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ARAB ENGINEERING BUREAU

3 DRAINAGE

3.1 INTRODUCTION

3.1.1 General

- 1 Water is the greatest natural destructive force affecting the highway system. Therefore, drainage facilities must be maintained in normal operating conditions to ensure that they will handle the maximum flows for which they were designed.
- 2 Drainage maintenance specifications comply mainly with Qatar Road Maintenance Manual (QRMM) published by Ashghal.
- 3 The main purposes of the drainage systems constructed and maintained by PWA are:
 - (a) To properly manage and treat water that would accumulate from drainage areas created by highway construction.
 - (b) To manage water which is shed onto the highway right-of-way from adjacent drainage areas.
 - (c) Under normal circumstances, manage and route stream and channel flow and runoff safely within drainage structures as to maintain traffic flow.

4 Related Sections and parts are as follows:

- Section 6 Part 17 - Road Drainage
Section 8 Drainage works
Section 20 Drainage works for Buildings

3.1.2 References

- 1 The following manuals and standards are referred to in this Part:

Qatar Road Maintenance Manual (QRMM)	PWA
The Qatar Highway Design Manual (QHDM)	PWA
The Qatar Traffic Control Manual (QTCM)	PWA
Work Zone Traffic Management Guide (WTZMG)	PWA, July 2014
Code of Practice and Specification for Road Openings in the Highway ,PWA,1992	
ISO 14001 Environmental management systems — Requirements with guidance for use	
OHSAS 18001 Occupational Health and Safety Management	
OHSAS 18002 Guidelines for Implementation of OHSAS 18001: 2007	
ISO 55000 Asset management — Overview, principles, and terminology	
ISO 55001 Asset management — Management systems — Requirements	
ISO 55002 Asset management — Management systems — Guidelines for the application of ISO 55001	
Qatar Sewage and Drainage Design Manuals	
The Highways Agency's Design Manual for Roads and Bridges	

Culvert Repair Best Practices Specifications and Special Provisions**Federal Highway: Maintenance of Highway Edge drains****US Army Corps of Engineers**

- 2 The local documents listed above (e.g. QRMM, QHDM, QTCM) are primary documents and should be taken as the lead document. Other documents referred to in the text such as any standards from the Highways Agency Design Manual for Roads and Bridges shall be taken as guidance documents and international best practice, unless otherwise stated within the text.

3.1.3 Definitions

- 1 All definitions related to road maintenance should comply with QRMM
- (a) Apron: The end section of a culvert which is designed to channel and contain water flow from upstream to downstream.
 - (b) Culvert: A structure constructed entirely below the elevation of the roadway surface and not a part of the roadway surface, which provides an opening under the roadway for the passage of water or traffic. A culvert is any structure not classified as a bridge which provides an opening under a roadway.
 - (c) Ditch: A depression, natural or man-made, that is normally used to channel water.
 - (d) Drainage Tile: Pipe that is usually underground that conveys runoff primarily from agricultural lands. The location of pipe is typically less than six feet from the existing ground surface.
 - (e) Drainage Facility: Drainage facilities include cattle passes, shoulder drains, under drains, contour ditches, collection ditches, side ditches, off-take ditches, culverts, storm drains, and catch basins.
 - (f) Edge Drain: A drainage inlet consisting of an opening in the roadway gutter area.
 - (g) Easement: A right acquired by public authority to use or control property for a designated highway purpose.
 - (h) Gutter: That portion of the roadway section adjacent to the curb which is utilized to convey storm water runoff.
 - (i) Inlet: The term "inlet" refers to all types of inlets such as apron inlets, grate inlets, curb inlets, catch basins and slotted inlets.
 - (j) Manhole: Structure that is included in a storm drain system to provide access to storm drain pipes for inspection and cleanout. Manhole structures are the same as inlet structures except for the castings and cover. Manhole structures are also referred to as access holes.
 - (k) Structural Pollution Control Device: A device, usually man-made or engineered for the specific purpose of filtering or treating urbanized storm runoff. These devices are typically found within man-made ponds, basins or depressed areas and can be above ground or underground.
 - (l) Wetlands: Transitional lands between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. In general terms, the land within the wetland is saturated for a minimum period of 14 days every other year during the growing season.

