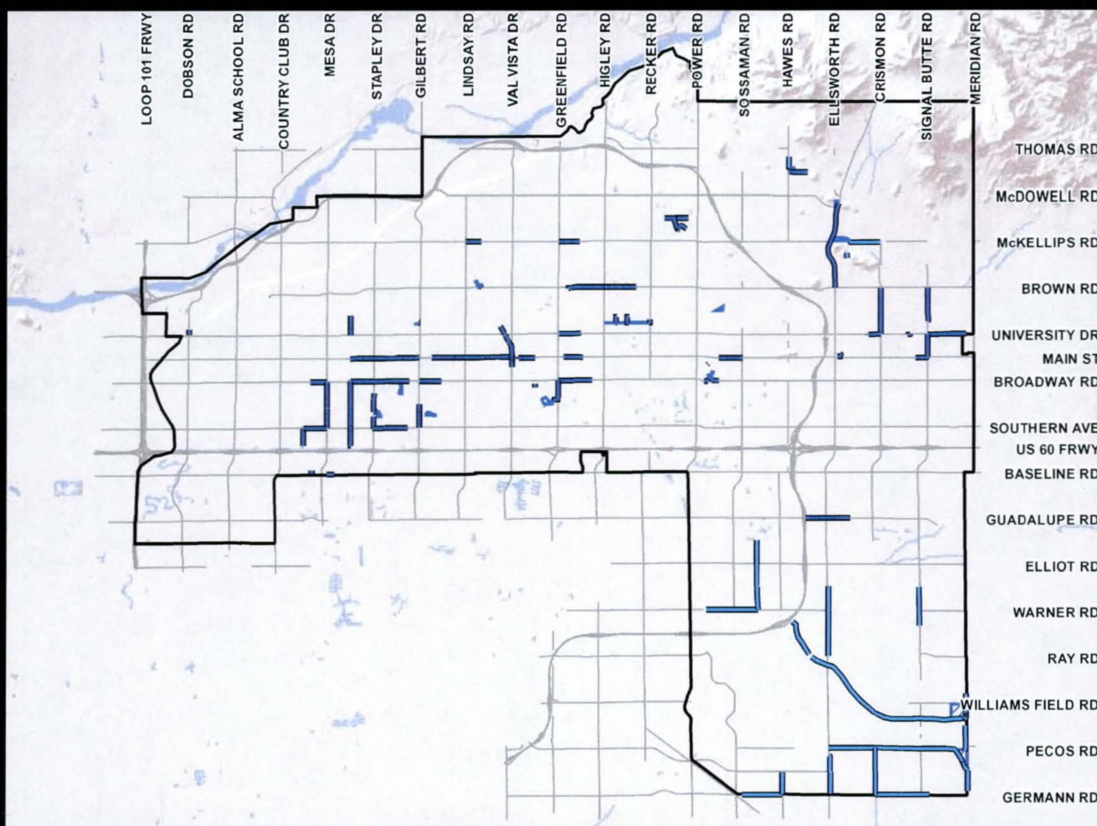
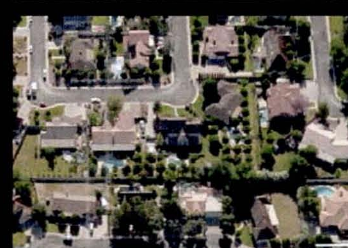
CITY OF MESA

STORM DRAIN MASTER PLAN





PREPARED FOR THE CITY OF MESA

JANUARY 2010

Entellus™

mesa·az

City of Mesa
Storm Drain Master Plan

City of Mesa Project No.
07-016-001

Prepared for City of Mesa
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CITY OF MESA
STORM DRAIN MASTER PLAN
TABLE OF CONTENTS

SECTION 1: INTRODUCTION....................1-1

1.1 Project Location....................1-1
1.2 Background....................1-2
1.3 Report Organization....................1-2

SECTION 2: DATA COLLECTION....................2-1

2.1 Topographic and Aerial Mapping]....................2-1
2.2 As-Builts....................2-1
2.3 Survey and GIS Data....................2-1
2.4 Existing Studies....................2-2
  2.4.1 Studies List....................2-2
2.5 Data Collection Deficiencies....................2-3

