipment

Dynamic Message Sign Equipment
- Equipment Cabinet
- DMS Back Panel
- DMS Controller
- F.O. Transceiver
- RS-232 Terminal Server

Fiber Optic Trunk
- 12 Patch Panel
- 144 Distribution Panel
- Splice Enclosures

Microwave Vehicle Detector
- Detector Unit
- RS-232 Terminal Server
- Fast Ethernet Switch
- F.O. Transceiver
ENHANCEMENTS

Routine and Preventative Maintenance

- **Inspection/testing regimes for RWIS equipment** - A detailed Acceptance Test Plan will be developed and followed when the RWIS equipment is tested. The RWIS field equipment will be purchased with a full manufacturer’s warranty. After the warranty period, a field equipment maintenance contract will be enacted. The manufacturer’s warranty and field equipment maintenance contract will be measured against the requirements for ITS field devices, as detailed in the SH 121 Technical Provisions – Attachment 11.

  Through normal operations, the TMC operators and supervisors will identify field equipment malfunctions and utilize the maintenance management software to track the malfunction and repair.

- **Spare Parts** - While a lot of equipment could theoretically be stored on-site, our experiences have shown that this is not necessary. Our proposed maintenance contract with its short response times will include the provision and installation of non-TMC-stocked spare parts within a very short period of time. However, some equipment that is easily replaceable by properly trained staff is proposed to be stored on-site.

- **As-Builts, Change Control & System Configuration Management** - The as built, change control and system configuration management for the RWIS will follow the systems engineering approach described in the ITS-TMC-TIM Technical proposal.

Reactive Maintenance
Testing and maintenance of the public traffic website application will follow the same procedures detailed for other, previously identified applications.

Programmed Major Maintenance & Renewal
Testing and maintenance of the public traffic website application will follow the same procedures detailed for other, previously identified applications.
TOLL COLLECTION SYSTEM

Toll Collection System

We include herein the maintenance tools and methodology proposed by our selected vendor, Raytheon, which shall be followed, with the necessary adaptations, even after the initial 2-year period of the vendor’s support.

Maintenance and On-line Monitoring (MOMS)

Our MOMS integrates highly automated standards-based tools to provide rich functionality and accurate performance statistics supporting cost-effective maintenance.

To guarantee we meet our service level agreements, Raytheon has developed a robust MOMS solution that combines failure detection and reporting, inventory/spare parts control, and availability tracking. It features full help desk support, but is also easily accessible with a simple browser interface for service technicians. Based on industry standards for the management of hardware and software resources from a central location, our MOMS fully complies with the Simple Networking Management Protocol (SNMP) and provides a flexible, powerful, easy-to-use solution. Figure 3.4.7-1 provides a pictorial overview of the features of the MOMS. MOMS data can be accessed remotely by TxDOT or other appropriately authorized users. This access can be controlled on a project-by-project basis.

Monitoring. The SNMP management model employs two basic entities: a Manager and an Agent. The Manager is the console through which the administrator performs management functions. Agents are the entities that interface to the actual device being managed. These objects are arranged in what is known as a virtual information database called a management information base (MIB). The MIB’s collection of information is organized hierarchically, and in the case of the Raytheon Toll Zone Controller, our MIB includes all ancillary devices such as the cameras, classifiers, readers, antennas and even the gantry lights.

Simple and extensible, SNMP allows us to easily add management functions to our existing products. The Raytheon MOMS solution is based on an off-the-shelf network monitor and the Intuit Track-IT software, combined to provide a centralized monitoring tool.
Maintenance Management Plan

Figure 3.4.7-1. Maintenance and Online Monitoring System. A common database houses all applications and data providing accessibility to field technicians via a browser interface.

A standards-based suite of tools provides automation of all aspects of Maintenance and On-line Management.

