
# CITY OF HOLTVILLE
# RANCHO MIRA VISTA

## HYDROLOGY STUDY

**JULY, 2007**

PREPARED FOR:
Rancho Mira Vista and
City of Holtville

PREPARED BY:

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**SECTION 6 Cont'd**

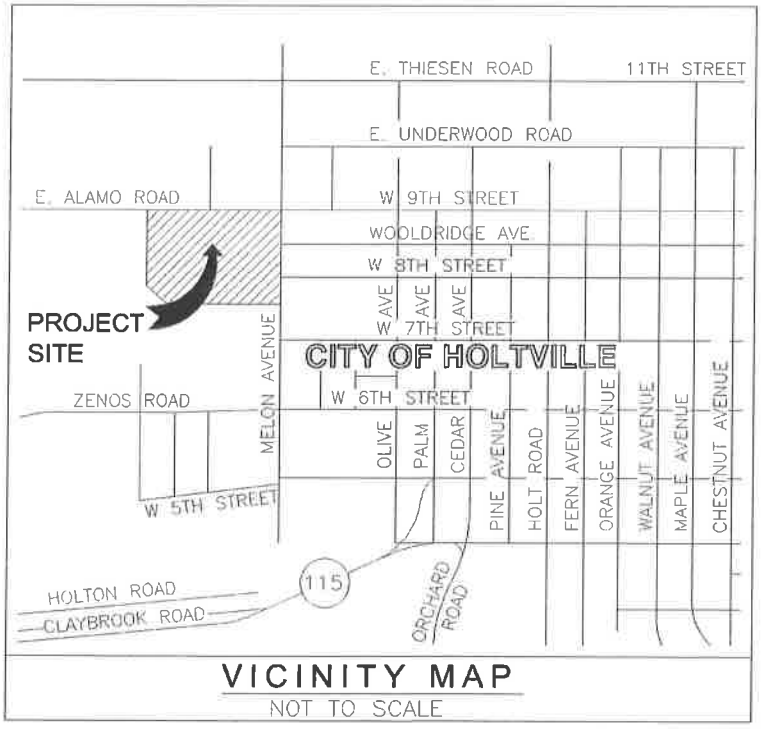
# HYDROLOGY STUDY
# for
# City of Holtville – Rancho Mira Vista

## THG Project No. 116.183E

## I. General Information

The project site is located at the southwest corner of Ninth Street (Alamo Road) and Melon Avenue within the City of Holtville (See Figure 1, below). The existing project site consists of approximately 33 acres of native vacant property. The site is to be developed as the Rancho Mira Vista residential subdivision project consisting of 107 dwelling units. The Rancho Mira Vista Subdivision will include off-site street improvements, on-site street improvements and domestic water, sanitary sewer and stormwater improvements.

**Figure 1 – Vicinity Map**




Currently, a majority of stormwater runoff generated from the area north of Fifth Street (State Highway 115) within the City Limits surface-flows toward the intersection of Ninth Street and Melon Avenue. It appears that the accumulated stormwater surface runoff arrives at the Ninth-Melon

intersection and flows to the Rancho Mira Vista project site. Ultimately the stormwater discharges to the Alamo River located west of the project site.

## II. Methodology

A field survey was conducted beginning at the downstream portion of the tributary area at the intersection of Melon Avenue and Ninth Street. The survey was continued until the upstream tributary area boundary was defined. Critical elevations were obtained at each intersection within the tributary area. The field survey for the west half of the tributary area was completed by GPS. The field survey for the east half of the tributary area was completed with a survey level. See Section 6 - Appendix B for the level notes completed for the verification of the east half of the tributary area. New benchmarks were established with a survey level within the west half tributary area to verify existing benchmarks located near the project site. See Section 6 - Appendix A for the benchmark loop level notes and map. Section 3 includes the existing schematic flow system plan sheets illustrating the obtained critical elevations at each intersection. The street surface stormwater flow pattern is also illustrated on the map.

For the purposes of completing hydrology calculations, the tributary area was divided into multiple sub-tributary areas (Areas 1 through 51) as shown in Section 2 - Tributary Area Map. The storm runoff generated from the sub-tributary areas 36 through 51 accumulates at the intersection of Holt Avenue and Ninth Street. A portion of the accumulated storm runoff flows north along the existing concrete surface stormwater conveyance system from the intersection of Holt Avenue and Ninth Street. The surface stormwater conveyance system consists of concrete cross-gutters and P.C.C. curbs and gutters. The grade difference separating the flow heading north and west from the intersection of Holt Avenue and Ninth Street is minimal. A portion of the storm runoff from sub-tributary areas 36 through 51 flows westward from the intersection of Holt Avenue and Ninth Street during major stormwater events. It was assumed that twenty five percent (25%) of the runoff generated from sub-tributary areas 36 through 51 overflows westward along Ninth Street and contributes to the project tributary area. The entire storm runoff from sub-tributary areas 1 through 35 and twenty five percent (25%) of storm runoff from sub-tributary areas 36 through 51 were considered as design storm runoff from the project tributary area. The project tributary area is bound by Brentwood and Grape Avenues on the east, Ninth Street on the north, Fifth and Sixth Streets on the south and Melon Avenue on the west.

The land use, flow path length and slope of each sub-tributary area were verified and/or calculated to derive the curve number and the time of concentration for each sub-tributary area as shown in Section 6 - Appendix D - Sub-tributary Area Fact Sheets. Other supporting documents for the

Haestad Methods' hydrology calculations were included in Section 6 - Appendix E.

The peak runoff flow rates and storm runoff volumes for various storms were calculated via the Soil Conservation Service (SCS) Unit Hydrograph Method, using Haestad Method's software. The computed curve number and time of concentration for each sub-tributary area were utilized to calculate the peak runoff flow rate and the runoff volume for each sub-tributary area. Accumulated runoff flow rates and runoff volumes at each stormwater conveyance system were also computed. The computed output calculations from Haestad Method's software are contained within Section 6 - Appendix F.