3.2 INSPECTION OF DRAINAGE FACILITIES

- 1 The contractor should be able to perform drainage structure and culvert inspections. Items that are inspected shall include:
 - (a) Pipe
 - (b) Structures (catch basins, manholes, drop inlets)
 - (c) Special Structures (i.e. aprons, weirs, special storm and hydraulic management devices)
 - (d) Structural Pollution Control Devices (settler, skimmer, filter, underground storm water treatment devices)
 - (e) Ditches
- 2 Enterprise Asset Management System (EAMS) shall be established as the primary data clearing house for culvert and storm structure inspection data.
- 3 EAMS includes IBM Maximo, Microsoft CRMS, ORACLE, SCADA, QPRO and ESRI GIS each function is explained in QRMM.
- 4 Inspection log (MAXIMO) allows personnel to record inspections, access data, schedule cleanings and maintenance for culverts and other storm drainage structures and contains a recommended inspection cycle.
- 5 Inspection log shall be tied to a Geographic Information System database, where physical location of identified structures is linked to a map. The database combined with the map can be accessed by field personnel, hydraulic engineers, and maintenance professionals.

3.3 OVERVIEW OF DRAINAGE SYSTEM MAINTENANCE OPERATIONS

3.3.1 CULVERTS

- 1 Culvert Cleaning :Culverts are checked either visually or with a remote camera, if available for typical field camera setup), for any obstructions that may restrict the free flow of water. Debris and silt (sediment) deposits should be removed as necessary.
- 2 When culverts cannot be cleaned by hand or machine methods, flushing with water may do the job. In most cases, it is only necessary to remove sufficient material to expose the original flow line and allow the natural flow of water to remove the remaining material.
- 3 Culvert Markers : Culvert Markers are a standard installation practice where markers are placed at centerline culvert locations. Marker posts are generally placed at the extreme end of the culvert.
- 4 Missing markers are flagged and are scheduled to be (re)placed as soon as possible.
- 5 Riprap : Riprap is inspected for unusual erosion or scour around or under a culvert. Replacement riprap can be hand-placed or random, either with sorted field stone or other durable material.
- 6 Riprap is inspected for unusual erosion or scour around or under a culvert. Replacement riprap can be hand-placed or random, either with sorted field stone or other durable material.

- 7 Concrete Animal Pass : Camel or Cattle passes should be checked for appropriate culvert marking. It is policy to remove only the dirt and debris washed into these structures due to inadequate drainage.
- 8 All other deposits should be removed in collaboration with the property owner.
- 9 Culvert Joint Repair : Typical joint repairs involve tying the two adjacent pipe joints in accordance with section 30.1
- 10 Major Culvert Repairs : Major culvert repairs are required for issues such as cracked or broken out concrete and severely deteriorated pipes.
- 11 The Engineer should be contacted prior to performing major repairs/replacing any centerline culverts since adjacent land development, drainage area characteristics and flow amounts may have changed since the original culvert installation.
- 12 Typical repair procedures may include:
 - (a) Slip-Lining, where a culvert of slightly smaller size is inserted into the damaged culvert. Once inserted, cement grout is placed between the old and new culverts to seal it off against water intrusion and provide support for the liner. Where access is permitted, cracks and small damaged areas may not need to be repaired until the reinforcing steel is exposed unless the damage may create more problems.
 - (b) Culvert Reconstruction generally is for concrete pipes of greater diameters where the interior of the pipe is accessible. Exposed reinforcing steel should be cleaned to solid concrete and then patched with concrete or other suitable material. It is generally impractical to patch metal culverts. These should be replaced if the cross section is sufficiently reduced to impede required water flow or if it is showing substantial section loss which could ultimately affect the integrity of the overlying road bed.

3.3.2 MANHOLE OR CATCH BASIN CLEANING

- 1 Catch basins and manholes are checked for damage and/or debris build-up. When these structures require cleaning, the grate casting and pipe inlet should be cleaned of all debris or obstructions so as to maintain hydraulic capacity.
- 2 Debris removed from the structure should be disposed of in a manner that will not create a nuisance and be in accordance with applicable laws. Debris capture bags and "balloons" to seal off pipe flows may need to be employed during manhole repair or cleaning.

3.3.3 MANHOLE OR CATCH BASIN COVER REPLACEMENT

- 1 Grates or manhole covers are inspected for damage at the same time they are inspected for cleanout.
- 2 The covers are considered in satisfactory condition if the seat is clean and free from pebbles or dirt which would cause the cover to move and become a hazard to pedestrians or vehicular traffic.
- 3 If the grate or cover is broken or damaged, it is flagged for repair or upgrade. Catch basin grates shall be installed at the proper angle in relation to the flow of water in the gutter.

