City of Amarillo

Playa Maintenance Manual

November 2013

ALAN PLUMMER ASSOCIATES, INC.
ENVIRONMENTAL ENGINEERS AND SCIENTISTS

TBPE Registration No. 13

BRANDT ENGINEERS®
TBPE Registration No.4174

City of Amarillo

Playa Maintenance Manual

November 2013

STATE OF TEXAS
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1. Introduction

The City of Amarillo and the Texas Department of Transportation operate the City of Amarillo's Municipal Separate Storm Sewer System (MS4), which discharges storm water to various playas, man-made reservoirs, and tributaries that eventually reach the Canadian River above Lake Meredith in Segment 0103 of the Canadian River Basin. Current estimates are that the MS4 serves approximately 40 percent of the area within the city limits, or about 25,661 acres.

In conjunction with the City of Amarillo, Alan Plummer Associates, Inc. (APAI) developed this document to guide the city's efforts in maintaining the hydraulic capacity, water quality, and aesthetics of the storm water facilities, with a focus on areas that drain to playas.

1.1. Playas

Most of the regulated storm water runoff drains to playas located throughout the city. A playa is a relatively shallow, ephemeral lake located at the low point of a drainage basin. Playas do not have natural drainage outlets, and water only leaves a playa by evaporation, by transpiration, by infiltration into the soil, by overflowing into another drainage basin, or by pumping to another drainage basin. Therefore, playas serve as terminal storage for much of the city's storm water. Twenty-nine major playas function as part of the city's MS4 (Table 1-1). The surface areas of the playas range from a few acres to over 100 acres.

Although playas only comprise about 2 to 5 percent of the western prairie landscape, they are responsible for about 85 to 90 percent of the recharge of the Ogallala Aquifer (Ref. 1). Playas are lined with clay soils. When a playa is dry, deep cracks form in the clay bottom. During initial stages of storm water runoff, water drains through the cracks in the playa floor and through fissures in the caprock layer, ultimately reaching the Ogallala Aquifer (Refs. 1 and 2). As the clay bottom of the playa becomes saturated, it swells, closing the cracks and significantly slowing aquifer recharge. After the cracks are closed, recharge continues to occur along the playa perimeter where the clay layer is thin or non-existent (Ref. 2).

1.2. Storm Water Conveyance Facilities

Facilities that convey storm water to and from playas include inlets, pipes, outfalls, open channels, and pumps. The system contains more than 3,300 inlets, more than 180 miles of pipes and culverts, and 15 miles of open channels (Ref. 3).

Inlets

Storm water enters the storm sewer pipe network through inlets. Inlet types include curb opening inlets, grate inlets, combination inlets, and slotted inlets (Figure 1-1). Inlets are typically installed in street gutters or drainage area low points.

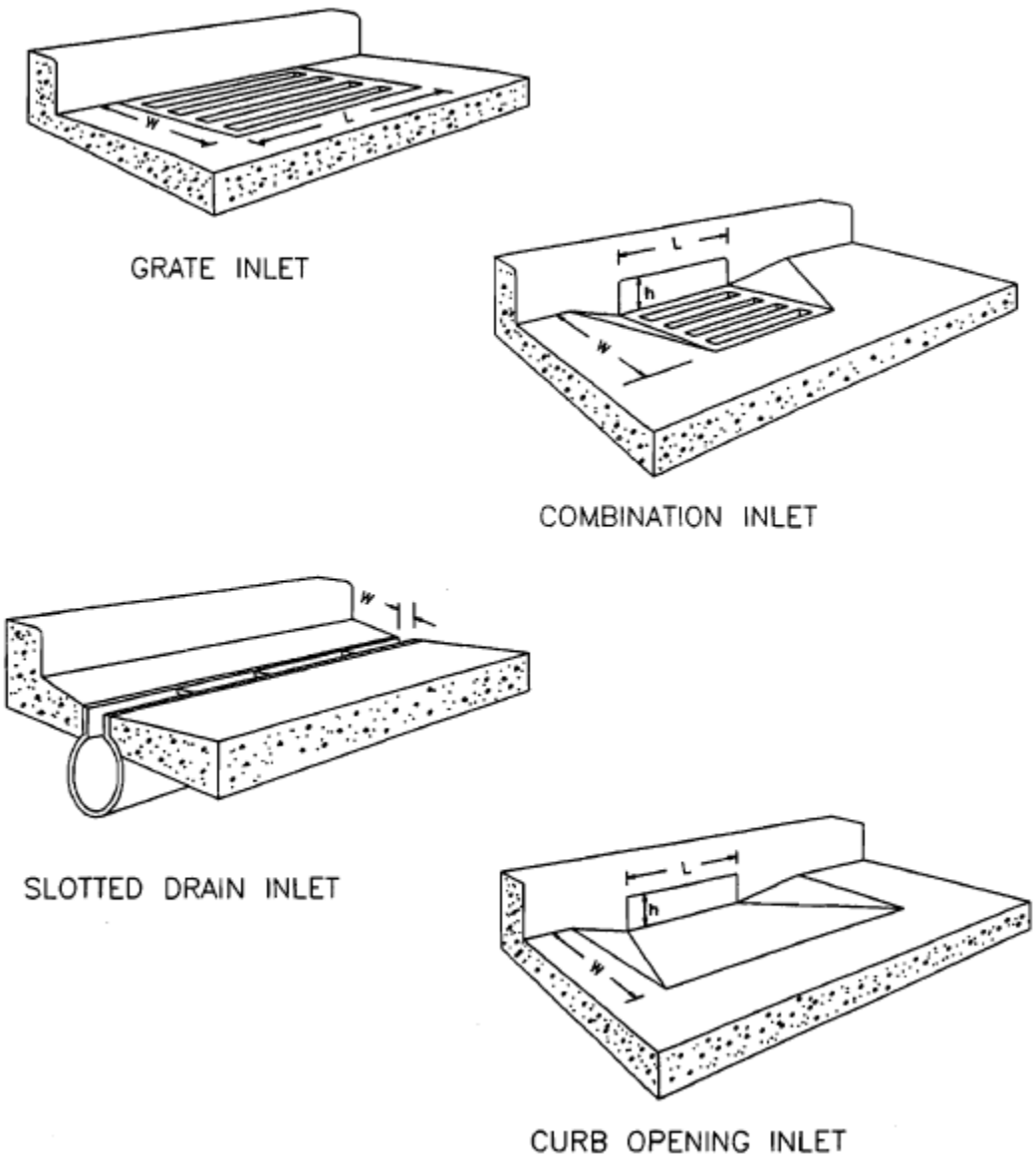
Table 1-1: Playa Lakes of the MS4

	Playa #	Name	Location	Inside City Limits	Ownership	Lake Type
1	03		45th and Soncy	No	Sam Attebury	Natural
2	04		Hillside Terrace	Partially	P Dub Investments ltd. (Williams Group)	Developed
3	05	McDonald Lake	John Stiff Park	Yes	City of Amarillo	Developed
4	06	Lawrence Lake	Wolflin Village	Yes	City of Amarillo	Developed
5	07	Greenways Park Lake	North of Arden East of Loop 335 west	Partially	Emeny 59 Ltd / City of Amarillo	Predominantly Natural
6	08		Southwest corner of Loop 335	Yes	Bush Partners Ltd	Natural
7	11		Sundown Lane and I -27	No	Attebury Elevators	Predominantly Natural
8	13		Western and Loop 335	Partially	Attebury Elevators / Attebury Grain	Predominantly Natural
9	14	Scotty and Bell	East of Bell and South of Scotty	Yes	Attebury Elevators	Developed
10	15	McCarty Lake	East of Western and South of 59th	Partially	YMCA / City of Amarillo	Developed
11	16	South Washington Lake	West of Washington / North of 59th	Yes	Keith Burch	Developed
12	17	Bennett Lake	South of I -27 and East of Georgia	Yes	Larry M. Price	Developed
13	18		58th and Burlington	No	H Bar H Turf Farms	Natural
14	19	Santa Fe Lake	East of Washington South of 46th	Yes	PWR 1997 Trust / Union Pacific RR	Developed
15	20	Gooch Lake	South East Park	Yes	City of Amarillo	Developed
16	21	T Anchor Lake	North of I- 40 East of Osage	Yes	City of Amarillo	Developed
17	22		East of Eastern / North of 10th	Yes	Spool Stockyards	Natural
18	23	Wildhorse Lake	South of Amarillo Blvd / East of Georgia	Yes	Amarillo Skyline, Splat Paintball, David Gilbert, John Adair, Lou Ellen Reynolds, Bobby Rutlidge, City of Amarillo	Predominantly Natural
19	24	Martin Road Lake	West of Martin Road / North of Amarillo Blvd	Yes	City of Amarillo	Developed
20	26	Juett Lake	East of Loop 335 South of I -40	Partially	Jane F Juett et al	Natural

Table 1-1 (Continued): Playa Lakes of the MS4

	Playa #	Name	Location	Inside City Limits	Ownership	Lake Type
21	27	T S T I Lake	South of HW 60 and West of FR 1912	Yes	Amarillo Junior College	Natural
22	28	Airport Lake	Northwest of Runway 23 AMA Int'l Airport	Yes	Texas 5 G Limited	Natural
23	29		Triangle drive East of Loop 335	Yes	J Lee Milligan, City of Amarillo, Curtis Construction, Myra Baily, Vaughn Price, Paloduro Homes	Predominantly Natural
24	33		Pullman Road and Hastings	Partially	Lillie Juanita Kinser / St. Pious X High School	Natural
25	34		I-40 and Parsley	Partially	Cummins Estate	Natural
26	35		I-40 and Spur 228	No	Amarillo Economic Development Corp.	Natural
27	58		North of HW 60 / East of Parsley	No	Tyson Fresh meats, David Whitaker, Bar V Partner	Natural
28	60		South of FM 2575 / West of FM 1912	No	Ninevah Kay Younger et al	Natural
29	61		South of Airport Blvd / East of Pulman	Partially	Amarillo Junior College	Natural

Figure 1-1: Example Inlet Types



From Ref. 4.