## III. Existing Stormwater Conveyance System

1. Overall Conveyance System

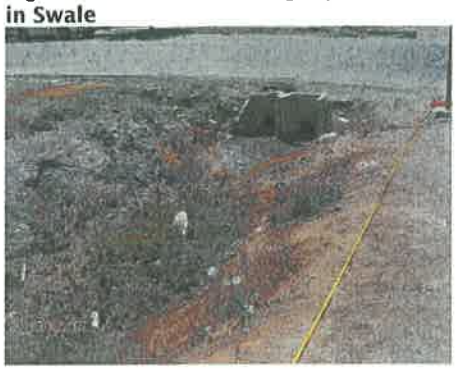
The storm runoff conveyed to the intersection of Melon Avenue and Ninth Street is first directed towards the existing open channel native earth swales (Swales 1 through 5 as illustrated on Sheet 8 of 9 titled "Existing Swale and Stormwater Pipeline System" in Section 3 of this document). Underground pipelines are located at side alley/street intersections on the east side of Melon Avenue south of Ninth Street. The small diameter pipelines transmit stormwater between sections of the open channel native earth swales. The design storm runoff continues to flow toward the inlet headwall structure of an existing concrete elliptical/circular pipeline located within Swale 5 on the east side of Melon Avenue south of Eighth Street. The stormwater runoff flows westerly through the concrete elliptical/36-inch diameter circular pipeline until it reaches the outlet headwall structure of the pipeline west of Melon Avenue and south of the Rancho Mira Vista project site. An existing open channel concrete stormwater conveyance system transmits the stormwater runoff from the outlet headwall structure to a 30-inch diameter outfall pipeline. The stormwater flow is conveyed through the 30-inch diameter outfall pipeline to the Alamo River.

2. Swales along Melon Avenue

There are five (5) existing earthen swales located along the east side of Melon Avenue south of Ninth Street. See Plan Sheet 8 - Existing Swale and Stormwater Pipeline System. The Existing Swale and Stormwater Pipeline System Plan Sheet is included in Section 3 of this report.

**Figure 2 - Swale at Ninth-Melon Intersection**

**Figure 3 - Interconnecting Pipelines in Swale**



Swale 1 is located between Ninth Street and the alley located between Ninth Street and Wooldridge Avenue. Swale 2 is located between the alley (located between Ninth Street and Wooldridge Avenue) and Wooldridge Avenue. Swale 3 is located between Wooldridge Avenue and the alley located between Wooldridge Avenue and Eighth Street. Swale 4 is located between the alley (located between Wooldridge Avenue and Eighth Street) and Eighth Street. Swale 5 extends approximately 630 feet south of Eighth Street. Two (2) 12-inch diameter cast iron underground pipelines connect each swale beneath the alleys and side-streets. There is an outlet headwall structure located along Swale 5 approximately 300 feet south of Eighth Street. The stormwater flow from the existing upstream swales is directed towards the outlet headwall structure.

The existing native earth swales contain vegetation and debris. The vegetation and debris reduce the stormwater flow capability of the native earth swales.

The small diameter 12-inch pipelines extending between open channel native earth swales at alley and side-street intersections along the east side of Melon Avenue constrict stormwater flow. Restricting the flow results in flooding of areas upstream of the swales during major stormwater events.

3. Elliptical/36" Diameter Circular Pipeline from Melon Avenue to Concrete Open Channel South of the Rancho Mira Vista Subdivision Location

   An elliptical 4.5 feet wide by 2.8 feet deep reinforced concrete pipeline/36-inch diameter circular pipeline extends approximately 804 feet west from the outlet headwall structure exiting Swale 5. The pipeline conveys stormwater flow from the upstream native earth swales along the east side of Melon Avenue south of Ninth Street. The elliptical pipe transitions to a 36-inch diameter circular pipe along the

enclosed conduit between the headwall structure on the east side of Melon Avenue and the downstream open channel concrete stormwater conveyance system. The transition location between the elliptical pipe and circular pipe is unknown. The 36-inch diameter circular reinforced concrete pipe extends beneath an existing industrial facility located south of the Rancho Mira Vista Project Site. The pipeline terminates at a concrete headwall outlet structure. The concrete outlet structure is located at the beginning of an open channel concrete stormwater conveyance system.

**Figure 4 - Inlet of Elliptical/36" Pipe at Swale 5**

**Figure 5 - Outlet of Elliptical/36" Pipe**

The existing elliptical/circular 36-inch diameter reinforced concrete pipeline appears to be functional; however the condition of the pipeline is unknown. As a portion of the pipeline is located beneath the existing industrial facility, it is not feasible to upsize the existing pipeline in its current location to improve stormwater flow capability.

4. Open Concrete Channel

The storm runoff flows from the existing 36-inch diameter reinforced concrete pipeline to an open channel concrete stormwater conveyance system. The trapezoidal shaped open channel concrete stormwater conveyance system is approximately 6 feet wide at the top and 2 feet wide at the bottom. The depth of the channel varies between 2 and 3 feet. The channel extends approximately 453 feet west (in an east-west orientation) from the outlet headwall structure of the 36-inch diameter pipeline to a 45 degree angle point. The channel changes direction from the 45 degree angle point in a northwest orientation for a distance of 260 feet. The channel terminates at the inlet headwall structure of the 30-inch diameter reinforced concrete outfall pipeline.

**Figure 6 - Open Concrete Channel - East**

**Figure 7 - Open Concrete Channel - West**

The open channel concrete stormwater conveyance system is in fair condition from the upstream end to the 45 degree bend. The open channel concrete stormwater conveyance system extending between the 45 degree bend and 30-inch diameter outfall pipeline is in poor condition.

5. 30" Outfall Pipeline

A 30-inch diameter reinforced concrete outfall pipeline extends 714 feet west (in an east-west orientation) from the inlet headwall structure located at the downstream point of the open channel concrete stormwater conveyance system. The outfall pipeline transmits the stormwater flow from the open channel concrete stormwater conveyance system to the Alamo River. The downstream termination point of the outfall pipeline is partially submerged beneath the water level of the Alamo River.

**Figure 8 - Existing Headwall Structure of 30" Outfall Pipeline**

**Figure 9 - Downstream Termination Point of 30" Outfall Pipeline at the Alamo River (Outlet)**

The condition of the existing 30-inch diameter reinforced concrete outfall pipeline is unknown.

6. Existing Stormwater Conveyance System Capacity

Computed stormwater flow rates and runoff volumes were compared with the capacity of each existing stormwater conveyance system described in the preceding section to determine the flow capability of the existing conveyance system. Computed stormwater flow rates and runoff volumes for each conveyance system were summarized in Tables 1 and 2 per the calculated results contained within Section 6 - Appendix G - Design Storm Runoff and Flow Rate Summary. Capacities of each existing stormwater conveyance system are summarized in Table 3. Detailed calculations for each stormwater conveyance system are contained within Section 6 - Appendix C.