3.3.4 ADJUSTMENT AND RECONSTRUCTION OF MANHOLES OR CATCH BASIN STRUCTURES

- 1 Manholes and catch basin structures are inspected for significant deterioration.
- 2 Catch basins located in the traveled area of the road surface are programmed to be adjusted when settlement becomes potentially hazardous to traffic or roadway safety.
- 3 Catch basins or manholes are typically raised by adding brick and mortar masonry and reset using pre-cast concrete adjusting rings.
- 4 Significant deterioration or settlement of the unit requires it to be reconstructed.

3.3.5 DRAINAGE TILES AND INSPECTION TEES

- 1 Blocked or damaged tile, drop inlets or inspection tees located within the right-of-way should be scheduled for repair or replacements.
- 2 Before making repairs, it should be determined why the structure failed, and the necessary corrections should be made during the repair work. If a tile failure is under or through the road bed area, it may be necessary to block off drainage at the inslopes and bore or jack a new tile line or pipe.

3.3.6 MAINTENANCE OF HIGHWAY EDGE DRAINS

- 1 Maintenance of edge drains is required to keep pavement subsurface drainage open so that the pavement structure will drain. Proper subsurface drainage is recognized as a major factor in extending pavement life.
- 2 Subsurface drainage typically consists of perforated pipe placed in a highly permeable layer of granular material where high groundwater or seepage inflow occurs.
- 3 Vegetative growth around pipe outlets, rodent nests, mowing clippings, sediment collected at end screens and crushing of the drain outlet are common maintenance problems.
- 4 Edge drains should be periodically checked for missing rodent screens, nests, roadside debris, sediment build-up, crushed outlets, and excessive vegetation at the outlet. Roadside mowing operations should ensure that edge drains are not damaged or blocked with grass clippings, etc.

3.3.7 PERFORATED PIPE

- 1 In general, most perforated steel pipe will not fail structurally unless most of the invert, or flow line area, is completely rusted out. Perforated pipe should be cleaned, with replacement of new pipe being done only when structural failure appears imminent.
- 2 Replacement should not be undertaken without checking whether a change in material or pipe size is required and whether the pipe is scheduled for replacement under an upgrading project.

3.3.8 CURB AND GUTTER

- 1 Gutters are typically kept free of all debris so that the water may flow unimpeded to the nearest drainage structure. As a general best management practice, maintenance crews sweep to clean gutters in the spring to remove accumulations of winter sand and debris. Grates within curb and gutters, if present, are evaluated to ensure grate openings are of proper size and orientation in the interests of bicycle and pedestrian safety.
- 2 Damaged or deteriorated areas of curb and gutter are scheduled for repair within Maximo when drainage or bicyclist and pedestrian safety has been seriously affected.

3.3.9 ELECTRIC WATER PUMPS

- 1 Automatic pumps, sumps and pipe at underpass structures or depressed sections of highway should be kept in good operating condition. Each installation should be inspected periodically.
- 2 Inspection should include electrical gear, control levels, ventilation and drainage system. In the case of a malfunction, the Area Maintenance Engineer should be notified.

3.3.10 DRAINAGE DITCHES

- 1 Drainage ditches are constructed along and parallel to a trunk highway or as off-take ditches to carry water away from the highway. Drainage ditches are monitored to ensure sufficient hydraulic capacity.
- 2 If vegetation, brush or debris compromise hydraulic capacity, the ditches are scheduled for cleaning. Care should be taken not to excavate beyond the original dimensions and grade of the ditch. Some ditches may have special features such as clay lining that should not be removed. Measures to perform the cleanings follow weed and brush control guidelines
- 3 If substantial erosion or large washouts are observed or appear imminent, Maintenance staff will consult with the District Hydraulics Engineer to schedule and provide ditch repair procedures.

3.3.11 DRAINAGE FACILITY REPAIR ENVIRONMENTAL GUIDANCE

- 1 Drainage facility repairs have the potential to impact adjacent water bodies so care should be taken in conducting repairs and restoring the site.
- 2 Maintenance staff should consult with the Engineer before performing repair or maintenance operations that involve land disturbance. Any permitting that is required should be placed within the HYDINFRA database for future reference.
- 3 Ditch repairs or stormwater facility repairs are potentially subject to additional environmental review by state and national agencies. The following agencies may have permitting authority depending on location and scope of work.
- 4 Work within a majority of these drainage facilities may be subject to the Occupational Safety and Health Administration (OSHA) "Confined Space" requirements. Before repairs are scheduled, the repair crew should obtain the required permit(s) as part of their normal work activities.

END OF PART