- Event
- Isolation & Diagnosis
  - Auto Correlation
  - Manual Correlation
  - Analysis
  - Troubleshooting
- Work Order Instructions
  - Auto Generated
  - Manual Instructions
  - Auto Dispatch (SMS, pager)
  - Progress monitoring
  - Auto Escalation
- Verification
- Maintenance Resolution
  - Calibration
  - Refill
  - Monitoring
  - Quality Assurance
  - FRU replace
  - Site Test
  - Site Action
  - Repair
  - Procurement
  - Shipping

SH121 Toll Project 72
The Raytheon SNMP Monitoring solution monitors MIB objects for threshold violations and faults so that alerts can be generated where necessary. Additionally, each trap that is captured through the MOMS will have its own type of monitoring profile automatically defined.

The monitoring profile dictates how SNMP traps should be processed before they arrive in the MOMS system, SNMP event messages can be restructured, event counts, alert thresholds, and alert severity can also be defined. This allows any maintenance service provider or operator to define two different levels functionality. One at the monitored component level and secondly at the MOMS level.

To support TxDOT (or a Regional Management Authority), we collaborate to identify the specific business rules or customization of those rules required. This ensures the MOMS system is tailored to the specific implementation and the tolling policy and business rules related to that implementation. This Business Rules Approach is beneficial for implementing best-practice business process flows that reduce errors and time to delivery and enable workforce optimization. In this way, we achieve optimal flexibility, and can adapt MOMS business rules and tolling policy to changing business realities.

For example, we can monitor a tolling zone for the percentage of video-only transactions, and if the level rises above a threshold send an alert to MOMS to notify the maintenance crews that a potential problem exists. After the trap is defined and the alert received at the MOMS, the system automatically generates and assigns a Work Order.

**Help Desk and Work Orders.** The Work Order is central to our MOM System and the Help Desk environment. Work Orders usually come in the form of problems, requests, questions, planned work, and unplanned work. Problems are typically interruptions in service caused by faulty hardware or software, or procedural errors. Requests are asking for help desk services such as ordering consumables, installing new equipment, logistics support and so on. Questions are queries about how to perform specific technical tasks. Planned work may include routine scheduled maintenance, while unplanned work may include installing firmware patches. All work orders have predefined parameters that include type, subtypes, classifications and priorities (i.e. type is hardware or software, subtype is the actual component, classification is whether scheduled or unscheduled or manually created, and the priority can be high, medium, or low). Further configuration allows definitions of default response times, notification times and Service Level Agreement (SLA) overrides. For example a fault from a camera component can be structured to generate a work order with a default response time of 10 minutes, requiring the technician to be notified immediately, and this work order will override normal hours of operation. Using this example, a technician can be automatically notified at 2:00 AM on Saturday if a camera goes non-operational regardless of other pre-set rules.

Notification is also configurable for each service technician. Profiles are used to determine when technicians will be notified and by what mechanism. The system can send e-mail, pager messages, and Short Message Service (SMS) messages to technicians when work orders are assigned, overdue or escalated; it sends e-mail to different end-users when work orders are completed; it can monitor an incoming mailbox, and can automatically create work orders from e-mail received from other end-users. This flexibility provides a robust work order system, though opening, investigation, solution and closure.

**Inventory.** Integrated into the Work Order is the Inventory module of the MOM System. All work orders are created against an inventory component of the system. This can be a tolling zone or any component located at that tolling zone. Through this methodology we are able to track the life of any device, from installation, repair, upgrade through end-of-life. Inventory knowledge allows us to maintain a steady supply of all parts, including consumables such as filters, light bulbs, fuses and surge-suppressors.

The inventory also provides details such as vendor names, suppliers, and maintenance contract specifics. To safeguard SLAs, we keep informed about the following attributes of each asset:

- What it is
- Where it is at any point in time
- Where it has been
Users can generate reports that list every asset, along with service tags and other details. The reports can be filtered to support maintenance activities, planning, and management reporting. The Inventory module provides an effective way to manage all inventory assets. It provides a clear picture of the toll collection system’s distributed assets.

**Purchasing.** Tied to the inventory is the Purchasing module that allows us to keep complete control of the inventory system. If a service technician were to find a component no longer serviceable, he can open a purchase order. The purchase order will be routed for management approval, after which the vendor is notified, the new component is received and entered into inventory (or escalated because the order is overdue). From there it is assigned to the active spares list or is assigned to a tolling zone location. Reports showing the status of Purchase Orders allow for easy follow-ups to ensure that materials continue to flow and do not jeopardize system availability.

