Exhibit "A"

DRAINAGE MANAGEMENT

DESIGN GUIDELINES

Exhibit "A"

I. INTRODUCTION

It is the intent of these standards to provide guidelines and criteria for the design and construction of flood control and drainage facilities within the City of Hesperia (City). These standards shall apply to all new land development projects, re-development projects, and new street construction and widening projects. These standards shall also apply to restoration work performed by City workers when determined by the City Engineer to be necessary for public safety and welfare, or to be cost effective protection of public and private property.

The criteria contained in this policy discussion shall be required for the design of all flood control facilities to attenuate and/or safely convey storm waters through a given project while maintaining a high standard of living for residents and maintaining the integrity of the high desert environment.

Exhibit "A"

II. HYDRAULIC DESIGN STANDARDS AND PROCEDURES

The Hydrologic Design of all flood control and drainage facilities shall be in accordance with the San Bernardino County Flood Control District Hydrology Manual, latest edition.

All hydrologic design in areas of special flood hazard, areas of flood related erosion hazards and areas of mudslide or mudflow hazards identified by the Federal Emergency Management Agency shall be in accordance with the City Municipal Code, Title 8, Chapter 8.28, relating to flood hazard protections.

The following facilities shall be designed for rainfall resulting from a 100-year, 24-hour storm event.

A. All major and secondary facilities located within the City as described in the Hesperia Master Plan of Drainage and the Victorville Master Plan of Drainage as prepared by the San Bernardino County Flood Control District.

B. All other open channels, closed conduits, detention basins and debris basins which are proposed to be constructed in, or intercept flow from natural flow path except where supplemental usage of the street is allowed.

C. Culverts under master planned roadways identified on the City General Plan Circulation Element, secondary arterial and greater. Also culverts under at least one roadway providing access to an isolated development.

D. Natural flow path analysis for the purpose of determining the elevations of habitable structures. The lowest finish floor elevation of all habitable structures shall be a minimum of two feet above the maximum water level determined by using criteria San Bernardino County Standard S.P. 100.

Roadway facilities shall be designed based on the following storm event criteria.

A. The peak runoff from a 100-year storm will be contained within the street right-of-way.

B. The peak runoff from a 10-year storm will be contained at or below the street curbs.

   If a storm drain is required to meet either of the two conditions listed above, it shall be designed for a minimum capacity of the peak flow from a 10-year storm.

Exhibit "A"

III. HYDRAULIC DESIGN STANDARDS AND PROCEDURES

The hydraulic design of all flood control and drainage facilities shall be in accordance with the Los Angeles County Flood Control District Hydraulics Manual, latest edition, the State of California Department of Transportation Highway Design Manual, latest edition, and the American Public Works Association Standards, latest edition. Master planned facilities shall be designed in accordance with the Hesperia and Victorville Master Plans of Drainage.

A. OPEN CHANNELS – Open Channels shall be designed in accordance with San Bernardino County Flood Control District Standard No. S.P. 100. Hydraulic design shall be in conformance with the Los Angeles County Flood Control District Hydraulic Design Manual, latest edition, and the State of California Department of Transportation Highway Design Manual, latest edition.

1. **Bulking and Freeboard**

   Bulking and freeboard shall be per San Bernardino County Flood Control District Standard No. S.P. 100.

2. **Lining**

   a. Unlined or natural channels are acceptable where flow velocities are no greater than 3 feet per second or where erosion is not a factor.

   b. Concrete or concrete rip rap will be required for side slope protection where flow velocities exceed 3 feet per second.

   c. Fully lined concrete channels will be required where flow velocities exceed 12 feet per second or where erosion is determined to be a potential factor based on soil and slope conditions, or as required by the City Engineer.

3. **Street Flow**

   In any street or highway, the depth of water at curb times the velocity shall not exceed six. When this condition cannot be met, catch basins will be required to intercept the flow.