Curb opening inlets (Figure 1-2) are located in a street gutter and have a relatively large opening, allowing dirt, rocks, sticks, and relatively large debris and trash to enter the inlet along with the storm water. Water flows into the inlet, down into a collection box, and into a storm sewer pipe (Figure 1-3). Many curb opening inlets have manhole access to the collection box for sediment and debris removal.

Figure 1-2: Curb Opening Inlet from Street

Figure 1-3: Looking Down Through Manhole into Curb Opening Inlet

For curb opening inlets observed in the Martin Road Lake drainage basin:

- The mouth of the storm sewer pipe is located at the bottom of the collection box,
- There is no sump to collect sediment and debris, and
- There is no trash rack to impede debris from entering the storm sewer pipe.

The grate on a grate inlet allows storm water, dirt, small rocks, and small trash and debris to flow/fall through the grate, while keeping sticks, larger rocks, and larger trash and debris from entering. A slotted drain inlet is similar, with a series of transverse bars performing the function of a grate.

Pipes

Storm sewer pipes convey storm water by gravity flow from an inlet to an outfall. The MS4 contains pipes with diameters as small as 8 inches and as large as 108 inches (Ref. 3). Pipe materials include vitrified clay (VCP), clay tile, reinforced concrete (RCP), polyvinyl chloride (PVC), high-density polyethylene (HDPE), cast iron (CIP), corrugated metal (CMP), and other materials.

Most storm sewer pipes are accessible through manholes for cleaning and maintenance. Manholes are typically located at pipe junctions and bends. Along a straight run of pipe, a manhole is usually located every 400 to 500 feet.

Outfalls

Outfalls discharge storm water from a pipe to an open channel or playa. Outfalls may or may not have endwalls, wingwalls, and other erosion protection (Figure 1-4).

Open Channels

Open channels typically convey storm water away from an outfall or other drainage structure to a culvert or a playa. Open channels can be naturally vegetated (Figure 1-5) or can be lined with grass, concrete, rock, or other materials.

Culverts

A culvert is a closed conduit, typically used to convey storm water flow from an open channel under a road crossing to another open channel. Culverts come in a wide variety of materials, sizes, and shapes.

Figure 1-4: Outfalls

Figure 1-5: Open Channel

Pumps

Within the more urbanized areas, the city has constructed pump stations and piping systems to move water from one playa to another and eventually to man-made impoundments (Thompson Park Lake and Medi-Park Lake) located within the Canadian River watershed in the northern portion of the city. These impoundments then spill into natural drainageways that convey the water to the Canadian River.

The five playas with pump stations are: Bennett Lake, Martin Road Lake, T-Anchor Lake, Lawrence Lake, and McDonald Lake.

A typical operating strategy is to pump water from a playa as necessary to maintain a target water elevation. Pumping does not occur during storm events.

1.3. Utility Resources

The city recently created a Drainage Utility and began collecting fees to fund the utility in October 2012. Based on a plan outlined in the Drainage Utility Study (Ref. 3), the city is beginning to develop the staff and equipment necessary to maintain and repair the MS4 according to the staffing and equipment plans shown in Tables 1-2 and 1-3.

Table 1-2: Drainage Utility Staffing Plan

Staff	Existing/ New	Level of Service	FTEs	Phase	Group			
					Open Channel/ Playa Maintenance	Storm Drain Rehabilitation	Storm Drain Cleaning	Street Sweeping
Sweeper Operators	Existing	Basic	7	--				X
Lower/Roll-Off Container Operator	Existing	Basic	1	--				X
Supervisor	New	Basic	1	A		X	X	
Storm Drain Cleaning Crew #1	New	Basic	2	A			X	
Vacuum/Jetter Truck Crew #1	New	Basic	2	A			X	
Video Crew	New	Basic	2	A			X	
Storm Drain Construction Crew #1	New	Basic	7	B		X		
Concrete Crew #1	New	Basic	2	B		X		
Supervisor	New	Basic	1	C	X			
Open Channel/Playa Crew #1	New	Basic	8	C	X			
Investigator	New	Basic	1	C	X			
Basic Subtotal			*34*					
Storm Drain Cleaning Crew #2	New	Enhanced	2	D			X	
Vacuum/Jetter Truck Crew #2	New	Enhanced	2	D			X	
Storm Drain Construction Crew #2	New	Enhanced	7	E		X		
Concrete Crew #2	New	Enhanced	2	E		X		
Open Channel/Playa Crew #2	New	Enhanced	8	F	X			
Enhanced Subtotal			*21*					
Grand Total			***55***					

From Ref. 3.

Table 1-3: Drainage Utility Equipment Plan

Equipment	Existing/ New	Number of Units by Level of Service		Group			
		Basic	Enhanced	Open Channel/ Playa Maintenance	Storm Drain Rehabilitation	Storm Drain Cleaning	Street Sweeping
Hydroscopic Excavator, Gradall XL4100	Existing	1	1	X			
Loader, Tracked, Deere CT315	New	1	--	X			
Loader, Tracked, Deere 605C	New	1	1	X			
Loader, Wheeled, Deere 304J	New	1	--	X			
Loader, Wheeled, Deere 544K	New	--	1	X			
Tractor, Deere 4105 w/ rotary mower	New	1	1	X			
Brush Truck, Effer 130.11LSV	New	1	--	X			
Dump Truck, 12 yd, 50,000GVW	Existing	3	3	X			
Equipment Trailers	New	as required		X			
Truck, 1-ton to 2.5-ton	Existing: 1-ton (1) 2.5-ton (1) New: (2)	2	2	X			
Excavator, Tracked, Deere 250G LC	New	1	1		X		
Hydraulic Breaker for Excavator	New	1	1		X		
Tractor-Trailer for Tracked Excavator	New	1	--		X		
Backhoe Loader, Wheeled, Deere 410J	New	2	2		X		
Dump Truck, 12 yd, 50,000GVW	New	1	1		X		
Boom Truck, Terex BT 3870	New	1	--		X		
Arrow Board	New	1	1		X		
Equipment Trailers	New	as required			X		

From Ref. 3.

Table 1-3 Continued: Drainage Utility Equipment Plan

Equipment	Existing/ New	Number of Units by Level of Service		Group			
		Basic	Enhanced	Open Channel/ Playa Maintenance	Storm Drain Rehabilitation	Storm Drain Cleaning	Street Sweeping
Vibratory Plate Compactor	New	1	1		X		
Air Compressor w/ Trailer	New	1	--		X		
Walk Behind Trencher	New	1	--		X		
Walk Behind Pavement Saw	New	1	--				
Vibratory Trench Roller, 22"	New	1	--		X		
Truck, 1-ton to 2.5-ton	New	2	2		X		
Vacuum/Jetter Truck, Vactor 2100	New	1	1			X	
TV Truck, Complete System, Aries	New	1	--			X	
Truck, 1/2-ton	Existing (1) New (1)	1	1			X	
Sweeper	Existing (5) New (3)	8	--				X
Loader/Dump Truck, 34,500GVW	New	1	--				X
Roll-Off Container/Tractor-Trailer	New	1	--				X

From Ref. 3.

Staffing and equipment acquisition is proceeding according to 6 phases and 2 levels of service. Acquisitions for basic service (phases A, B, and C) are expected to be completed within 5 years, and acquisitions for enhanced service (phases D, E, and F) are expected to be completed within 10 years.

The recommendations in this document are long-term goals based on providing an enhanced level of service.

Storm water maintenance and repair functions are divided among the following groups in the Drainage Utility:

- Open Channel/Playa Maintenance Group: Maintains open channels, playas, borrow ditches, and roadway bridges/culverts and repairs erosion damage.
- Storm Drain Rehabilitation Group: Repairs and replaces storm water pipelines, manholes, junctions, inlets, headwalls, concrete, and driveway culverts.
- Storm Drain Cleaning Group: Cleans storm water inlets and pipelines and performs video inspections of storm water pipelines.
- Street Sweeping Group: Removes trash and particulates from paved streets using street sweepers.

1.4. Best Management Practices (BMPs)

To maintain the hydraulic capacity, water quality, and aesthetics of the storm water facilities, the city should implement a number of best management practices (BMPs), including the following:

- Public Education BMPs
- Utility Repair/Improvement BMPs
- Utility Maintenance BMPs
- Development Standards
- Water Quality Monitoring

Recommended BMPs, staff/contractor training, and recordkeeping and reporting practices are described in the remainder of this document.