**Library Services.** Completing the MOM System is a Library feature to the system. The Library module is a repository for resources, such as specialized hardware, software, equipment, books, and training materials. The Library module organizes the process of distributing information and leverages our experience and knowledge. It organizes that knowledge in such way to allow users to get the right answers the first time, every time. This encourages knowledge sharing and re-use and enables less experienced staff to use complex knowledge (of senior staff).

With the Library module, remote service technicians can easily look-up procedures for quick on-site help or research a component service manual. The Library also can follow resources so they are available for reserve, check out, and or use at an appointed time. When a user checks out an item, it is distinguished from similar assets. Specialized tools or other assets can be properly tracked. For example, the Library may include several maintenance laptops of the same model type from the same manufacturer that are used by a rotating staff. The Library shows who has what asset, how long they have had it, and when it will be returned.
**Reporting.** The MOMS allows the user to choose from dozens of predefined reports or to develop customized reports as required. The predefined reports are populated by the database and formatted using a Crystal Reports 9.0 interface. Through the reporting module, users can view and print reports or report sections. Additionally, from any of the previously discussed modules, users can access relevant, predefined reports that cover every piece of information required.

**Summary.** MOMS provides extensive monitoring and diagnostic capabilities, including displaying system and component status, alerting operations staff to significant events, providing diagnostic aids, and supporting analysis of maintenance trends. The configurable, scalable design supports efficient system expansion and evolution of tolling policy and business rules. The MOMS can be configured to monitor a single tolling location or can be scaled to monitor numerous geographically diverse tolling zone locations. Similar configurations are successfully deployed in Canada, Israel and select portions are now in use in Minnesota.
System Components and Spare Parts

A decade of toll system maintenance provides mature and proven methods that ensure availability of the parts when and where they are needed.

All Raytheon’s field components are developed with common features that support effective performance monitoring, efficient detection of faults and timely, accurate field replacement. We recognize that time to repair is a critical factor that may impact toll functions and the ability to operate within the availability requirements. Furthermore, the solution must prevent unnecessary loss of tolls (leakage) that can occur when a component fails.

Raytheon maintains contractual interfaces with key OEM suppliers, and uses these channels to ensure timely supply of replacement, refurbished, and repaired OEM parts. Our maintenance experience has provided us with historical data for repair, refurbishment and replacement lead times. In addition, our engineering and procurement departments interact with OEMs to obtain advanced knowledge of component obsolescence and determine technical roadmaps that ensure continual form-fit-function maintainability throughout the program.

Our solution for TxDOT includes providing spare FRUs (see Section 3.2) close to each of the Project Segments. Sufficient standby stock is kept local with specific FRU counts derived from historical repair lead times, quantities installed, and component MTBF data, and nevertheless includes at least one of every FRU. It is through our experience and understanding of the expected mean time between failures and our historical maintenance records that we are able to ensure that adequate spares are maintained and thus the availability, and response/resolution time performance requirements are achieved.

Our service center in Austin will house additional spare inventory that includes FRUs, SRUs, discrete components, mechanical components, and OEM parts. Here Raytheon staff disassemble, test, repair, and refurbish FRUs returned from the field maintenance. Components that require OEM repairs and refurbishment are returned to the OEMs.

Figure 3.8-1 illustrates Raytheon’s maintenance organization and flow of spare FRUs.

Figure 3.8-1. Maintenance Organization and Spare Parts. The Raytheon model for maintenance ensures pre-calibrated ‘hot’ spare parts are immediately available to local maintenance personnel.
Our years of maintenance experience have enabled us to optimize FRUs which are designed for long life and efficient replacement. Key features of our FRU inventory that enable timely and accurate field replacement include the following:

**Pre-alignment.** Each gantry device is aligned at our service center within its field enclosure such that there is never a need to perform alignment in the field. Gantry mounted devices utilize a bracket that is affixed to the gantry and has index registration pins that ensure proper and repeated accurate alignment when the device (the FRU) is attached. Field experience has demonstrated many years of service without the need to perform field alignment.