4. **Configuration and Access**

   All open channels shall be made accessible for maintenance and operations and shall provide an access along one side of the channel. All trapezoidal open channels shall be provided with vehicular access to the channel bottom. Channels with a bottom width of fifty feet or greater shall include access along both sides.

5. **Fencing**

   All open channels shall be fenced with chain link fencing as a minimum to prevent unauthorized access.

6. **Inlet and Outlet Structures**

   For inlet and outlet structure design see Sub-Section No. 6 and 7 of CLOSED CONDUIT DESIGN.

B. CLOSED CONDUIT – Closed conduit shall be designed in accordance with the Los Angeles County Flood Control District Hydraulics Manual, latest edition.

1. **General**

   a. Closed conduits may be designed as flowing full and may be allowed to flow under pressure if the hydraulic grade line is sufficiently below the street surface to intercept catch basin flows with a minimum of 0.5 feet freeboard in the catch basin below the gutter invert.

   b. Where debris may be expected, the design flows will be increased by an appropriate bulking factor.

2. **Design Requirements for Manholes**

   a. Spacing

      Manholes shall be located at the beginning or ending of curves, pipe size changes, angle points, junctions, and as required for maintenance.

      1. Conduit diameter 30 inches or smaller:

         Manholes shall be spaced at intervals of approximately 300 feet. Where the proposed pipe is less than 30 inches in diameter the horizontal alignment has numerous bends or angle points, the manhole spacing shall be reduced to approximately 200 feet.

      2. Pipe diameter larger than 30 inches but smaller than 45 inches:

         Manholes shall be spaced at intervals of approximately 400 feet.

3. Conduit diameter 45 inches or larger:

   Manholes shall be spaced at intervals of approximately 500 feet.

   The spacing requirements shown above apply regardless of design velocities. Deviations from the above criteria shall be subject to City approval.

b. Location

Manholes shall not be located in street intersection where possible, especially when one or more streets are heavily traveled.

In situations where the proposed pipe is to be aligned both in easement and in street right-of-way, manholes shall be located in street right-of-way wherever possible.

Manholes shall be located as close to changes in grade as feasible when the following conditions exist:

1. The upstream pipe has a steeper slope than the downstream conduit and the change in grade is greater than 10 percent of the upstream slope. Sediment tends to deposit at the point where the change in grade occurs.

2. Transitioning to a smaller downstream pipe due to an abruptly steeper slope downstream. Smaller downstream pipe shall not be allowed except when extreme downstream conditions require the use of a smaller downstream pipe. The use of smaller downstream pipe will be subject to written approval of the City Engineer. In cases where storm drains pass through, and are discontinuous through detention basins, this rule does not apply.

c. Design

When the design flow in a pipe flowing full has a velocity of 20 fps or greater, or is super critical in a partially full pipe, the total horizontal angle of divergence or convergence between the walls of the manhole and its center line shall not exceed 45 degrees.

d. Pressure Manholes

Pressure manholes shall not be allowed. Exceptions may be made on a case-by-case basis by the City Engineer.

e. Deep Manholes

A manhole shaft safety ledge shall be provided in all instances when the manhole shaft is 20 feet or greater in depth. Installation shall be in accordance with Los Angeles County Flood Control District Standards.

3. Inlets into Main Line Drains

Lateral pipe entering a mainline pipe storm drain, generally shall be connected radially. Lateral pipe entering a main line box structure shall conform to the following:

a. Invert of lateral pipe 24 inches or less in diameter shall be no more than five feet above the invert.

b. Invert of lateral pipe 27 inches or larger in diameter shall be no more than 18 inches above the invert, with the exception that catch basin connector pipe less than 50 feet in length may be no more than five feet above the invert.

4. Minimum Pipe Size

The minimum diameter of mainline and catch basin connector pipe shall be 18 inches.

In cases where the pipe may carry significant amounts of debris, the minimum diameter of mainline pipe shall be 36 inches.

5. Minimum Slope

The minimum slope for main line pipe shall be .001 (.10 percent), unless otherwise approved by the City Engineer.