1.5. Annual Plan Update

The city should update this Playa Maintenance Plan annually, based on factors including, but not limited to:

- The accumulated experience in maintaining the storm water conveyance system,
- The maintenance budget,
- Personnel and equipment availability,
- Seasonal trends (precipitation, trees losing leaves in fall, etc.)

- Land use types (residential, commercial, etc.),
- Historical loads of sediment/debris/trash by neighborhood, and
- Storm water conveyance system metrics, such as:
    - Total length of pipe by size,
    - Number of inlets, and
    - Age and condition of facilities,

During the annual update, the city should:

- Document additional or revised BMPs/maintenance procedures.
- Revise maintenance goals, such as:
    - Street sweeping frequency for different types of streets,
    - Inlet cleaning frequency,
    - Feet of storm sewer pipe to be cleaned or inspected with CCTV,
    - Response time to emergency/priority calls, and/or
    - Other performance measures.
- Document additional or revised training requirements.

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2. Public Education BMPs [FUTURE]

2.1. Hydraulic Capacity [FUTURE]

Stop Littering [FUTURE]

Keep Leaves/Lawn Clippings Out of the Street [FUTURE]

Line Locator [FUTURE]

Report Storm Water System Problems [FUTURE]

2.2. Water Quality [FUTURE]

Reduce Illicit Discharges [FUTURE]

Prevent Illegal Dumping [FUTURE]

Stencil Storm Drains "Dump No Waste -- Flows to Playa" [FUTURE]

Prevent Contact of Materials with Rainwater/Stormwater [FUTURE]

Proper Coverage/Storage of Materials [FUTURE]

Proper Disposal of Waste Materials [FUTURE]

Good Housekeeping Practices [FUTURE]

Selection/Use of Fertilizers/Pesticides/Herbicides/Deicing Compounds [FUTURE]

3. Routine Facility Inspection and Condition Assessment

City staff and/or contractors should visually inspect all readily accessible storm water system facilities (inlets, outfalls, channels, culverts, playas, and pump stations)[1] on a periodic basis (Table 3-1). Each facility should be photographed, and the location and identification number should be noted. The structural condition of the facility should be assessed, including erosion concerns, and a risk score should be calculated as described in Appendix A. The structural condition and any maintenance needs should be recorded.

Table 3-1: Minimum Inspection Frequency by Facility

Facility	Minimum Inspection Frequency
Inlets	Once each 1.3 years
Outfalls	Twice per year
Channels	Once per year
Culverts	Once per year
Pipes	On request/as budget allows
Playas	Once per year
Pump Stations	On request/as budget allows

Note: These frequencies should be reevaluated each year and revised as necessary to ensure optimal operation of the MS4.

After inspection, repair and maintenance should be scheduled in priority according to the risk score and the severity of the need for maintenance. If substantial repairs beyond the capabilities of storm water personnel are required, details will be communicated in a timely manner to the city's Public Works Division.

The minimum recommended inspection frequency is shown by facility in Table 3-1. Facilities with a history of maintenance needs, such as large volumes of trash and debris, and facilities with repeated reports of high water during storm events should be inspected more often.

On average, almost two-thirds of Amarillo's rainfall occurs during the summer months (May through September). Therefore, the city should schedule inspections during the summer months, when problems are more likely to be evident. Repairs and maintenance can then be scheduled promptly for emergency/priority conditions or scheduled for off-peak times for low priority conditions.

[1] Buried pipe is not readily accessible. Pipe inspection is discussed beginning on page 27.

3.1. Inlets

The inlet inspection should include removing the manhole and viewing conditions in the collection box. Typical maintenance needs may include manholes that are buried, manholes that cannot be removed, large volumes of trash/debris in the collection box, obstruction of the inlet, odors, and other issues.

Examples of adverse conditions identified in the Martin Road Lake drainage basin include a curb opening inlet with a collection box full of trash and an opening largely obstructed by plant growth and dirt (Figure 3-1) and an inlet with damaged concrete and exposed reinforcing bar (Figure 3-2).

Figure 3-1: Curb Opening Inlet Obstructed and Collection Box Full of Trash

Figure 3-2: Curb Opening Inlet with Damaged Concrete and Exposed Reinforcing Bar

3.2. Outfalls

The presence of dry weather flow should be noted. Typical maintenance needs may include removal of trash/debris from the outfall, an obstructed outfall, and other issues. An example of adverse conditions identified in the Martin Road Lake drainage basin is an outfall with severe erosion behind the endwall and partial obstruction of the outfall pipes with dirt (Figure 3-3). Note that the erosion has exposed an irrigation system pipe and caused a sidewalk to collapse.

3.3. Channels

Typical maintenance needs may include mowing of drainage swales, removal of heavy vegetation that obstructs the channel, and other issues. An example of adverse conditions identified in the Martin Road Lake drainage basin is a channel where the concrete lining has failed and actually obstructs flow in the channel (Figure 3-4).

3.4. Culverts

Typical maintenance needs may include removal of sediment, debris, or heavy vegetation that obstructs the culvert, and other issues.

Figure 3-3: Outfall with Severe Erosion and Partial Obstruction

Figure 3-4: Concrete-Lined Channel with Lining Failure

3.5. Pipes

Buried pipe is not readily accessible and is not routinely inspected. The Storm Drain Cleaning Group's TV Crew will perform video inspections of 30 miles of buried pipe per year. These inspections could include scheduled inspections, emergency situations, cases where pipe failure is suspected, or requests by the Public Works Division. The purpose of these inspections is to find broken pipe, deteriorated pipe, obstructed areas, areas with tree roots growing into the pipe, and locations with interference from other utilities. Such locations should be recorded and scheduled for repair and maintenance.

Typical maintenance needs are removal of sediment and trash/debris from the pipes. Video inspection of pipes in the Martin Road Lake drainage basin identified sections of pipe with accumulated trash.

3.6. Playas

Typical maintenance needs may include mowing, removal of sediment, debris, or heavy vegetation, and other issues.

3.7. Pump Stations

There are existing storm water pump stations at Bennett Lake, Martin Road Lake, T-Anchor Lake, Lawrence Lake, and McDonald Lake. These stations have not had their condition or performance formally or systematically assessed. It is recommended that an assessment of the major components of each pump station be performed to evaluate their current condition and provide refined guidance for ongoing maintenance or replacement schedule.

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4. Utility Repair/Improvement BMPs

In this section, repair and improvement BMPs are recommended for existing facilities to maintain the hydraulic capacity, water quality, and aesthetics of the storm water system. Proactive BMPs are recommended for pipe replacement/rehabilitation, playa excavation for additional storage, debris barriers/trash racks, catch basin treatment processes, sedimentation basins, enlargement/lining of channels, outfall pipe extension, bed and bank erosion control, and other treatment facilities. The city should update its Storm Water Management Program, referenced in the MS4 permit, as necessary to reflect physical changes to the MS4.

The Drainage Utility's Storm Drain Rehabilitation Group will perform the BMPs described in this chapter. The maintenance performance goal for this group is to repair and/or replace 2,000 feet of pipeline per year per crew and to respond to flood events as necessary. The equipment set specified in Table 1-3 should allow utility staff to place pipes as large as 72 inches in diameter. As discussed in Section 1.5, the maintenance goals/performance measures should be updated annually.

Storm sewer personnel typically repair minor and emergency problems. Major repairs and improvements are typically performed by private contractors with supervision from the city's Public Works Division.

4.1. Pipe Replacement/Rehabilitation [FUTURE]

4.2. Playa Excavation for Additional Storage [FUTURE]

Slopes [FUTURE]

Aesthetics [FUTURE]

4.3. Debris Barriers/Trash Racks [FUTURE]

4.4. Catch Basin Treatment Processes [FUTURE]

Oil-Water Separator [FUTURE]

Catch Basin Insert [FUTURE]

4.5. Sedimentation Basins

A routing method should be developed to help prevent erosion and pollution of the lake by utilizing a series of flow intercepting areas surrounding the lake that will act as sedimentation basins. The drainage areas adjacent to the sediment basins could consist of a series of terraces, channels, and storm sewers that would route the runoff into the basins. The basins would slow and pool the water while intercepting debris and sediment before it flows to the main body of water. This system could also reduce the size of the conveyance system into the main body of water by providing interim storage. The sedimentation basins should be designed such that they are completely emptied by conveying the total runoff into the main body of the lake after the rain event. The basins could then be cleaned of sediment and debris that remain after they have emptied the runoff water. The basins could also be landscaped using grasses and trees and incorporated into the parks system as open areas.

Slopes

Playa slopes normally range from 0% to 1% in the basin and 0% to 3% on the side slopes to no more than 3% to 5% on the upper most slopes. After excavation, slopes typically exceed the naturally-occurring slopes. Side slopes greater than those naturally occurring will normally experience a greater degree of erosion. Various standards are used in regulating the maximum side slopes. It is recommended that the side slopes for fill sections be flatter than 5% and side slopes for cut section be flatter than 15%. Variances to this recommendation would require consideration on a case by case basis with no slopes being steeper than 20%.