**Table 1 - Summary of Design Flow Rates**

| | COMPUTED FLOW RATE, Q (CFS) | | | | | | |
|---|---|---|---|---|---|---|---|
| | X-Year 24 Hour Storm Event | | | | | | |
| | 1 | 2 | 5 | 10 | 25 | 50 | 100 |
| **SWALE 1 / PIPE 1** | 7.625 | 21.388 | 60.833 | 99.713 | 160.065 | 212.323 | 271.288 |
| **SWALE 2 / PIPE 2** | 7.675 | 21.708 | 61.933 | 102.083 | 163.975 | 217.583 | 278.048 |
| **SWALE 3 / PIPE 3** | 7.765 | 22.368 | 64.663 | 107.053 | 172.495 | 229.253 | 293.328 |
| **SWALE 4 / PIPE 4** | 7.765 | 22.368 | 64.663 | 107.053 | 172.495 | 229.253 | 293.328 |
| **SWALE 5-S** | 0.270 | 1.860 | 9.460 | 18.580 | 33.790 | 47.540 | 63.460 |
| **SWALE 5** | 8.025 | 24.198 | 74.113 | 124.943 | 205.325 | 275.633 | 355.418 |
| **ELLIPTICAL/36" RCP** | 8.025 | 24.198 | 74.113 | 124.943 | 205.325 | 275.633 | 355.418 |
| **OPEN CONC. CHNL.** | 10.315 | 30.148 | 90.233 | 151.003 | 246.755 | 330.353 | 425.108 |
| **30" OUTFALL RCP** | 10.315 | 30.148 | 90.233 | 151.003 | 246.755 | 330.353 | 425.108 |

* See Plan Sheets 1, 8 & 9 of Section 3 for swale, open concrete channel and pipe locations.

**Table 2 - Summary of Design Runoff Volumes**

| | COMPUTED RUNOFF VOLUME, V (AC-FT) | | | | | | |
|---|---|---|---|---|---|---|---|
| | X-Year 24 Hour Storm Event | | | | | | |
| | 1 | 2 | 5 | 10 | 25 | 50 | 100 |
| **SWALE 1** | 1.309 | 2.998 | 7.369 | 11.606 | 18.188 | 23.954 | 30.528 |
| **SWALE 2** | 1.325 | 3.047 | 7.517 | 11.856 | 18.602 | 24.514 | 31.258 |
| **SWALE 3** | 1.357 | 3.149 | 7.824 | 12.373 | 19.459 | 25.675 | 32.770 |
| **SWALE 4** | 1.357 | 3.149 | 7.824 | 12.373 | 19.459 | 25.675 | 32.770 |
| **SWALE 5-S** | 0.113 | 0.416 | 1.381 | 2.419 | 4.129 | 5.686 | 7.503 |
| **SWALE 5** | 1.471 | 3.565 | 9.205 | 14.792 | 23.588 | 31.361 | 40.274 |
| **ELLIPTICAL/36" RCP** | 1.471 | 3.565 | 9.205 | 14.792 | 23.588 | 31.361 | 40.274 |
| **OPEN CONC. CHNL.** | 1.774 | 4.276 | 10.989 | 17.622 | 28.052 | 37.261 | 47.815 |
| **30" OUTFALL RCP** | 1.774 | 4.276 | 10.989 | 17.622 | 28.052 | 37.261 | 47.815 |

* See Plan Sheets 1, 8 & 9 of Section 3 for swale, open concrete channel and pipe locations.

**Table 3 - Summary of Existing Stormwater Conveyance System Capacities**

| | Flow Rate, Q | Runoff Volume, V | |
|---|---|---|---|
| | (cfs) | (cf) | (ac-ft) |
| **SWALE 1** | 19.68 | 585 | 0.013 |
| **SWALE 2** | 11.93 | 1,584 | 0.036 |
| **SWALE 3** | 27.40 | 2,439 | 0.056 |
| **SWALE 4** | 44.89 | 1,724 | 0.040 |
| **SWALE 5** | 68.88 | 11,246 | 0.258 |
| **TOTAL - SWALES 1 to 5** | n/a | 17,578 | 0.404 |
| **PIPE 1** | 5.55 | n/a | |
| **PIPE 2** | 3.32 | n/a | |
| **PIPE 3** | 6.60 | n/a | |
| **PIPE 4** | 8.37 | n/a | |
| **AVERAGE - PIPES 1 to 4** | 5.96 | n/a | |
| **ELLIPTICAL/36" RCP** | 38.58 | n/a | |
| **OPEN CONCRETE CHANNEL** | 68.16 | 7,382 | 0.169 |
| **30" OUTFALL RCP** | 83.83 | n/a | |

The summary of acceptable storm events for each existing stormwater conveyance system is shown in Table 4.

**Table 4 - Summary of Acceptable Storm Event**

| | Flow Rate Q | Runoff Volume V | Acceptable Storm Event Q | Acceptable Storm Event V |
|---|---|---|---|---|
| | (cfs) | (ac-ft) | (cfs) | (ac-ft) |
| **SWALE 1** | 19.68 | 0.013 | 1-yr storm ($Q_1$=7.625) | |
| **SWALE 2** | 11.93 | 0.036 | 1-yr storm ($Q_1$=7.675) | |
| **SWALE 3** | 27.40 | 0.056 | 2-yr storm ($Q_2$=22.368) | |
| **SWALE 4** | 44.89 | 0.040 | 2-yr storm ($Q_2$=22.368) | |
| **SWALE 5** | 68.88 | 0.258 | 5-yr storm ($Q_5$=74.113) | |
| **TOTAL - SWALES 1 to 5** | n/a | 0.404 | n/a | |
| **PIPE 1** | 5.55 | n/a | less than a 1-yr storm | less than a 1-yr storm |
| **PIPE 2** | 3.32 | n/a | less than a 1-yr storm | |
| **PIPE 3** | 6.60 | n/a | less than a 1-yr storm | |
| **PIPE 4** | 8.37 | n/a | 1-yr storm ($Q_1$=7.765) | |
| **AVERAGE - PIPES 1 to 4** | 5.96 | n/a | less than a 1-yr storm | |
| **ELLIPTICAL/36" RCP** | 38.58 | n/a | 2-yr storm ($Q_2$=24.198) | |
| **OPEN CONC. CHNL.** | 68.16 | 0.169 | 2-yr storm ($Q_2$=30.148) | |
| **30" OUTFALL RCP** | 83.83 | n/a | 5-yr storm ($Q_5$=90.233) | |

* See Plan Sheets 1, 8 & 9 of Section 3 for swale, open concrete channel and pipe locations.

The calculations show that Swales 1 and 2 are capable of transmitting a stormwater runoff flow rate between a 1-year and 2-year storm. Swales 3 and 4 are capable of transmitting the runoff with a stormwater flow rate between a 2-year and 5-year storm. The flow rate capacity of Swale 5 is slightly less than the calculated flow rate of a 5-year storm. The total runoff storage volume of all existing swales is much less than a 1-year storm runoff volume.