**Pre-test.** Each FRU placed in field inventory is tested in our service center to ensure proper function. In the case of cameras for example, exposure and focus is tested and set such that all cameras have identical characteristics and can thus replace any other field camera and produce consistently accurate images. Similarly, all devices are tested to a common standard that ensures identical form, fit and function throughout their service lives.

**Field-Replacement.** All our gantry mounted components are designed for over-traffic maintenance and with just one common 9/16” wrench. With the use of a lanyard, a maintainer ensures that all necessary tools and parts are prevented from falling on traffic while performing a replacement. In the field we currently perform all replacements safely over live traffic, without costly lane closures. We have never had an accident and routinely complete a replacement task within minutes.

**Connector Interfaces.** Both gantry-mounted and IRU installed devices are equipped with connector interfaces. Components that are mounted outside use military-spec potted connectors to prevent moisture intrusion. Connector interfaces reduce the time to remove and install, and eliminate wiring mistakes that might otherwise damage a FRU. Connectors, together with efficient mounting make replacement accurate and quick.

Raytheon’s Maintenance and Online Monitoring System (MOMS) is the central records base used to manage, track and report all spares levels. Using MOMS, we record all field events, generate and track work orders, and record all repairs (both reactive and proactive). From this we are able to track individual parts (FRU and SRU) such that the life of a part can be measured and monitored. We are able to order replacement parts and track records of orders placed and for new and returned-for-repair OEM units. Using data from previous programs we are able to accurately model and predict the needs for Texas projects. By applying our proven processes for Texas we will, accurately record the maintenance trends which facilitates the reporting of availability during performance audits. Using our knowledge of typical repair and supply lead times with our OEMs, we have further established service level agreements that allow sufficient time for typical repairs while maintaining a reasonable number of spares. Our experience has determined that for optimum efficiency, we maintain a level a spares equivalent to 5% of the installed equipment. Thus, we have optimized the balance necessary for toll zone availability.
Raytheon’s high levels of system performance and functional availability are achieved through our practical approach to preventative maintenance and comprehensive warranty program.

Raytheon maintains a strong track record in servicing roadside infrastructure to stringent performance levels on behalf of both private and public sector clients. The key to our success is continuous monitoring of the system through scheduled preventative maintenance, site inspections and automated processes. Long term experience has shown us that to successfully and proactively sustain the long-term health of the system, each tolling location must have advanced built in self-monitoring capabilities. In conjunction with the built-in diagnostics, the sites maintain their own internal statistical analysis of sensor performance, to ensure the proper alerts or faults are generated in a timely manner, while minimizing false alarms. This automation ensures a quick dispatch to facilitate the repair of any failed component. In addition, our proven Preventative Maintenance Program helps to ensure that the system availability remains high.

Preventative Maintenance. The Preventative Maintenance Plan objectives are based on Raytheon’s philosophy of maximizing the Buyer’s toll revenues while minimizing the costs of collecting those revenues:
1. Minimize the duration of any roadway maintenance procedures by incorporating this objective in the initial design.
2. Maximize the free flow of traffic during performance of maintenance actions by incorporating this objective during the development of maintenance procedures.
3. Provide a high level of system availability through initial design, scheduled preventative maintenance, system performance monitoring and preventative repairs that usurp predictable failures.

Raytheon recognizes that the success of any tolling system depends on high availability and high performance, and maximizing the uptime of the tolling equipment is an essential factor. Our preventative maintenance plan addresses this uptime factor by scheduling such tasks as filter replacements, camera and VDAC cleaning, and other inspections and monitoring. This approach eliminates the latent degradation of system components or functions. (E.g. camera cleaning ensures images are kept clear and readable).