Aesthetics

The sedimentation basins should be constructed to conform to the natural landscape rather than a rectangular pit excavation. The sedimentation basin should have landscaping and should be incorporated into the park system as an open area. The sedimentation basin should be designed so that it can be cleaned and the vegetation can be maintained. The basin should also be designed with consideration for the ingress and egress of pedestrians.

4.6. Enlargement/Lining of Channels

The channels that convey runoff from the watershed to the playa lakes have historically been designed to convey the 2-year frequency storm. Conveyance structures that are designed for less than the 100-year frequency storm are inadequate to convey the runoff into the main body of the lake without damage to the structure and erosion of the banks of the basin. These channels

should also be constructed at an adequate depth so that the runoff water from a 100-year frequency storm does not inundate the channel and compromise both the side slopes of the lake and the structure itself.

Channels that enter both the sedimentation basins and the main body of the lake should be lined and constructed to the base of the sedimentation basin and the lake. The lining of the channels should be of materials that are relatively maintenance free. Historically the lining has been done using concrete structures placed on the native clay soils. These structures have a high failure rate because they are undermined by erosion. This erosion is a result of cracking of the structures; runoff exceeding the design capacity of the structure; and/or the structure not being constructed to the base of the lake. If concrete structures are constructed these items must be addressed. It is recommended that the channels be lined with large riprap or other such materials that will not fail due to subgrade movement. The riprap or other materials should be of adequate size that the velocity of the runoff water does not move the material. The materials should be placed with filter cloth and protection bedding to resist erosion of its subgrade.

The existing channels constructed to convey the 2-year frequency storm could be utilized to transport the runoff to the sedimentation basins. When entering the sedimentation basin, the channels should be modified to have the capacity to convey the 100-year frequency storm and lengthened to convey the runoff to the base of the sediment basin. Channels used to convey the runoff from the sedimentation basin to the main lake body would be overflow or spillway type structures and should be designed to convey the runoff from the 100-year frequency storm.

4.7. Outfall Pipe Extension

The storm sewers that convey the runoff water from the watershed to the main lake body have historically been designed to convey the 2-year or 5-year frequency storm with no provisions to address the additional runoff from the 100-year frequency storm. Generally these structures discharge along the slopes of the lake rather than conveying the water to the base of the lake. These methods of design result in erosion of the banks and potential failure of the headwall and conveyance structures.

To address the maintenance and erosion associated with the storm sewer piping, it is recommended that structures capable of conveying the 100-year frequency storm be constructed from the discharge of the existing storm sewer to the base of the sedimentation basins. For conveyance of runoff from the sedimentation basins to the main lake it is recommended that a series of inlet boxes and storm sewers be constructed. Small grated inlets are recommended at the base of the sedimentation basin to ensure positive drainage while trapping debris. Larger grate inlet boxes, that are capable of intercepting the 100-year frequency storm, are recommended to be elevated above the base of the sedimentation basin to allow sediment and debris to settle before being carried to the lake when conveying the 100-year frequency storm.

The discharge points of the storm sewer should be protected by structural erosion control measures. This is recommended to be done by using concrete or stone stilling basins constructed in the base of the sedimentation basin and at the base of the lake.

4.8. Bed and Bank Erosion Control [FUTURE]

Revegetation

Vegetation reduces erosion by stabilizing the soil with its roots. The growth of the roots make fissures within the soil that aid in infiltration. Additionally, vegetation filters and utilizes nutrients from runoff.

The use of sedimentation basins can address the restoration of vegetation adjacent to the lake body which has historically been excavated for runoff storage. Because inundation of the sedimentation basins will be for a limited time, grasses, bushes and trees can be maintained in the sedimentation basins and used to filter sediment and debris before it enters the lake. Should the area become inundated for an extended period of time, the pumps at the lake should be used to remove the excessive water and the vegetation restored as needed.

Revetments [FUTURE]

Rip-Rap, Armoring [FUTURE]

Geofabric [FUTURE]

Headwalls and Endwalls [FUTURE]

Flow/Grade Control and Drop Structures [FUTURE]

Dissipation Piles [FUTURE]

Drainage Flumes [FUTURE]

4.9. Other Treatment Facilities [FUTURE]

Infiltration Trenches [FUTURE]

Infiltration Basins [FUTURE]

Wet Ponds [FUTURE]

Detention Basins [FUTURE]

Vegetated Swales [FUTURE]

Vegetated Buffer Strips [FUTURE]

Bioretention [FUTURE]

Media Filters [FUTURE]

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5. Utility Maintenance BMPs

In this section, maintenance BMPs are recommended for existing facilities to maintain the hydraulic capacity, water quality, and aesthetics of the storm water system. Proactive BMPs are recommended for emergency/priority response, street sweeping, sediment and debris removal, vegetation removal, and utility relocation. As the utility repairs and improves parts of the system, additional BMPs may become necessary for maintenance of inlet quality processes, sedimentation basins, and/or other facilities.

The Drainage Utility's Open Channel/Playa Maintenance, Storm Drain Cleaning, and Street Sweeping Groups will perform the BMPs described in this chapter. Maintenance performance goals are presented for these groups in Table 5-1. As discussed in Section 1.5, the maintenance goals/performance measures should be updated annually.

5.1. Emergency/Priority Response

Response to emergency or priority situations is a highly visible BMP. Emergency or priority calls may come from storm water personnel, residents, businesses, other city departments, etc. Upon notification of exigent circumstances, the Storm Drain Rehabilitation and Cleaning Groups should prioritize the situation and respond accordingly. Priorities include:

- Emergency Calls: Storm water personnel should respond to an emergency immediately, 24 hours a day, to ascertain the cause of the emergency, restore the hydraulic capacity of the system, and/or alleviate hazardous conditions. Examples of emergency situations include:
    - The hydraulic capacity of a portion of the storm water conveyance system is diminished to the point where flooding and substantial property damage are occurring or imminent.
    - A hazardous condition has been created in the storm water conveyance system, (*e.g.*, a fuel spill into an inlet).
- Priority Calls: Storm water personnel should investigate and assess priority calls in a timely manner.
    - For a high priority situation, where conditions that can be expected to cause flooding and property damage during a significant rainfall have been observed/reported, remedial action may be scheduled for a later time, not to exceed 24 hours.
    - For a medium priority situation where flooding and property damage do not appear to be imminent, such as odor in an inlet, remedial action may be scheduled for a later time, not to exceed one week.

Table 5-1: Maintenance Performance Goals

Group	Performance Unit	Annual Performance Goals by Crew/Sweeper[a]	Approximate System Statistics	Annual Percentage of System Maintained by Level of Service	
				Basic	Enhanced
Open Channel/Playa Maintenance	Crew	Clear 15 miles of channel Clear 250 acres of playa	15 miles of channel 1,163 acres of playa[b]	100% 21%	200% 43%
Storm Drain Cleaning	Crew	Clean 2,500 inlets TV 30 miles Clean 25,000 feet of pipeline Respond to flood events	3,300 inlets 180 miles of pipe 950,400 feet of pipeline	76% 17% 2.6%	152% 33% 5.3%
Street Sweeping	Sweeper	Sweep 7,200 miles	900 miles	800%	800%

[a] Unless otherwise specified, all data from Ref. 3.

[b] Assuming an area of 40.1 acres per playa (the average playa lake area in Potter and Randall Counties based on data presented in Ref. 5) and 29 playa lakes (from Table 1-1).

- Low priority situations may be addressed during the course of normal maintenance activities.

When emergency or priority situations are caused by structural problems that are beyond the ability of storm water personnel to repair, details will be communicated in a timely manner to the city's Public Works Division.

5.2. Street Sweeping

Regular street sweeping is a proactive BMP that maintains the hydraulic capacity and aesthetics of storm water facilities by collecting trash, leaves, and other visible debris from streets and gutters before these materials can clog facilities and pollute channel and playa boundaries. In addition, street sweeping maintains playa water quality by removing particulate matter containing metals, oil and grease, and other pollutants before it enters the MS4.

The Street Sweeping Group generally sweeps downtown streets daily, major thoroughfares once or twice per week (depending on volume), and residential streets once per quarter (Ref. 6). Adherence to this schedule depends on the weather and the availability of personnel and equipment.

The city should maintain records of the amount of materials removed from each street sweeping route and consider increasing the frequency of sweeping in areas that consistently yield large loads.

5.3. Storm Event Sediment/Trash/Debris Removal

During storm events, Storm Drain Cleaning Group personnel should patrol locations in the MS4 that are particularly vulnerable to clogging with sediment, trash, and debris. These locations may include grates, trash racks, etc. When hydraulic problems caused by clogging are encountered, Storm Drain Cleaning Group personnel should work to restore hydraulic capacity while maintaining personal safety.

5.4. Routine Sediment/Trash/Debris Removal

The city attempts to control the introduction of floatables into the MS4 by removing debris and litter from streets, easements, parks, and storm water outfalls. Cooperating entities include the Solid Waste, Street, and Parks and Recreation Departments, along with Keep Amarillo Beautiful, an independent, all-volunteer organization. However, there is little to impede the remaining debris and litter from entering the MS4.