For debris carry storm drains, the minimum pipe slope shall be 0.03 (3 percent). If the surface grade is less than 3 percent, a debris basin will be required upstream of the area which does not meet this criteria.

6. Inlet Structures

An inlet structure shall be provided for storm drains originating in natural channels. The structure shall generally consist of a headwall, wingwalls to protect the adjacent banks from erosion, and a paved inlet apron with a minimum 4-foot-deep cutoff wall. The apron slope should be limited to a maximum of 2:1. Wall heights should conform to the height of the water with one foot of freeboard upstream of the inlet, and be adequate to protect both the fill over the drain and the embankments. Headwall and fill over the drain and the embankments. Headwall and wingwall fencing and protection barrier or trash rack shall be provided to prevent public entry. The trash rack should be used for inlets 48 inches (diameter or width) and smaller. For inlets larger than 48 inches a special designed trash rack may be required.

If debris is prevalent, barriers consisting of vertical 3 inch or 4-inch diameter steel pipe spaced at 1/3 the main line diameter or width to a maximum of 30 inches on centers should be embedded in concrete immediately upstream of the inlet apron.

7. Outlet Structures

When a storm drain outlets into a natural channel, an outlet structure shall be provided which prevents erosion and property damage. This outlet structure shall be designed with a cutoff wall having a minimum depth of three (3) feet. Velocity of flow at the outlet should agree as closely as possible with the existing channel velocity. Fencing and a protection barrier shall be provided.

When the discharge velocity is low, or subcritical, the outlet structure shall consist of a headwall, wingwalls, and an apron. The apron may consist of a concrete slab, or grouted rock with a minimum 3-foot-deep cutoff wall.

When the discharge velocity is high, or supercritical, the designer shall design bank protection in the vicinity of the outlet and an energy dissipater structure.

8. Protection Barriers and Trash Racks

A protection barrier is a means of preventing access to storm drains. Protection barriers may consist of large, heavy breakaway gates, single horizontal bars across catch basin openings, or chain link fencing around an inlet of exposed outlet. Protection barriers shall be provided wherever necessary to prevent unauthorized access to storm drains.

9. Debris Barriers

A debris barrier or deflector is a means of preventing large debris, such as tree limbs, logs, boulders and refuse, from entering a storm drain and plugging the conduit. The debris barrier should have openings wide enough to allow as much small debris as possible to pass through and yet narrow enough to protect the smallest conduit in the system downstream of the barrier. It shall be the designer's responsibility to provide a debris barrier or deflector appropriate for the situation.

10. Other Closed Conduit Criteria

a. Angle of Confluence

In general, the angle of confluence between main line and lateral shall not exceed 30 degrees under any of the following conditions:

1. Where the flow (Q) in the proposed lateral exceeds 10 percent of the main line flow.

2. Where the velocity flow in the proposed lateral is 20 fps or greater.

3. Where the size of the proposed lateral is 60 inches or greater.

4. Where the hydraulic calculations indicate excessive head losses may occur in the main line due to the confluence.

Connector pipe may be joined to main line pipe at angles greater than 30 degrees up to a maximum of 90 degrees provided none of the above conditions exist. Connections shall not be made to mainline pipe which may create conditions of adverse flow in the connector pipes.

b. The velocity in pipe shall not exceed 40 fps. For velocities from 20-30 fps, the minimum cover over steel in the pipe shall be ½ inch greater than the normal cover (1 -1 ½" minimum). For velocities from 30-40 fps, the minimum cover over the steel in the pipe shall be 1 inch greater than the normal cover (2" minimum).

IV. DETENTION FACILITIES

Onsite detention facilities are required for all development projects. Volume may be by means of underground chambers for commercial development or earthen basins for non-commercial development, or as approved by the City Engineer.

For sites less than 1 acre in size, volumes shall be 13.5 cubic feet per 100 square feet of impervious area. For sites larger than one acre, required volume shall be the difference between the 100-year, 24-hour volume of the post construction volume, less 90% of the pre-construction volume, all in accordance with the San Bernardino County Hydrology Manual.