When faults do occur, a well-defined process is in place to transition those faults into work orders as shown in Figure 3.12-1. Regardless of whether the work order was generated automatically by tolling zone system, manually by a technician, or a regularly scheduled preventative work order, they are all handled centrally by our Maintenance Online Monitoring System (MOMS). As soon as a work order is generated, MOMS assigns a technician to the order. Work orders are dispatched by e-mail, fax, pager, or sms, and are even accessible through a Web browser.
MOMS aligns the work order with a competency matrix and with the proximity of the technician. This ensures that the most appropriate person to fix the problem is assigned, minimizing possible downtime. The MOMS dispatch function also provides the technician with the details required to address the work order.

Raytheon’s system design minimizes disruption to the road traffic during maintenance activities by permitting replacement of components on the gantry without disrupting traffic flows. The technology and work instructions that have been proven in a decade’s use in other Raytheon tolling systems have removed the risk of disruption to road traffic from mishandling of equipment on gantries.

The engineer assesses faults with one of three outcomes:
- Fixing of the fault
- Identification of additional engineering support required
- Replacing the failed component.

Most field actions require a simple remove and replace action with a Field Replaceable Unit (FRU). Some configuration may be necessary, such as setting a site identifier, but all FRUs can be replaced within 15 minutes.

The MOMS is updated depending on these outcomes which can be done remotely by the technicians. The MOMS inventory is then updated to reflect equipment used in the repair, thereby ensuring that spares can be replenished automatically and inventory accurately tracked. The system also requires the technician to log the symptoms and diagnosis of the fault to enable further analysis of the different types of faults and possibly identify any recurring failure issues with the system.

Equipment can be rapidly and easily removed and reinstalled on the gantries. Faulty units are taken to the Raytheon workshop for repair, return to the vendor, or scrap. Through development of an extensive suite of bench tests, we can rapidly diagnose and service the toll zone components and avoid costly OEM repairs.

Further, fault escalation is built into the MOMS. Criteria, tailor made to the severity of the various incidents, dictates an automatic alerting process. This allows work orders to be escalated in stages, thus ensuring response to problems are provided swiftly and efficiently. These escalations are reviewed and recorded at monthly management meetings to ensure awareness of any requirement for remedial action or tailoring of the scheduled maintenance plan.
Maintenance Management Plan

Maintenance Management and Depot Services. Raytheon’s fault management and maintenance service can be managed from a central location. This location acts as a logistics base for the distribution of field replacement units to the strategically located Regional Service Centers for the project segments across Texas (See Figure 3.12-2). Each service center has a mix of office and storage space for spares and maintenance materials. Stores of less standard support stock are maintained in the central pool and distributed as required to the regional centers.

Raytheon’s fault management and maintenance team includes the following positions:
- Maintenance Manager, responsible for management of the overall maintenance contract
- General Support Specialist providing general infrastructure support via the helpdesk
- Technical Support Specialist, providing detailed technical support for the helpdesk
- Maintenance Supervisors, overseeing the maintenance contract at a particular regional center
- Maintenance Technicians, responsible for maintenance of the equipment.

The staff level is adjustable, to ensure the MTTR objectives are met. Our Preventative Maintenance Program ensures the Raytheon maintenance team will be available 24/7 for critical or emergency response via on-call services in addition to non-critical response during normal working hours and performance of periodic routine/preventative maintenance services during low traffic times. Raytheon continues to maintain interfaces with all hardware component suppliers to ensure that suitable hardware platforms are available and that previously deployed systems are supportable. While monitoring all components of the system for availability and obsolescence, as end-of-life notices are received from suppliers, Raytheon assesses and develops form-fit-function replacement strategies to ensure smooth migration, if necessary.

Historically, we maintain a level a spares equivalent to 5% of the installed equipment. This is not fixed for all FRUs, but is set based on MTBF, and Raytheon/OEM repair lead times. We repair our spares whenever possible, and return previously faulted (now repaired) units to the spares inventory, so that very little equipment is thrown away.

Figure 3.12-2. Maintenance Logistics. Maintenance Supervisor, overseeing the maintenance contract at a particular regional center
- Maintenance Technicians, responsible for maintenance of the equipment.
Warranty. Raytheon stands behind their products and provides a comprehensive warranty package. Since the major components used in the system have a proven track record for outstanding reliability and performance, we warrant that the hardware, workmanship, and software is fit for the purpose expected and is compliant with the technical requirements. The one year warranty provides prompt repair of defective or failed hardware items and is included as part of the maintenance package.