Removal of sediment, trash, and debris is one of the most tasks in maintaining the hydraulic capacity of the system. Facilities that have historically accumulated large volumes of sediment, trash, and debris should be serviced more often. Where feasible, one or more of the removal

events can coincide with the routine inspection described in Section 3 (*i.e.*, the inspection and cleaning can occur during the same site visit).

The city should track the volume by weight of materials gathered during routine sediment/trash/debris removal, along with the source location. This will assist with scheduling of future inspections.

If any material is suspected to be hazardous, field personnel should contact a supervisor. The supervisor should seek direction on how to proceed from the following agencies:

- For small quantities, the city's Industrial Waste Section at (806) 378-3024.
- For larger quantities, the regional office of the Texas Commission on Environmental Quality at (806) 353-9251.

Inlets

Using a vacuum truck, Storm Drain Cleaning Group personnel should vacuum sediment, trash, and debris from inlets, grates, and collection boxes in priority order according to the maintenance need identified during routine inspection. The maintenance target is to clean 2,500 inlets per crew per year. For some inlets, it may be necessary for Storm Drain Cleaning Group personnel to clean inlets, grates, and collection boxes with hand tools. No person who has not completed confined space training should enter a manhole, collection box, or other confined portion of the MS4.

Outfalls

Where feasible, Open Channel/Playa Maintenance Group personnel should use a vacuum truck to collect sediment, trash, and debris at MS4 outfalls. For outfalls that a vacuum truck cannot reach, Open Channel/Playa Maintenance Group personnel should collect sediment, trash, and debris with hand tools.

Channels, Culverts, and Playas

Open Channel/Playa Maintenance Group shall remove sediment, trash, and debris from channels, culverts, and playas.

Sediment accumulation is the largest threat to maintaining a playa's hydraulic function (Ref. 2). As sediment fills a playa, it can store less water. In addition, the water surface area is increased, increasing evaporation and reducing aquifer recharge.

Severe erosion could cause sufficient sedimentation in a channel or playa to warrant dredging or excavation. This should be evaluated on a case-by-case basis. Dredging and other in-channel or in-lake work may require one or more permits and should be closely coordinated with local, state, and federal agencies. Such work may require the use of heavy equipment, including skid-steers, backhoes, excavators, loaders, dump trucks, bulldozers, etc. Removal of sediment from inundated areas would require a dredging barge and associated dewatering equipment.

More frequent trash/debris removal will be necessary for culverts that are protected with trash racks.

Pipes

Storm Drain Cleaning Group personnel should use a vacuum truck to pump high-pressure water through 25,000 feet of storm sewer pipe per crew per year to flush sediment, trash, and debris from the pipe. If a difficult clog is encountered, a rodding truck should be used to dislodge the clog. Sediment, trash, and debris are removed from the system by pumping/vacuuming it from manholes along the pipe or collecting it at an outfall.

Where tree roots are growing into the line and high-pressure water does not remove them, storm water personnel should use augers or other cutting tools to remove the roots. If root growth in a given location becomes a persistent problem, the city should investigate and consider tree or shrub removal.

5.5. Vegetation Removal

Removal of excess and vegetation from channels and playas is another important part of maintaining the hydraulic capacity and the aesthetics of the MS4. Where feasible, channel cleaning/vegetation removal can coincide with the routine inspection described in Section 3 and/or sediment/trash/debris removal events described in Section 5.4 (*i.e.*, inspection, sediment/trash/debris removal, and/or channel cleaning/vegetation removal can occur during the same site visit).

Grass-lined channels should be mowed at least monthly during the growing season during dry weather. Grass clippings should be removed from the channel regular schedule.

Woody vegetation should be removed from channels and playas as necessary to maintain hydraulic capacity and aesthetics. Vegetation should be cut at the base, leaving the roots in place for soil stability. Cut vegetation will be removed from the channel or playa and disposed of in a pre-approved location.

It is anticipated that this work will require hand tools such as brushcutters and chainsaws. Use of heavy equipment that would disturb the channel or playa may require one or more permits and should be closely coordinated with local, state, and federal agencies.

5.6. Utility Relocation

Video inspection of storm sewer pipes in the Martin Road Lake drainage basin showed numerous locations where other utility lines have penetrated and crossed the inside of a storm sewer pipe. This causes a high potential for trash and debris to catch on the other utility line and form a blockage in the storm sewer pipe.

As video inspections are conducted, locations with interference from other utilities should be recorded. The city should work with other utilities to remove their lines from the storm sewer pipe and repair the damaged section in a timely manner.

5.7. Inlet Quality Processes [FUTURE]

5.8. Sedimentation Basins [FUTURE]

5.9. Other Facilities [FUTURE]

6. Development Restrictions for Playas

As described in Section 1.1, the main hydrologic functions of an urban playa are to collect storm water from the surrounding drainage area and to allow the collected water to infiltrate into the soil column and recharge the aquifer. Restrictions on development in and around playas are intended to maintain these hydrologic functions. Current restrictions and recommended additional restrictions are described in the following sections.

6.1. Current Restrictions

The city requires developers to comply with Code of Ordinance Chapter 4-8 Flood Damage Mitigation (Ref. 7). As summarized below, this ordinance places restrictions on excavation and fill in a playa, development in and around playas, and pumping storm water between playas:

- Excavation and Fill in a Playa:
    - Must apply to the City Engineer for permission to excavate in a Special Flood Hazard Area in a playa lake and use the excavated material to make fill in the same Special Flood Hazard Area for the purpose of contracting the area inundated by the Base Flood to salvage the greatest amount of usable land. Permission is contingent on:
        - City Engineer finding that excavation in a Special Flood Hazard Area of a playa lake will not violate the purpose of the flood damage mitigation ordinance.
        - City Engineer approval of the submitted excavation plan.
    - Excavation plan requirements:
        - Public safety:
            - Excavation or embankment slopes shall be constructed in such a manner so that any slopes shall have a one-foot drop for each four feet of run to a minimum of seventy-five feet from the bank of the excavation <u>or</u>
            - The embankment perimeter shall have security fencing consisting of at least a six-foot chain-link fence with three strands of barbed wire.
            - The fencing and slopes shall be maintained in good condition, free of defects, at all times by the permittee or his successor in title or interest.
        - Flood storage: A drainage method satisfactory to the City Engineer will provide storage in the Special Flood Hazard Area equal to the Base Flood.
        - Easements:
            - Vehicular access easements are provided throughout the Special Flood Hazard Area and into any excavation area.

            - Drainage easements are provided from the runoff area that any excavation is designed to serve, of sufficient number, size, and location to accommodate the Base Flood.
        - Covenants and certifications:
            - Certification that all easements and methods of drainage will be maintained in good condition at all times by the permittee or his successor in title or interest.
            - A covenant filed in the deed records that no property within the Special Flood Hazard Area may be conveyed unless the successor in title agrees to the requirements of the excavation plan.
            - A covenant filed in the deed records establishing the procedure for removal and final placement of material from the Special Flood Hazard Area to be utilized on other properties in the area.
        - Permits required by any governmental agency.
    - Required approvals from the Federal Insurance Administration:
        - Approval for Risk Premium Zone changes if excavation in Special Flood Hazard Areas changes Flood Zones.
        - Approval for any reduction in storm water elevation that reduces the boundary of the FEMA Base Flood.

- Development In or Around Playas:
    - Unless specifically permitted by city code, developers must obtain a floodplain development permit from the City Engineer for any development within any Special Flood Hazard Area.
    - All development proposals shall:
        - Comply with the city's floodplain management regulations and floodplain development permit requirements.
        - Include Base Flood Elevation data. (Apparent exception for small subdivisions and manufactured home parks.)
        - Provide adequate surface drainage and vehicular access to reduce exposure to flood hazards.
        - Locate and construct public utilities and facilities (i.e. sewer, gas electric, water) to minimize or eliminate flood damage.
    - Finish floor elevations:
        - Residential construction: New construction and substantial improvement must have the lowest floor (including basement) elevated to or at least one foot above the Base Flood Elevation.
        - Non-residential construction: New construction and substantial improvement must either:

        - Have the lowest floor (including basement) elevated to or at least one (1) foot above the Base Flood Elevation or
        - Together with attendant utility and sanitary facilities, be designed so that the structure below the Base Flood Elevation is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy.
    - Placement of material in a Special Flood Hazard Area
        - Acceptable material from outside a Special Flood Hazard Area may be placed upon a tract of land within a Special Flood Hazard Area equal to or above the Base Flood elevation if a quantity equal to such material is first removed from the Special Flood Hazard Area.
        - Developers can place acceptable material from outside a Special Flood Hazard Area may be placed upon a tract of land within a Special Flood Hazard Area if the tract of land was previously raised to or above the Base Flood Elevation with material from within the Special Flood Hazard Area.
    - Developers shall obtain a Letter of Map Revision or Letter of Map Revision-F from the Federal Emergency Management Agency for development in the FEMA Base Flood floodplain unless the city allows otherwise.
    - The city can construct any public work, extend any public utilities or roadway paving, or locate and improve any public park in any Special Flood Hazard Area when the project is planned or the work or contract is approved by or is done under the supervision of the City Engineer and complies with development permit requirements.

- Pumping Storm Water Between Playas
    - A registered professional Engineer shall certify that there is no appreciable additional risk of flooding to the receiving playa lake.
    - An agreement between the developers or owners of each playa lake shall be filed of record acknowledging the transfer of storm water and binding the successors in title to the transfer of storm water.