The flow rate capacity of the interconnecting pipelines, Pipes 1 through 3, is much less than the calculated 1-year storm flow. Pipe 4 is capable of transmitting the runoff flow resultant from a 1 to 2-year storm event rate. The majority of the interconnecting pipelines have a flow rate capacity of less than a 1-year storm.

The elliptical/36-inch diameter circular pipeline and the open concrete channel are capable of conveying the stormwater runoff flow of between a 2-year and 5-year storm. The runoff storage volume of the open channel concrete stormwater conveyance system is far less than a 1-year storm. The 30-inch diameter outfall pipeline flow capability is less than the flow generated from a 5-year storm event.

7. Summary of the Existing Stormwater Conveyance System

Swale 5 and the existing 30" diameter reinforced concrete outfall pipeline can almost convey the stormwater flow from a 5-year storm. However; the flow rate and stormwater runoff capacity volume of the existing swales along Melon Avenue are less than the flow rates and stormwater runoff volumes generated from a 2-year storm. The existing swales overflow and flood the areas adjacent to and upstream of the existing swales along Melon Avenue during a 2-year or greater stormwater event.

## IV. Proposed Stormwater Conveyance System

1. Overall Proposed Conveyance System

The proposed stormwater conveyance system for the City of Holtville is to accommodate a 100-year, 24-hour storm. The stormwater conveyance system within the Rancho Mira Vista Subdivision is to be designed for a 10-year, 24-hour storm for the onsite infrastructure and a 100-year, 24-hour storm for the establishment of finish floor design. Based on this criteria, a comprehensive analysis was conducted to identify recommended improvements for the City's existing stormwater conveyance systems and the Rancho Mira Vista Subdivision.

The summary of the calculated stormwater runoffs and flow rates is illustrated by Table 5, below. Stormwater runoff and flow rate calculations are contained within Section 6 - Appendix G.

**Table 5 - Summary of Design Storm Runoff and Flow Rate**

| | | Flow Rate Q (cfs) | Runoff Volume Vol. (ac-ft) |
|---|---|---|---|
| **Proposed City Stormwater Conveyance System** | | | |
| Interim Improvements to Existing Swales | Existing Flow Rate of Elliptical/36" RCP (2 to 5-year 24-hour storm) | Q = 38.58 | N/A |
| Pipeline Between Melon Avenue and Regional Detention Basin | 100-year 24-hour Storm | $Q_{100}$ = 388.368 | N/A |
| Improvements to Swale 5-S | 100-year 24-hour Storm | $Q_{100}$ = 63.460 | N/A |
| Regional Detention Basin and Regional Pump Station | 100-year 24-hour Storm | N/A | $V_{100}$ = 47.815 |
| **Rancho Mira Vista Subdivision** | | | |
| Detention Basin/Project Site Pipe Network Design | 10-year 24-hour Storm | $Q_{10}$ = 11.720 | $V_{10}$ = 1.560 |
| Pump Station/Project Site Runoff Storage Capacity Design | 100-year 24-hour Storm | $Q_{100}$ = 36.740 | $V_{100}$ = 4.559 |
| Finish Floor Determination | 100-year 24-hour Storm | N/A | $V_{100}$ = 24.696 |

City of Holtville

The existing open channel and closed conduit pipeline stormwater conveyance system downstream of the Melon Avenue/Ninth Street Intersection are undersized and incapable of transmitting stormwater generated from a 2-year storm or greater. Calculations were completed to analyze the stormwater runoff flow capability of the existing stormwater conveyance system. Interim improvements are offered for the existing open channel native earth swales and interconnecting pipelines along the east side of Melon Avenue south of Ninth Street. The interim improvement calculations and suggested improvements are contained within Section 6 - Appendix H. Major improvements to the stormwater conveyance system downstream of the intersection of Ninth Street and Melon Avenue are recommended. The major improvements are divided into three (3) phases. The major stormwater conveyance system calculations and recommended improvements are contained within Section 6 -Appendix I.

The objective of the interim improvements is to increase the stormwater flow capabilities of the existing open channel earth swales on the east side of Melon Avenue south of Ninth Street. The interim improvements do not include improving the stormwater flow capabilities of the 30-inch and 36-inch diameter pipelines or open concrete lined channel. The recommended interim improvements would increase the flow capacity of the existing stormwater facilities to between a 2-year and 5-year storm. The minimal increase in stormwater flow capability is not considered to be cost-effective and is not recommended.

Major stormwater improvements to the existing stormwater conveyance system downstream of the intersection of Ninth Street and Melon Avenue are intended to mitigate the 100-year, 24-hour stormwater runoff from the existing upstream tributary area. The recommended major stormwater improvements are not intended to transmit stormwater flow from future development areas north of Ninth Street or outside the tributary areas.

Rancho Mira Vista Subdivision

The recommended on-site stormwater conveyance system capacity for the Rancho Mira Vista Subdivision is based on stormwater flow from solely the Rancho Mira Vista Subdivision (and not areas outside of the Rancho Mira Vista Subdivision). However; the off-site tributary area runoff was used to establish the finish floor elevations within the Rancho Mira Vista Subdivision.

The on-site stormwater infrastructure including the stormwater pipeline and detention basin is recommended to be designed for a 10-year, 24-hour storm. The on-site 100-year, 24-hour stormwater runoff volume is recommended to be stored within the surrounding off-site streets, on-site streets, alleys and landscape areas of the Rancho Mira Vista Subdivision. A stormwater pump station is recommended to be constructed at the detention basin. It is recommended the pump station be designed for an on-site 100-year 24-hour storm. The minimum finish floor elevations within the Rancho Mira Vista Subdivision are recommended to be designed for the combined runoff volume of the on-site 100-year, 24-hour storm and fifty percent (50 %) of the off-site 100-year, 24-hour storm directed to the intersection of Ninth Street/Alamo Road and Melon Avenue. The detailed analyses regarding the prior noted hydrology calculations and recommendations for the Rancho Mira Vista Subdivision are contained within Section 6 - Appendix J.

2. Interim Improvements to Existing Swales along Melon Avenue

The native earth swales along the east side of Melon Avenue south of Ninth Street were evaluated. It is recommended the stormwater flow capability of the native earth swales be increased to equal the stormwater flow capability of the existing downstream elliptical/36" diameter circular pipeline (Q = 38.58 cfs). The recommended improvements would allow the native earth swales to transmit stormwater flows generated from slightly less than a 5-year storm.