Transition of Maintenance Know-How. Raytheon has provided a variety of support options to its customers including full maintenance services, selected maintenance services, user maintenance training and manuals and transitioning of maintenance components. Our training uses a combination of theoretical and practical/on-the-job training supported by detailed user manuals. Raytheon user training methodology allows the operator to confidently control the day-to-day operation of the system and to recognize when the system requires maintenance actions to restore performance levels.

Raytheon has successfully transitioned the operation of routine maintenance on two large toll road systems, in Canada and Israel. Raytheon provides training that ensures the Operator's staff is qualified to assume responsibility for maintenance of the Electronic Toll Collection System and ensures a smooth transition.

Knowledgeable staff and system specialists will be used to conduct the training courses in order to impart the necessary knowledge, and to provide on-the-spot answers to trainee questions. Manuals are meticulously put together and reviewed by the system development team in order to provide ease of use and easy reference and to ensure complete maintenance coverage. Training also includes the use of the Maintenance Online Monitoring System which provides the central repository for activity and repair data. It provides the work order tracking system, inventory system and also a knowledge base which allows us to have all our procedure manuals and training material in an online format to further ensure a smooth transition. Table 3.12-I is a list of the current document set in use in Israel.

Availability Tracking. Through the MOMS analysis of the collected data, we can accurately report the system availability and further ensure that the system can sustain the desired goals. This data or analysis statistics can be audited at any time.

Moreover, we plan to audit the tolling zone systems once a year to conduct a complete functional and performance test to provide truth to our statistical data, from which we can provide a performance audit. This is achieved through the injection of controlled test scenarios. This test approach allows us to measure the system performance relative to a set of controlled vehicles. In this way the actual trips made are known, and can be accurately compared to the trips detected by the toll collection system. Once this performance measure is known, as measured under normal operational conditions, it is applied to the entire volume of traffic using the highway. In addition, this test approach verifies the ability of the tolling system, under normal operating conditions, to automatically detect transponders, read license plates and to detect and identify vehicles with a variety of anomalous conditions, such as a classification mismatch or a defective transponder. Further analysis of all system events, work orders, outages and unusual occurrences can give a clear picture of the true system functionality.
## Table 3.12-I. Maintenance Documentation Set

<table>
<thead>
<tr>
<th>Maintenance Documentation</th>
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<tbody>
<tr>
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<td>P40</td>
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<tr>
<td>P41</td>
</tr>
<tr>
<td><strong>Maintenance Documentation</strong></td>
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<tr>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>P42     Communication equipment WAN/LAN</td>
</tr>
<tr>
<td>P43     Communications - System reconfiguration and verification</td>
</tr>
<tr>
<td>P44     Communications - Subsystem Trouble Shooting</td>
</tr>
<tr>
<td>P45     TIP – Hardware Replacement</td>
</tr>
<tr>
<td>P46     TIP - System reconfiguration and verification</td>
</tr>
<tr>
<td>P47     TIP - Subsystem Trouble Shooting</td>
</tr>
<tr>
<td>P48     MOM - Hardware replacement</td>
</tr>
<tr>
<td>P49     MOM - System reconfiguration and verification</td>
</tr>
<tr>
<td>P50     MOM – Subsystem Trouble Shooting</td>
</tr>
<tr>
<td>P51     TIP - System Administration Maintenance</td>
</tr>
</tbody>
</table>
BACK-OFFICE SYSTEM

Introduction

The object of this section is the description of the support and maintenance service scheduled in order to keep the Back Office System in the best operating conditions throughout the Concession period. This support and maintenance will include the necessary service to correct errors, a daily supervision of the system as well as the necessary advice to final users, as well as the development of small updates when required. In the case of major updates or modifications of the system, the assistance of the Provider will be necessary.