The city also requires developers to comply with its Storm Water Management Criteria Manual (Ref. 4). This document provides engineering guidance and design criteria for storm water runoff, street drainage, storm inlets, storm sewers, open channels, culverts, bridges, playas, detention, sediment control, erosion control, and water quality. As summarized below, criteria in this manual address hydraulic/hydrologic evaluations, compensation for development, and public safety:

- Hydraulic/Hydrologic Evaluations:
    - The effects of new development near playas or within playa boundaries should be evaluated to avoid increasing flood levels and related damages.
    - The effects of playas on upstream drainage improvements should be incorporated into the design of such improvements.
    - Proposals for development and required compensatory measures can be evaluated using the Playa Simulation Model (ASAPP).
    - Playa elevations for a compatible storm should be used for backwater calculations.

- Compensation for Development:
    - Compensation is required for any development which is planned below the base flood level such that there is no increase in the post-development base flood level.
    - Acceptable measures for compensation include excavation, pumping, gravity draining, or a combination of these measures.
        - Excavation:
            - Material equal in volume to the proposed infill below the base flood elevation must be removed from the playa below the base flood elevation.
            - Although it is believed that excavation from playas contributes to increased infiltration (Ref. 4), no credit is to be provided due to the unquantifiable nature of the seepage increase.
            - Excavation slopes, as well as infill slopes, should be no steeper than 4H:lV.
            - If the proposed infill and excavation project results in a decrease in playa surface area, the City Engineer may increase the required excavation volume to compensate for reduced evaporation loss.
        - Pumping:
            - Permanent pumps are installed to draw down playa levels such that the resulting base flood level does not exceed the level before development.
            - The general idea is to dewater playas during dry weather periods in order to increase the flood storage available in the playas during storm events.
            - Pump discharge may not adversely affect the flood levels downstream of the pumped discharge point.
        - Gravity drainage:
            - Accomplished through open channel cut or tunneling.
            - Must completely compensate for any proposed infill without adversely affecting the receiving channel or downstream facilities.

- In general, only those playas which currently spill to neighboring playas are candidates for gravity drainage modifications.

- Public Safety
  - All detention basins and playa lakes shall have a level safety ledge extending three feet into the basin from the shoreline and two feet below the normal water depth.
  - Playa modifications shall be designed to protect the safety of any children or adults coming in contact with the system during runoff events.
  - The shorelines of all playa lakes at 100-year capacity shall be as level as practicable to prevent accidental falls into the basin and for stability and ease of maintenance.

6.2. Restrictions in Other Cities

Historically, developers have recovered land around the edges of a playa by filling a portion of the playa and excavating remaining portions to maintain the playa's storage capacity. Such land recovery is allowed in certain circumstances by Section 4-8-5(a) of the city code (Ref. 7). In general, this type of land recovery leads to deeper playas with smaller surface areas, shorter perimeters, and steeper side slopes. The new configuration changes the hydrology of the playa, reducing evaporation and reducing groundwater recharge.[2] The steeper, altered sides of such a playa can increase public safety risks and can increase erosion, reducing the playa's storm water holding capacity.

A few cities have special restrictions on development in and around playas that are similar to Amarillo's current restrictions. For example:

- The City of Midland requires a floodplain permit for all types of development, new construction, major additions and improvements, mobile home placement, fill placement, or changes to playas (Ref. 8).
- For drainage improvements, the City of Odessa requires that (Ref. 9):
  - Natural playa lakes shall not be filled unless such loss in drainage capacity is equally compensated for in some other manner.
  - Access must be provided for maintenance purposes.
  - The finished floor of buildings in or adjacent to playa lakes or drainage ways shall be at least 1 foot above the 100-year storm water surface elevation.

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[2] See the discussion of playa hydrology in Section 1.1. A shorter perimeter reduces recharge along the perimeter of the playa. For a playa that goes dry, a smaller bottom area allows fewer cracks for storm water infiltration during the initial stages of a storm. A smaller bottom area reduces recharge through the clay bottom (though this is thought to be a minor contribution to the overall recharge).

- The City of Levelland requires approval of the Planning and Zoning Commission before "any playa lake or any other area which affects drainage within the corporate limits of the City of Levelland shall be excavated, any earth is removed, is reshaped or is cut and filled by private authority" (Ref. 10).

Levelland has also set a goal to restrict development in close proximity to playas (Ref. 11).

Of the cities surveyed, the City of Lubbock has developed the most comprehensive restrictions on development in and around playas. Restrictions include (Ref. 12):

- Classification of Playas:[3,4]
    - *Marginally non-overflow: base flood elevation ≤ 0.5 feet below natural overflow crest elevation.*
    - *True non-overflow: base flood elevation > 0.5 feet below natural overflow crest elevation.*
    - *Overflow: does not have sufficient storage to contain base flood.*
- Playa Reclamation and Alteration
    - Runoff storage preservation
        - Maintain or increase natural lake storage volume below base flood elevation or overflow elevation
        - *No more than 30 percent reduction in area at overflow elevation or base flood elevation.*
        - *No alteration of overflow crest elevation.*
    - Side slopes
        - *Fill slope no greater than 20H:1V.*
        - *Cut slope no greater than 7H:1V.*
        - *No slope in publicly accessible areas greater than 5H:1V.*
    - Aesthetics
        - *New lake configuration should fit development layout and topography.*
        - *Gradual curves and transitions.*
        - *Square or rectangular pits not desirable.*
- Overflow Conveyance:
    - *Development should not encroach significantly into the overflow crest area.*
    - *Overflow routes for playa lakes shall not be altered (e.g., rerouted to different lakes).*
    - *Follow natural paths of overflow routes during development.*

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[3] Italicized text indicates a restriction that has not been applied in the City of Amarillo or is different from current Amarillo restrictions.

[4] Some of the Lubbock restrictions depend on the playa classification.

- Topsoil Salvage and Placement
  - *Existing topsoil for cut or fill areas salvaged and stockpiled for reclamation as final lift in cut and fill areas.*
  - *Minimum topsoil finished lift elevation of 6 inches.*
- Erosion Control
  - *Where playa disturbed from natural condition, must incorporate measures to control sheet and rill erosion on disturbed areas.*
  - *Permanent gully erosion control measures are available to mitigate the potential for erosion around playas, including:*
    - *Concrete-lined drainage flume with concrete extended to lake bottom.*
    - *Concrete-lined drainage flume discharging to baffled apron that extends to lake bottom.*
    - *Concrete-lined drainage flume constructed to existing water level with geofabric and rock riprap placed below water level.*
    - *Convey storm water runoff to the lake bottom through storm drain.*
- Other Criteria
  - *No transfers of storm water from one lake to another.*
  - *Where there are multiple overflow crests, maintain proportional discharges.*
  - *Area of contributing subbasin not increased or decreased by development.*
  - *No isolation of playas that are "predicted to achieve common water surface elevation so that they act as a single unified lake." Man-made hydraulic connections shall have sufficient capacity to minimize the water surface differential at peak flow rates.*
- Finish Floor Elevations
  - *Marginally non-overflow playa: At least 2 feet above the overflow crest elevation.*
  - *Overflow playa: At least 2 feet above overflow crest elevation* or at least 1 foot above the base flood elevation, whichever is greater.
  - *True non-overflow playa that:*
    - *Overflows for 500-year, 24-hour storm: At least 2 feet above the overflow crest elevation.*
    - *Does not overflow for 500-year, 24-hour storm: At least 1 foot above the 500-year, 24-hour base flood elevation.*

6.3. Recommended Additional Restrictions

Since there is little additional information on regulatory restrictions on development around playa lakes, it is recommended that current restrictions in Amarillo be continued and that each development that impacts a playa lake should be reviewed for opportunities to preserve the lake’s natural functions where it is feasible to do so.

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7. Water Quality Monitoring

Section 7 of the Playa Maintenance Manual is taken principally from the current (2010) Storm Water Management Plan. No new or additional monitoring requirements are recommended.

The City of Amarillo has an existing program that utilizes multi departmental cooperation in the investigation reporting and notification of suspected dry weather flows. City vehicles are on the streets at any given time and personnel are trained to report suspected sightings to the Storm Water department.

The Waste Water Collection, Street, Solid Waste, and Water Distribution departments, recognize unusual conditions and flows, and report these to the Storm Water department. Reports from the general public are also investigated in the same manner.

All areas of the MS4 will be screened at a minimum once each permit term. All of the identified outfalls in the MS4 will be screened twice per year for debris, excessive plant growth, and dry weather flows. The methodology of the screening may not conform to the protocol of 40 CFR 122.26 (d) (1) (D). Sample collection and analysis may not conform to 40 CFR 136.

Storm water personnel will screen outfalls for debris, oil and grease sheen, odors, erosion, structural damage, and any other unusual conditions during and immediately after sampling events. Unusual conditions will be logged for that event and if hazards are created by any of these conditions they will be reported to the proper authorities.

The City of Amarillo floatables program consists of monitoring a minimum of one storm water conveyance twice per year. The floatable material will be estimated in cubic yards and included on an annual report. The City of Amarillo reserves the right to identify the locations and to change locations as needed to insure that the program is adequate and accomplishing the intended goals.