Existing swales measure approximately 8 to 16 feet in width and approximately 2.67 feet in depth. The maximum slope (S=0.156%) along the improved swales was obtained from the most upstream flowline elevation of the swale to the invert elevation of the elliptical/36" diameter circular pipeline. Manning's formula was used to design the recommended improved swales with various widths, depths and velocities. Based on the results, it is recommended that the improved swales be trapezoid-shaped with 1 to 1 side-slopes. It is recommended that the improved swales measure 10 feet wide at the top, 5 feet wide at the bottom and possess an average depth of 2.5 feet. The longitudinal flowline slope of the swales was calculated to be 0.156%.

The existing interconnecting pipelines between the native earth swales were analyzed. There are currently two (2) 12-inch diameter pipelines installed side by side beneath the alleys and side-streets east of Melon Avenue. The pipelines transmit stormwater flow between the open channel native earth swales. The interconnecting pipelines are undersized and do not possess an adequate diameter size to transmit the required stormwater volume from a 2-year storm or greater. It is recommended that the interconnecting pipelines between the native earth swales be replaced.

HDPE pipelines and concrete box culverts were considered as replacement options for the existing small diameter interconnecting pipelines. The required pipeline diameter size to convey a 5-year stormwater flow is 36 inches. The vertical distance between the native earth swale flowline (pipe invert) and the street/alley surface is less than 36 inches. A 36-inch diameter pipeline would extend above the alley/street surface. The use of a 36-inch diameter circular pipeline is not a viable option. It is recommended that the existing small diameter 12-inch interconnecting pipelines be replaced with a concrete box culvert. A concrete box culvert can be constructed with a sufficient cross-sectional area to convey a stormwater flow from a 5-year storm while remaining below the top of alley/street surface. It is recommended that the concrete box culvert interior dimensions measure 1 foot deep x 10 feet wide.

Table 6 illustrates the existing swale/interconnecting pipeline information prior to interim improvements and information/criteria after interim improvements are implemented.

Table 6 - Summary of Existing Native Earth Swales Before and After Interim Improvements

| | | Before | After |
|---|---|---|---|
| **Existing Swales** | Size | 8' to 16' wide x 2.67' deep | 10' wide x 2.5' deep |
| | Slope | Inconsistent | 0.156% |
| | Min. Flow Rate | 19.68 cfs | 38.58 cfs |
| | Acceptable Storm Event | Less than 1-year 24-hour storm (Due to restrictive interconnecting pipelines) | Slightly less than 5-year, 24-hour storm |
| **Interconnecting Pipelines** | Size & Type of Culvert | 2 - 12 inch Conc. Pipe | 1' deep x 10' wide Conc. Box Culvert |
| | Slope | Inconsistent | 0.156% |
| | Min. Flow Rate | 5.96 cfs (average) | 38.58 cfs |
| | Acceptable Storm Event | Less than 1-year 24-hour storm | Slightly less than 5-year, 24-hour storm |

It is estimated that the recommended interim improvements will cost $216,391.00. A copy of the Engineer's opinion of probable cost is included in Section 5 - 1 of this report. The minimal stormwater flow increase provided by the recommended improvements is not considered cost effective. Interim stormwater improvements are not cost effective and are not recommended.

3. Proposed Stormwater Conveyance System for the City of Holtville

It was determined that the existing stormwater conveyance system extending downstream of the Ninth Street/Melon Road intersection (except for the 30-inch diameter outfall pipeline to the Alamo River) requires replacement. Sections of the existing stormwater conveyance system are in poor condition. All sections of the stormwater conveyance system are undersized and incapable of transmitting flow from a 5-year storm or greater. The existing native earth swales along Melon Avenue south of Ninth Street, the elliptical/36" diameter circular pipeline between the native earth swales and the existing open channel concrete stormwater conveyance system west of Melon Avenue, and the open channel concrete stormwater conveyance system are to be replaced with a new stormwater conveyance system. It is recommended that a regional detention basin be constructed capable of accepting the stormwater volume from a 100-year, 24-hour storm. It is recommended a stormwater pump station and downstream stormwater forcemain be constructed. The stormwater pump station and forcemain would convey the detention basin stormwater to the existing 30-inch diameter

outfall pipeline within 72 hours after a 100-year, 24-hour stormwater event as required by the State of California Department of Health. The existing 30-inch diameter stormwater outfall pipeline is not capable of conveying peak flows for a 100-year, 24-hour stormwater event. The existing 30-inch diameter pipeline possesses the capacity to convey the volume of a 100-year, 24-hour stormwater event over a 72-hour period. It is recommended that the existing 30-inch diameter stormwater pipeline be maintained as a component of the proposed 100-year, 24-hour stormwater conveyance system.

The major recommended improvements to the stormwater conveyance system downstream of Ninth Street/Alamo Road and Melon Avenue Intersection are capable of accommodating stormwater flows resultant from a 100-year, 24-hour storm. It is recommended that the major improvements be constructed in three (3) phases. Phase I consists of the construction of a regional detention basin southwest of the Rancho Mira Vista Subdivision. Phase II consists of the replacement of the existing stormwater conveyance system between the intersection of Melon Avenue and Ninth Street/Alamo Road and the new regional detention basin with a new high density polyethylene (HDPE) pipeline. Phase III consists of the installation of a regional pump station and forcemain pipeline to convey the storm runoff from the regional detention basin to the existing 30-inch diameter outfall pipeline. The existing 30-inch diameter outfall pipeline is to remain in service. The existing 30-inch diameter outfall pipeline will transmit the stormwater from the new detention basin/stormwater pump station/forcemain pipeline to the Alamo River.

Phase I

It is recommended the regional detention basin store a 100-year, 24-hour storm runoff volume of 47.815 acre-feet. The groundwater table was assumed to be approximately 25 feet below the native surface elevation of the proposed regional detention basin site. The size of the regional detention basin was determined based on the assumed groundwater table elevation. The groundwater table was not determined in the field during the preparation of this report as the proposed detention basin area is privately owned. Permission to access the site to determine the groundwater elevation was not granted by the property owner. It is extremely important to verify the actual groundwater table elevation prior to the preparation of the improvement plans for the regional detention basin. If the groundwater table is determined to be less than 25 feet, then it will be necessary to increase the area of the detention basin to insure the 100-year, 24-hour stormwater volume be accommodated within the detention basin. The bottom of the detention basin is to be maintained a minimum of 5 feet above the actual groundwater table.

The vacant land proposed to be acquired for the construction of the detention basin is approximately 13.6 acres and consists of two (2) parcels. It appears that the runoff from the upstream tributary area (2/3 of the City of Holtville) has been flowing through the proposed detention basin area since before Holtville was a Town as evidenced by the watercourse washes carved through the area. The proposed detention basin is at the low point of the tributary area and located close to the existing 30-inch diameter outfall pipeline. The proposed location of the detention basin is ideal.