Maintenance methodology

Execution of the maintenance service

The BOS maintenance service will cover 8 hours per day from Monday to Friday and an on-call service during the rest of hours of the day, plus weekends and banking holidays. The TMC operators will register and process the incidences or update petitions through an specific Web module.

To ensure an optimum tracking, it will be recommended that all the incidences are documented with, at least, the following information:

- Detailed description of the process, indicating the different steps that were followed.
- An image of the displays, if it applies
- Batch execution logs, if it applies
- Data involved in the incidence, if it applies

To begin managing an incidence related with the efficiency of the system, it will be necessary to assess, together with the description of the incidence, the statistics corresponding to the database in which the error has been found. The usage statistics of the system of the machine that is being studied as well as its technical features will also be needed. The following items are included in the statistics which will be normally required: The size of the database, the number of daily transactions, the number of concurrent users, the memory that is being used, the CPU use percentage, as well as any interesting information for the evaluation and resolution of any incidence related with efficiency.

Programmed visits

The maintenance team will programme a periodical revisions in order to provide a preventive maintenance. During these visits a complete inspection of the system will be performed.

Incidence resolution

‘Incidence’ shall mean any error in the software that makes it behave differently from what is specified in the Technical and Functional documentation.

The first step after the reception of an incidence will be to determine whether it’s an error or a petition for an update (because no error in the software is detected), and the result will be communicated to the user reporting the incidence. Updates will be developed and implemented according to the same methodology explained for the development of the application itself. In any case, the overall impact of each update will be carefully analyzed before approving it.
Incidence classification

The incidences will be treated, according to their priority based on the impact caused in the system operation. The assistance centre will classify all the reported errors according to their type and priority based on the information provided by the user reporting them. In case that there are two incidences with the same priority level at the same moment, the IT Director will be able to decide which one will be solved first.

When an incidence is solved, the user reporting it will receive a confirmation. A weekly report of the incidences solved the previous week will be prepared by the system, as well as showing the estate of the ones not solved yet. A specific procedure will determine the procedure to automatically close an incidence, in the event the user does not acknowledge the repair done.

The different types of incidences and their solving times are described herein:

Incidence types and maximum solving times

Incidence type

The priorities are referred to the resolution of software incidences.

Type A: High operational impact (HIGH PRIORITY)

The error has one of the following technical characteristics:

- The software efficiency is severely damaged because of the error
- A critical functionality is not working so there is a restricted operation.
- The software doesn't respond or it closes uncontrollably.

The presence of a high priority error means that the software works but some of its functionalities are deactivated or give erroneous results, which causes a negative impact.

Type B: Impact on some operations (MEDIUM PRIORITY)

The error has one or more of these technical features:

- Software efficiency is reduced because of the error.

The impact on the software is minor.

The presence of a medium priority error means that some functionalities are affected, but it is possible to avoid the error so that the software can be used. Although the efficiency will decrease the impact on the activities will be null.

Type C: Operational minor impact (LOW PRIORITY)

This is a software error that doesn't cause any service loss. The presence of a low priority error means that there is an anomalous behavior, but it doesn't prevent its function and there is no impact on the activities.

Maximum resolution times

<table>
<thead>
<tr>
<th>PRIORITY</th>
<th>HIGH</th>
<th>MEDIUM</th>
<th>LOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Response</td>
<td>1 Hour</td>
<td>1 Hour</td>
<td>1 Hour</td>
</tr>
<tr>
<td>Immediate Solution</td>
<td>1 day</td>
<td>3 days</td>
<td>7 days</td>
</tr>
<tr>
<td>Analysis</td>
<td>3 days</td>
<td>7 days</td>
<td>15 days</td>
</tr>
<tr>
<td>Maintenance Management Plan</td>
<td></td>
<td></td>
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<tr>
<td>-----------------------------</td>
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<td></td>
<td></td>
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<tr>
<td><strong>Permanent Solution</strong></td>
<td>7 days</td>
<td>15 days</td>
<td>30 days</td>
</tr>
</tbody>
</table>

In case that there is a high priority incidence during weekends or holidays the immediate resolution will be at eight o’clock the first labour day.