The city conducts regular activity at all applicable outfall locations that include mowing and control of invasive plant removal.

The Storm water program conducts semi-annual dry weather screenings at all of the MS4 outfalls. In addition, personnel are at the sampling outfalls and adjacent outfalls regularly for maintenance of sampling points, and windshield surveys of nearby neighborhoods. Flows are traced when found. Sampling and analysis is conducted when contamination is suspected.

In addition, once per permit term, Storm water personnel drive the city and observe every storm water conveyance for dry weather flows. Flows are traced when found, and facilities that may be required to obtain a permit for the stormwater industrial program are identified.

7.1. Sample Locations

The TPDES Permit requires monitoring storm water quality at the following five stations:

- Outfall 001 – Thompson Park Lake
- Outfall 002 – Medi-Park Lake
- Outfall 003 – T-Anchor Lake
- Outfall 004 – Lawrence Lake
- Outfall 005 – Martin Road Lake

Sampling locations for each outfall are indicated schematically on Figure A1-2. The locations for the three playas are in specific MS4 collection pipes shortly before discharge into their respective lakes. For the two man-made lakes, the sampling points are at the spillways of the two lakes, just after discharge from the lakes.

7.2. Sample Frequency

There are two seasons identified in TPDES Permit WQ0004678000, as follows:

Season	Period
1	October 1 – March 31
2	April 1 – September 30

Sampling is required for one storm event during each of the two seasons and at each of the five outfalls. Therefore, the total number of event samples to be collected each year is 10.

Minimum qualifying precipitation events are defined as 0.10” with a minimum of 72 hours since the last measurable precipitation event of at least 0.10”.

TPDES Permit WQ0004678000 defines an annual reporting period that extends from October 1 of one year, to September 30 of the following year. Each reporting year is divided into the two previously defined seasons. For purposes of clarity, it is necessary to define how each reporting year is identified.

Each Reporting Year (RY) will be defined as follows:

Reporting Year	Time Period	
	October 1 to September 30	
RY 2006	2005	2006
RY 2007	2006	2007
RY 2008	2007	2008
RY 2009	2008	2009
RY 2010	2009	2010
RY 2011	2010	2011

Serious and diligent efforts will be made to collect and analyze samples, adhering to the described schedule. There are some extraneous conditions, which present problems, and may cause the permittee to fail to comply with the schedule.

Personnel will not be required to expose themselves to unsafe conditions. Dangerous weather conditions, such as lightning, hail, ice accumulations, and extreme winds, will be avoided. If no other storm event occurs, which offers a safe sampling opportunity, an explanation (sampling waiver), certified by the appropriate official, will be submitted in the records.

The semi-arid climate of the Amarillo area also presents problems with the schedule. There may occasionally be seasons in which no sampling opportunity exists, for one or more outfalls. It is not unusual for a sampling opportunity to exist at one outfall and not at one or more of the remaining outfalls.

One problem that exists is the distance between outfalls, and their related drainage basins. Moderate to heavy thunderstorms can drop significant rainfall on one drainage basin, while one or more of the remaining drainage basins receive less than the minimum required for a valid sampling event.

Another problem is the physical difference that exists, of these outfalls, and their respective drainage basins. Outfalls 003, 004, and 005, usually receive immediate flow from their drainage basins, while outfalls 001, and 002 receive flow directly from impoundments. These flows may be significantly delayed, when extended periods of dry weather allow the lake levels to drop below the spillways.

Diligent attempts will be made to sample the missed outfalls at the next available opportunity in the season, however there may be seasons in which no opportunity occurs. These seasons will be designated as “No Flow” on the appropriate Discharge Monitoring Report, for that outfall.

Automatic sampling and switching devices placed in the field in the second season of RY 2003, have reduced the exposure time to storm events and are expected to greatly improve sampling success during storm events for Amarillo’s MS4.

When sampling snowmelt, care should be taken to avoid sampling when snow removal practices create non-representative concentrations of pollutants. Avoid sampling when snow mounds have been created, that provide concentrations of de-icing compounds, and / or sediment, that are greater or less than would normally be a part of the general snow melt runoff.

7.3. Analysis Parameters

Both grab and composite samples are to be collected at each storm event, from outfalls 003, 004, and 005. Grab samples will be collected from outfalls 001 and 002. These samples are to be analyzed for 22 water quality parameters. The parameters are listed in Table 3.A-1

Flow weighted composite samples may be collected manually or automatically. The samples will be collected at a minimum, for the first three hours of discharge, or for the entire length of discharge where the discharge lasts less than three hours. The composite shall be comprised of a

minimum of three aliquots per hour, separated by a minimum of 15 minutes. Where more than three aliquots per hour are collected comparable intervals between aliquots shall be maintained.

Grab samples shall be taken during the first two hours of discharge.

Sample collection and analysis will conform to requirements of 40 CFR Part 136, where these methods exist.

Wet-Weather Monitoring Parameters

Parameter	**Type of Sample**
Biochemical Oxygen Demand	Composite
Cadmium, Total	Composite
Chemical Oxygen Demand	Composite
Copper, Total	Composite
Diazinon	Composite
E. coli	Grab
Fecal Streptococcus	Grab
Hardness (as $CaCO_3$)	Grab
Lead, Total	Composite
Nickel, Total	Composite
Nitrogen, Nitrate+Nitrite	Composite
Nitrogen, Total	Composite
Nitrogen, Total Kjeldahl	Composite
Oil and Grease (O & G)	Grab
PH	Grab
Phenols, Total	Composite
Phosphorus, Dissolved	Composite
Phosphorus, Total	Composite
Solids, Total Dissolved	Composite
Solids, Total Suspended	Composite
Temperature	Grab
Zinc, Total	Composite

8. Staff/Contractor Training

The city should provide training to staff members to promote effective job performance and ensure personnel safety. The city should require that contractors have similar training.

8.1. Effective Job Performance

To increase productivity and reduce accidents, injuries, and mistakes, storm sewer personnel must be trained to use the equipment that they need to perform repair and maintenance on the MS4. As described elsewhere in this document, this may include:

- Specialized equipment such as vacuum trucks, rodding trucks, augers, and cutting tools
- Hand tools such as mowers, brushcutters, and chain saws.
- Heavy equipment such as skid-steers, backhoes, excavators, loaders, dump trucks, bulldozers, and dredging barges and associated dewatering equipment.
- Other equipment.

For most equipment, training should consist of a trainee working for a significant amount of time under the tutelage of a person experienced with the equipment. Training continues until the trainee has developed sufficient experience to use the equipment without supervision and can demonstrate safe, proper, and efficient use of the equipment.

If no in-house training is available for certain equipment, staff members should attend outside training classes. The city should cross-train storm sewer personnel on the equipment needed to perform multiple tasks to create a more knowledgeable, more flexible staff.

The city should also send staff members to schools, seminars, trade shows, certification programs, and other educational conferences to stay abreast of the latest developments in MS4 repair and maintenance.

The goal of this type of training is to increase productivity and reduce accidents, injuries, and mistakes.

8.2. Safety

Potential safety hazards include, but are not limited to, confined space entry and exposure to hazardous materials. As described in the following sections, training is required to deal with these hazards in a safe manner.

Confined Spaces

The MS4 contains confined spaces with limited or restricted means for entry or exit, including manholes, inlet collection boxes, pipes, and other facilities. Repair and maintenance of these facilities may require a staff member or contractor to physically enter the facility. All city staff members and contractors should complete confined space safety training before entering any

confined portion of the MS4. There should always be at least one trained person present outside the entrance/exit of the confined space to monitor the safety of personnel inside the confined space.

To prevent drowning or other injury, confined space entry should take place during dry weather conditions with no imminent forecast of rain. During a confined space entry, the "outside" trained person will monitor the weather and notify personnel to evacuate the confined space if rainfall occurs.

Hazardous Materials

Hazardous materials may enter the MS4 through accidental spills and illegal dumping and must be contained and removed from the system. All storm sewer personnel must be trained to identify/detect hazardous materials. All city staff members or contractors must receive appropriate hazardous materials training before working to contain or remove hazardous materials from the MS4.

8.3. Illicit Flows

Storm sewer personnel should be trained to recognize and report illicit flows to the MS4.

8.4. Other Training

Successful repair and maintenance of the MS4 may require training in addition to that described above. Training needs should be reevaluated annually as part of the update to this plan (described in Section 1.5).

9. Equipment Maintenance

Storm sewer personnel must use various types of equipment to perform repair and maintenance on the MS4, including:

- Specialized equipment such as vacuum trucks, rodding trucks, augers, and cutting tools
- Hand tools such as mowers, brushcutters, and chain saws.
- Heavy equipment such as skid-steers, backhoes, excavators, loaders, dump trucks, bulldozers, and dredging barges and associated dewatering equipment.
- Other equipment.

Personnel should follow all manufacturer's recommendations for routine equipment maintenance such as oil and fluid changes, tune-ups, etc. Fluid levels should be checked on a daily basis.

Equipment operability should be verified before use. Equipment repairs should be performed as needed, and any defects should be corrected before use.