The proposed regional detention basin is to be designed with maximum 3:1 (horizontal : vertical) side-slopes. The regional detention basin is to store the stormwater generated from a 100-year, 24-hour storm. The stormwater runoff volume shall be stored within the regional detention basin to an elevation not greater than the invert elevation of the most upstream stormwater inlet structure at the intersection of Melon Avenue and Ninth Street. The high water regional detention basin elevation shall be determined according to these criteria in order to prevent the upstream stormwater inlet structure from surcharging.

It is recommended that the regional detention basin be constructed within a minimum area of 8.6 acres as illustrated on the proposed stormwater drainage system plan sheet included in Section 4 of this report. The top area of the detention basin shall be 7 acres. It is recommended a 1.6 acre buffer area be maintained around the detention basin. The recommended stormwater depth of the detention basin is 10.4 feet. It is recommended a minimum of two (2) vertical feet of freeboard be maintained between the high water surface and top embankment of the detention basin.

The Phase I improvement cost is estimated to be $2,736,352. A copy of the Engineer's opinion of probable cost is included in Section 5 - 2 of this report.

Phase II

The proposed stormwater conveyance system extending from the Ninth Street/Alamo Road and Melon Avenue intersection to the regional detention basin is to be capable of conveying the stormwater flow from a 100-year, 24-hour storm. The existing swales along the east side of Melon Avenue south of Ninth Street, the elliptical/36" diameter reinforced concrete circular pipeline and the open channel concrete stormwater conveyance system are to be replaced with a new 72-inch diameter high density polyethylene (HDPE) pipeline.

The majority of the stormwater runoff from the tributary area upstream of the Rancho Mira Vista Project flows to the intersection of Melon Avenue and Ninth Street/Alamo Road. The flow is directed south along the existing native earth lined swales to the elliptical/36" diameter circular concrete pipeline inlet headwall. There is a native earth swale section on the east side of Melon Avenue located south of the inlet headwall. The native earth swale section extends approximately 313 feet south of the inlet elliptical/36-inch diameter circular pipeline headwall. The stormwater in the 313-foot long native earth swale flows from south to north to the elliptical/36-inch diameter circular pipeline inlet headwall structure. The swale has been designated "Swale 5-S" on Plan Sheet 8 contained within Section 3 of this report. It is recommended that Swale 5-S be replaced with a 36-inch diameter underground stormwater pipeline. A stormwater catch basin is to be located at the southerly termination point of Swale 5-S.

The downstream invert elevation of the new 72-inch diameter HDPE pipeline at the regional detention basin has been determined from the depth of the detention basin as previously described. It is assumed that the HDPE pipeline invert is a minimum of 5 feet above the existing groundwater table. It will be necessary to confirm the groundwater table depth prior to the preparation of improvement plans. The maximum upstream invert elevation of the new HDPE pipeline is defined by maintaining a minimum 1 foot vertical separation from the bottom of the existing sanitary sewer pipeline extending along the alley east of Melon Avenue between Wooldridge Avenue and Ninth Street to the top of the new HDPE pipeline. The bottom of the existing sanitary sewer pipeline is the constraining factor at the upstream section of the 72-inch HDPE stormwater pipeline. The maximum design slope of the new HDPE stormwater pipeline is defined by the invert elevation at the regional detention basin and the top of HDPE pipeline at the alley sanitary sewer crossing between Wooldridge Avenue and Ninth Street on the east side of Melon Avenue. Given these two (2) constraints, the design slope along the new HDPE pipeline was calculated to be 0.410%.

Manning's formula was utilized to analyze various diameter sizes of HDPE pipeline according to the prior noted constraints. Trial and error calculations resulted in the determination that the minimum recommended pipeline diameter size is 72 inches. It is recommended that a 72-inch diameter HDPE pipeline be installed to replace the existing swales (excluding Swale 5-S), the elliptical/36" diameter circular concrete pipeline and the open channel concrete stormwater conveyance system west of Melon Avenue. It is recommended Swale 5-S be replaced with a 36-inch diameter HDPE pipeline. See Table 7, below, for the parameters and values for the analysis of the 36" and 72" stormwater pipeline diameters.

Table 7 - HDPE Pipeline Design Criteria

| | 72" dia. HDPE Pipeline | 36" dia. HDPE Pipeline |
|---|---|---|
| Replaced from | Existing Swales along Melon Avenue (except for Swale 5-S), Elliptical/36" dia. RCP and Open Concrete Channel | Swale 5-S |
| Slope, S | 0.410 % | 0.500% |
| Velocity, *v* | 13.85 ft/sec | 9.64 ft/sec |
| Flow Rate, Q | 391.50 cfs | 68.15 cfs |

Phase II improvements are estimated to cost $2,710,281. A copy of the Engineer's opinion of probable cost is included in Section 5 - 3 of this report.

Phase III

A regional pump station with a forcemain shall be constructed to convey the stored 100-year, 24-hour stormwater volume to the existing inlet headwall structure of the 30-inch outfall pipeline extending to the Alamo River. The regional detention basin is to be completely emptied within a maximum detention period of 72 hours.

It is recommended that a pump station with a minimum discharge rate of 3,700 gallons per minute (gpm) be constructed with a downstream forcemain pipeline extending from the pump station to the existing 30" outfall pipeline. The stormwater forcemain is to be 18 inches in diameter.

The cost of Phase III improvements is estimated at $985,875. A copy of the Engineer's opinion of probable cost is included in Section 5 - 4 of this report.

4. Proposed Stormwater Conveyance System for the Rancho Mira Vista Subdivision

An analysis of the proposed on-site Rancho Mira Vista Subdivision stormwater infrastructure including stormwater pipelines and catch basins, the on-site detention basin and the on-site pump station was completed. In addition, the stormwater runoff from the on-site Rancho Mira Vista Project Site, on-site stormwater volume within street and landscape areas and the finish floor elevations of the residential housing units were evaluated and analyzed. The calculations are illustrated within Section 6 - Appendix J. The appropriate design flow rates and runoff volumes selected for the analyses were calculated as illustrated within Section 6 - Appendix G. All analyses and design recommendations were completed based on the Rancho Mira Vista

Tentative Tract Map dated April 2007 (Appendix K) previously submitted to the City.

On-site Stormwater Pipeline System

The on-site HDPE stormwater pipelines were designed to transmit a 10-year, 24-hour stormwater flow rate using Manning's formula. Various sizes of HDPE pipelines were analyzed with the calculated flow rate of 11.720 cfs. Based on the results of the calculations and analyses, it is recommended that 24-inch diameter HDPE pipelines with a minimum slope of 0.150% be constructed within the Rancho Mira Vista Project Site. Stormwater catch basins are to be constructed in the street areas along the length of the new stormwater pipelines. The 24-inch diameter pipelines and catch basins are to convey nuisance water and up to 10-year, 24-hour stormwater flows to the on-site detention basin.

Rancho Mira Vista Detention Basin

It is recommended that the on-site detention basin be constructed to contain a 10-year, 24-hour storm volume. The detention basin is to be constructed with maximum 3:1 (horizontal:vertical) side-slopes and 1 foot of freeboard. The minimum stormwater volume to be stored is 1.560 acre-feet. The detention basin area is 0.9 acres (39,182 s.f.) as illustrated on the Rancho Mira Vista Tentative Tract Map dated April 2007 (Appendix K) previously submitted to the City. In order to prevent the lowest upstream stormwater catch basin/manhole from surcharging, the highest stormwater elevation in the detention basin is to be less than the surface elevation of the lowest upstream stormwater catch basin/manhole.

The capacity of the on-site detention basin was analyzed based on the information illustrated on the Rancho Mira Vista Tentative Tract Map (Appendix K). The detention basin illustrated on the Rancho Mira Vista Tentative Tract Map dated April 2007 (Appendix K) previously submitted to the City can adequately store a 10-year 24-hour storm volume.

On-site Runoff Storage Capacity

It is recommended the 100-year, 24-hour storm volume generated by the Rancho Mira Vista Subdivision be contained within the subdivision site. The stormwater volume of 4.559 acre-feet is to be stored temporarily within the onsite detention basin and within the streets, alleys and landscape areas of the Rancho Mira Vista Subdivision.

The stormwater volume to be contained within the Rancho Mira Vista Subdivision Site was analyzed based on the information illustrated on the Rancho Mira Vista Tentative Tract Map (Appendix K). The storm volume shall be temporarily stored within the on-site detention basin and on-site streets, alleys and landscape areas within the subdivision. It is recommended that the east, south and west driveway entrances from the exterior roadways surrounding the Rancho Mira Vista Subdivision be elevated (raised) to maintain the required stormwater volume within the subdivision site. The finish floor elevations of the residential units within the subdivision are to be maintained at an elevation higher than the 100-year, 24-hour stormwater surface elevation. The stormwater analysis contained within Appendix J in Section 6 of this document demonstrates that the 100-year 24-hour design runoff volume generated from the Rancho Mira Vista Subdivision can be temporarily contained within the Subdivision.

Rancho Mira Vista Pump Station

An on-site pump station with a forcemain pipeline is to be constructed to convey a maximum 100-year, 24-hour on-site stormwater volume to the existing 30-inch stormwater outfall pipeline extending to the Alamo River. The stormwater volume generated from the Rancho Mira Vista Subdivision is to be transmitted from the detention basin within a 48 hour period after a 100-year, 24-hour storm event. The State of California Department of Health requires a minimum of 72-hour detention period. However, a more stringent detention period was applied to the Rancho Mira Vista Subdivision as the majority of a 100-year, 24-hour stormwater runoff volume will be stored within onsite alleys, streets and landscape areas during a major storm event.

It is recommended that a stormwater pump station with a minimum discharge rate of 520 gallons per minute (gpm) be constructed. It is recommended that a smaller 50 gallon per minute nuisance water pump be placed within the stormwater pump station. It is recommended that the stormwater forcemain pipeline be 6 inches in diameter. It is recommended a 3-inch diameter nuisance water forcemain be extended from the nuisance water pump to the 6-inch diameter stormwater forcemain.

At the time the Regional Detention Basin southwest of the Rancho Mira Vista Subdivision is constructed, it will be required the stormwater volume of the Rancho Mira Vista Subdivision be conveyed to the Regional Detention Basin by a gravity pipeline. The on-site Rancho Mira Vista pump station and forcemain are to be abandoned after the gravity pipeline is constructed from the Rancho Mira Vista Subdivision to the

Regional Stormwater Detention Basin. It may be possible to abandon or reduce the size of the Rancho Mira Vista Subdivision detention basin as long as the entire stormwater runoff and the nuisance water from the site are conveyed through the gravity pipeline to the Regional Detention Basin. The Rancho Mira Vista Subdivision will be required to comply with the minimum open space/landscape/park requirements per the City Ordinance after abandoning and/or reducing the size of the on-site detention basin.

It is recommended that the HDPE gravity pipeline extending from the Rancho Mira Vista Subdivision to the Regional Detention Basin be designed to convey a 100-year, 24-hour stormwater flow of 36.740 cfs. The recommended HDPE gravity pipeline diameter was calculated using Manning's formula for various pipeline diameter sizes on a trial and error basis. Per the trial and error calculations, it is recommended that a 36-inch diameter HDPE pipeline with a minimum slope of 0.150% be installed to convey a 100-year, 24-hour stormwater volume to the Regional Stormwater Detention Basin. An increased pipeline slope would result in greater flow capacity and a smaller pipeline diameter size. It is recommended that a greater pipeline slope be further investigated during the initial design phase of the HDPE gravity pipeline extending between the Rancho Mira Vista Subdivision and Regional Stormwater Detention Basin.

## Finish Floor Elevation Determination

The analysis and recommended finish floor elevations were based upon the assumption that the major off-site City of Holtville Stormwater Infrastructure Improvements will not be completed prior to the construction of the Rancho Mira Vista Subdivision. The finish floor elevations of the Rancho Mira Vista residential units are to be placed above the 100-year, 24-hour average stormwater level resultant from the tributary area upstream of the Rancho Mira Vista Project Site and the on-site 100-year, 24-hour average stormwater level.

Half of the off-site stormwater runoff at the intersection of Melon Avenue and Ninth Street resultant from the upstream tributary area was assumed to flow northward and the other half was assumed to flow westward. The combined runoff volume resultant from the on-site 100-year, 24-hour storm and fifty percent (50 %) of the off-site 100-year, 24-hour storm was used to establish the finish floor elevations of the Rancho Mira Vista housing units. The combined runoff volume totaled 24.696 ac-ft.

Based on the calculations, flooding will occur up to an elevation of approximately 24 inches above the adjacent off-site roadway top of

curb. It is recommended the Rancho Mira Vista finish floor elevations be constructed a minimum of 24 inches above the adjacent off-site street top of curb elevation.