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10. Recordkeeping and Reporting

Records of all storm sewer repair and maintenance activities should be kept, analyzed, and reported to meet MS4 Texas Pollutant Discharge Elimination System (TPDES) permit requirements and assist in efficient operation of the drainage utility.

10.1. Recordkeeping

All MS4 facilities should be assigned an identification number, and location information and the results of inspections, repairs, and maintenance should be recorded for each facility. At a minimum, records should include:

- Inspection dates and results
  - Facility condition score
  - Facility criticality score
  - Facility risk score
  - Repairs needed
  - Maintenance needed
- Problems reported with dates
  - High water
  - Trash accumulation
  - Odors
- Repair dates and repairs performed
- Maintenance dates and maintenance performed
  - Volumes of sediment, trash, and debris removed
  - Volumes of vegetation removed
  - Utilities relocated
- Staff training records
- Equipment maintenance records

Forms should be developed for every inspection, repair, and maintenance activity to assist in recordkeeping and performance tracking. These forms should be completed and filed electronically.

In addition performance metrics should be tracked annually. Examples include, but are not limited to:

- Number of inlets cleaned
- Cubic yards of sediment, trash, and debris removed
- Cubic yards of vegetation removed
- Feet of pipe inspected with video camera
- Feet of pipe cleaned with high-pressure water and/or rodding

- Number of emergency/priority call responses
- Number of storm sewer facility locations marked in advance of other construction
- Numbers of facilities repaired by facility type
- Staff time used for each repair and maintenance BMP
- Other costs associated with each repair and maintenance BMP

These records should be accessible to all storm sewer personnel through a GIS interface. Records should be analyzed geographically to assist the utility in identifying the sources of repair and maintenance needs and to assist the utility in targeting repair and maintenance efforts.

10.2. Reporting

The utility should develop an annual report showing performance metrics and associated unit costs (*e.g.*, dollars per inlet cleaned, dollars per cubic yard of trash removed, dollars per feet of pipe cleaned, etc.). This report should be used to allocate staff and budget for optimal repair and maintenance of the MS4.

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Appendix A:
Risk Score for Inlets, Outfalls, and Channels

(Note that the appendices and figures of the following criteria memo were removed)

TECHNICAL MEMORANDUM

CITY OF AMARILLO
MARTIN ROAD LAKE
Storm Water Master Plan Project
Data Collection Criteria Manual

Project No.: 0458-022-01

Date: April 22, 2013

Prepared For: Mark Read, P.E., City Engineer

Prepared By: Adam Rose, P.E.
Lauren Plunk, P.E.

cc: file

INTRODUCTION:

The purpose of this memorandum is to document the methodology and results of a risk-based assessment of drainage structures located throughout the City of Amarillo (City) Martin Road Lake Drainage Area. The results of the condition assessment are intended to support project recommendations (Task 4). This risk-based approach to asset management provides not only the condition information required to make project recommendations but also a ranking of each location, which can be used to develop, group and phase solutions to drainage problems. Due to the size (approximately 800 pages) the photographs of each site are included on the project website.

CONDITION ASSESSMENT METHODOLOGY:

A condition assessment was performed on specific drainage structures (outfalls, inlets, channels, the pump station, the storm sewer system, and the playa lake) selected by the project team as part of the kickoff meeting. Condition (likelihood and type of failure) information collected at each site is used to catalog the varying types of erosion and conveyance control measures and determine the primary cause of existing or potential failures such as playa lake wave erosion, channel erosion outfall failure, or structural failure. For the inlets, channels, and outfalls, the risk of each site was estimated by collecting condition and criticality data for each of the specific drainage locations. For the pump station and playa lake, a visual inspection was used to identify signs of hydraulic degradation or condition failures. For the storm sewer system, CCTV technology was used to evaluate the internal condition of the pipe. The

general drainage sites are displayed in Figure 1. Condition scores, criticality scores, and risk scores for inlets, channels, and outfalls are provided in Appendix A.

Outfalls, Inlets and Channels

Criticality (consequence of failure) information was also collected at each site. These data were used to rank the individual sites based on total risk and to explore any connections between existing condition and current criticality. The general drainage sites are displayed in Figure 1.

Due to the numerous structures to be evaluated, a mobile phone application was developed which enabled data to be collected while in the field. These data included photos of each site with location specific identification, GIS coordinates, and date and time stamp of each investigation. In addition to the photographic documentation, the condition and criticality score could be uploaded remotely and site specific notes could be added for reference purposes, such as utility conflicts. More information about this methodology can be found in Appendix B.

The condition of each structure was evaluated based on its current physical condition, erosion protection performance within 100-feet of the structure, and maintainability based on the scoring system is outlined in Tables 1 and 2. Each category was assigned a weighted percentage as outlined in Tables 3 and 4. The criteria, scores and weights were developed as part of the project workshop facilitated in Task A. The sum of an individual condition criteria score and criterion weight determines the weighted score of the criterion. The sum of all criteria provides an overall condition score.

Table 1: Condition Description Guidelines – Outfalls and Channels

Element	**Description**				
SCORE	**1**	**2**	**3**	**4**	**5**
Physical Condition of Structure	Substantially exceeds current requirements	Exceeds current requirements	Obvious concerns: cost/benefit questions	Inefficient; becoming ineffective, obsolete	Failing, not capable of sustaining required performance
Erosion Protection Performance within 100' of Structure	Negligible attention required: exceeds requirements	Minor erosion concerns	Obvious concerns: cost/benefit questions	Difficult to sustain performance	Failing, not capable of sustaining required performance
Maintainability (Replacement Magnitude)	None	Minimal	Moderate: specifications probably required but effort not significant	Can be maintained with significant effort	Not currently maintainable
% Physical life consumed	Almost new; up to 10% physical life consumed	Up to 30% physical life consumed	Up to 70% physical life consumed	Up to 90% physical life consumed	Virtually consumed, imminent failure

Table 2: Condition Description Guidelines – Inlets

Element	Description				
SCORE	1	2	3	4	5
Physical Condition of Structure	Substantially exceeds current requirements	Exceeds current requirements	Obvious concerns: cost/benefit questions	Inefficient; becoming ineffective, obsolete	Failing, not capable of sustaining required performance
Prior Complaints	None	None	1 complaint	1 complaint	2+ complaints within 5 years
Capacity	<24" main line	<36" main line	<48" main line	<60" main line	>60" main line
Maintainability (Replacement Magnitude)	None	Minimal	Moderate: specifications probably required but effort not significant	Can be maintained with significant effort	Not currently maintainable
% Physical life consumed	Almost new; up to 10% physical life consumed	Up to 30% physical life consumed	Up to 70% physical life consumed	Up to 90% physical life consumed	Virtually consumed, imminent failure

Table 3: Condition Weightings – Outfalls and Channels

Category	Weight
Physical Condition	45%
Erosion Protection Performance	35%
Maintainability (Replacement Frequency)	20%
Total (must = 100%)	**100%**

Table 4: Condition Weightings - Inlets

Category	Weight
Physical Condition	30%
Prior Complaints	30%
Capacity	20%
Maintainability (Replacement Frequency)	20%
Total (must = 100%)	**100%**

The criticality of each structure was evaluated based on the structure's potential failure and its impact to the community, safety and liability to the public, environmental and regulatory concerns, and replacement

difficulty based on the scoring system outlined in Table 5. Each category was assigned a weighted percentage as outlined in Table 6. The criteria, scores and weights were developed as part of the project workshop facilitated in Task A. The sum of an individual criticality criteria score and criterion weight determines the weighted score of the criterion. The sum of all criteria provides an overall criticality score.

Table 5: Criticality Description Guidelines – Outfalls, Channels, Inlets

Element	**Description**				
SCORE	**1**	**2**	**3**	**4**	**5**
Community Impact	No Impacts	Small Impact (only immediate landowner impacted; minimal customers impacted)	Moderate Impact (short duration, affect directly adjoining landowners, customers may avoid site)	Serious Impact (long duration, affect multiple landowners and structures, customers avoid site)	Severe Impact (affect multiple landowners and/or customers daily lives for a large distance from site)
Safety/Liability Impact	No impacts	Unlikely but potential safety hazard	Minor potential damage to property or unlikely injury	Major potential damage to property or likely injury	Potential loss of life
Environmental/Regulatory Impact: Scale of Soil/Habitat Lost or Disturbed in Current Condition)	No impacts	Minimal disturbance: erosion only directly at structure/soil interface	Disturbance within 100' of structure	Disturbance beyond 100' of structure	Immediate remediation required to prevent loss of significant habitat or regulatory violation.
Replacement Difficulty to Original Design Condition (Not Including Land Rights)	Replacement with existing manpower/ equipment/ maintenance schedules	Replacement required through additional contracts or specialized equipment/contractors	Replacement requires outside contractor and/or minimal engineering	Full engineering services required: can be restored to original design	Full engineering services required, Impractical to replace with existing design; requires extensive modifications to existing conditions
Failure Consequence	Almost none	Short term affects to small area	Long term affects to small area	Long term affects to large area	Virtual disaster

Table 6: Criticality Weightings

Category	Weight
Community Impact	25%
Safety/Liability Impact	40%
Environmental/Regulatory Impact	15%
Replacement Difficulty	20%
Total (must = 100%)	**100%**