## V. Conclusion and Recommendations

### 1. Rancho Mira Vista Subdivision

The Rancho Mira Vista Subdivision is susceptible to flooding from the storm runoff generated from the off-site upstream tributary area during major stormwater events. Rancho Mira Vista Subdivision grading recommendations were provided assuming that major off-site stormwater infrastructure improvements would not be completed prior to the construction of the Rancho Mira Vista Subdivision. It is recommended the Rancho Mira Vista site be elevated above the average 100-year, 24-hour stormwater flow. The Rancho Mira Vista grading recommendations are as follows:

- It is recommended the east, north and west roadway entrances be constructed with a high grade break. The high grade break elevations shall be a minimum of 1 foot above the adjacent off-site street centerline elevations. The high grade break will maintain the off-site stormwater flow within Melon Avenue, Ninth Street/Alamo Road and Tamarack Avenue during low to medium stormwater events. The elevated grade breaks will also allow on-site stormwater to be stored within the streets, alleys and landscape areas of the Rancho Mira Vista Subdivision until such time as it can be discharged to the existing 30-inch outfall pipeline southwest of the project site or to the regional stormwater detention basin in the future.
- It is recommended on-site east-west oriented streets within the Rancho Mira Vista Subdivision be designed to maintain a straight grade flowing from east to west to the detention basin without grade breaks.
- It is recommended on-site north-south oriented streets within the Rancho Mira Vista Subdivision be designed to possess high points (elevated grade breaks) near or at the mid points of the streets. The high grade breaks will direct stormwater to the north and south end of the street sections. North-South oriented streets designed according to this recommendation will prevent flooding of residential units located at and near the center of the subdivision.

- Design grades along alleys shall be parallel (or close to being parallel) with the on-site streets.
- It is recommended the storm drainage infrastructure, as illustrated on the Rancho Mira Vista Tentative Tract Map, be relocated as required to accommodate the on-site street grades per the previous recommendations.
- The new Rancho Mira Vista on-site detention basin shall be designed to store a 10-year, 24-hour stormwater volume. The Rancho Mira Vista on-site stormwater pump station and forcemain shall be constructed to convey both nuisance water and stormwater generated from a 100-year, 24-hour stormwater event. The stormwater forcemain will extend from the Rancho Mira Vista on-site stormwater pump station to the existing 30-inch diameter stormwater outfall pipeline extending to the Alamo River. The 30-inch outfall pipeline is located southwest of the Rancho Mira Vista Project Site. It may be possible to eliminate the Rancho Mira Vista Stormwater Pump Station and Rancho Mira Vista detention basin after the City of Holtville Regional Stormwater Detention Basin is constructed. The improvement plans for the Rancho Mira Vista Subdivision are to be prepared for the future elimination of the on-site stormwater pump station and detention basin at the time the City of Holtville regional stormwater detention basin is constructed. It is recommended that a 36-inch diameter HDPE gravity pipeline be constructed from the Rancho Mira Vista Detention Basin to the south pavement termination point of Tamarack Avenue during the construction of the Rancho Mira Vista Subdivision. The HDPE gravity pipeline can be constructed with relative ease and cost-effectively during the construction of the Rancho Mira Vista Subdivision before Tamarack Avenue is paved. The installation of the gravity pipeline will be more costly after Tamarack Avenue is constructed.
- It is recommended the finish floor elevations of the Rancho Mira Vista Residential Units be constructed 24 inches above the highest top of off-site street concrete curb elevation adjacent to each lot.
- It is recommended the developer provide a stormwater and construction easement to construct the new City of Holtville 72-inch diameter stormwater pipeline beneath the existing gravel road south of the Rancho Mira Vista Project Site (West 8th Street on Parcel "B" as illustrated on the Rancho Mira Vista Tentative Tract Map contained within Section 6 - Appendix K).
- New stormwater catch basins shall be constructed at the curb return spandrels of the roadway entrances (at the driveway entrances at Tamarack Avenue, Alamo Road/Ninth Street and Melon Avenue). Stormwater pipelines shall be constructed from

the stormwater catch basins to the future location of the off-site 72-inch diameter HDPE stormwater pipeline.

- It is recommended 8-inch curb and gutter be constructed along Alamo Road, Melon Avenue and Tamarack Avenue to allow maximum stormwater flow along the off-site streets.

2. Recommended City of Holtville Stormwater Improvements

The Rancho Mira Vista recommendations are intended to provide on-site mitigation measures and prevent catastrophic flooding of the Rancho Mira Vista Project from the off-site upstream tributary area 100-year, 24-hour stormwater flow. The area surrounding the Rancho Mira Vista Site will be subject to the same flooding conditions that existed prior to the construction of the Rancho Mira Vista Project.

The recommended Phase I, II and III City of Holtville Stormwater Improvements south of the Ninth Street/Alamo Road and Melon Avenue Intersection were previously reviewed in detail. Phase I, II and III recommended improvements will be briefly described as follows:

Interim Improvements - Interim Improvements are offered to improve the capacities of the existing swales and interconnecting pipelines along the east side of Melon Avenue south of the Ninth Street/Alamo Road and Melon Avenue Intersection. The existing swales shall be capable of conveying storm runoff from slightly less than a 5-year storm after the improvements are completed.

Phase I - Phase I is to consist of the construction of the regional detention basin at a location southwest of the Rancho Mira Vista Subdivision. It will be necessary for the City of Holtville to acquire the property at the recommended location of the Regional Detention Basin. The Regional Detention Basin is to conform to the requirements of the Phase I Improvements noted on pages 14 and 15 of this section of the study. The regional detention basin shall be able to store a 100-year 24-hour storm.

Phase II - Phase II is to consist of the installation of a 72-inch diameter HDPE pipeline from the intersection of Ninth Street/Alamo Road and Melon Avenue to the Regional Detention Basin. The 72-inch diameter HDPE pipeline shall be capable of conveying the stormwater runoff from a 100-year, 24-hour storm at peak hour flow.

Phase III - Phase III is to consist of the construction of a Regional Stormwater Pump Station with a flow capacity of 3,700 gallons per minute. The Regional Detention Basin shall be emptied within a maximum of 72-hours after a stormwater event per State of California Health Department

requirements. An 18-inch diameter stormwater forcemain shall be constructed from the Regional Stormwater Detention Basin to the existing 30-inch diameter stormwater outfall pipeline. The existing 30-inch diameter outfall pipeline will convey the stormwater to the Alamo River.

The summary of the engineer's opinion of probable cost is illustrated by Table 8, below.

**Table 8 - Engineer's Opinion of Probable Cost Summary**

| | Design Storm | EOOPC |
|---|---|---|
| Interim Improvements | Approximately a 5-year storm | $ 216,391 |
| Phase I | 100-year storm | $2,736,352 |
| Phase II | 100-year storm | $2,710,281 |
| Phase III | 100-year storm | $ 985,875 |
| **Total** | | **$6,648,899** |