SECTION 3: STANDARDS AND POLICIES REVIEW....................3-1

3.1 Comparison of Standards and Policies....................3-1
  3.1.1 Retention/Detention:....................3-1
  3.1.2 Street Drainage:....................3-1
  3.1.3 Storm Drain:....................3-2
  3.1.4 Miscellaneous:....................3-2
3.2 Investigation of Green Drainage Solutions....................3-2
3.3 Drywell Regulations Evaluation....................3-4

SECTION 4: HYDROLOGIC ANALYSIS....................4-1

4.1 Hydrologic Models....................4-1
4.2 Future Conditions Hydrologic Model Modifications....................4-2
  4.2.1 Retention Modeling....................4-2
    4.2.1.1 Tempe Canal Retention Modeling....................4-3
    4.2.1.2 Consolidated Canal Retention Modeling....................4-4
    4.2.1.3 Eastern Canal Retention Modeling....................4-4
    4.2.1.4 East Mesa ADMP Retention Modeling....................4-4
    4.2.1.5 Spook Hills Retention Modeling....................4-4
  4.2.2 Model Linking....................4-4
    4.2.2.1 EC, CC, TC Model Linking....................4-4
    4.2.2.2 NE, SE Model Linking....................4-6
    4.2.2.3 NW Model....................4-6
  4.2.3 Eastern Canal Model Modifications....................4-7
    4.2.3.1 Corrected Original Model Errors Encountered....................4-7
    4.2.3.2 Additional Eastern Canal Model Modifications....................4-7
  4.2.4 Consolidated Canal Model Modifications....................4-7
    4.2.4.1 Corrected Original HEC-1 Error....................4-7
    4.2.4.2 HEC-1 Record Duplicate Name Modification....................4-8
    4.2.4.3 Additional Consolidated Canal Model Modifications....................4-8
  4.2.5 Tempe Canal Model Modifications....................4-9

4.2.5.1 Corrected Original HEC-1 Error 4-9
4.2.5.2 Additional Modeling Area North of Tempe and Crosscut Canals ..4-9
4.2.5.3 Added Concentration Points 4-9
4.2.6 Northeast Mesa – East Mesa Model Modifications 4-10
4.2.6.1 Combining Existing and Future Conditions Models 4-10
4.2.7 Northwest Mesa – East Mesa Model Modifications 4-10
4.2.7.1 Added Storm Drains and Concentration Points 4-10
4.2.7.2 Modified Routing Methodology 4-11
4.2.7.3 Modified Subbasin Retention 4-11
4.2.8 Southeast Mesa – East Mesa Model Modifications 4-11
4.2.8.1 Loop 202 and 802 Freeway Modifications 4-11
4.2.9 Spook Hills Model Modifications 4-11
4.2.10 10-Year 24-Hour Storm Modifications 4-11
4.2.10.1 10-Year Eastern Canal Model Modifications 4-12
4.2.10.2 10-Year Consolidated Canal Model Modifications 4-13
4.2.10.3 10-Year Tempe Canal Model Modifications 4-13
4.2.10.4 10-Year Northeast Mesa – East Mesa Model Modifications 4-15
4.2.10.5 10-Year Northwest Mesa – East Mesa Model Modifications 4-16
4.2.10.6 10-Year Southeast Mesa – East Mesa Model Modifications 4-17
4.3 Proposed Hydrologic Model Modifications 4-17
4.3.1 Eastern Canal Model Modifications 4-18
4.3.2 Consolidated Canal Model Modifications 4-18
4.3.3 Tempe Canal Model Modifications 4-18
4.3.4 Northeast Mesa – East Mesa Model Modifications 4-19
4.3.5 Northwest Mesa – East Mesa Model Modifications 4-19
4.3.6 Southeast Mesa – East Mesa Model Modifications 4-20
4.3.7 Spook Hills Model Modifications 4-20
4.4 Compilation of Data into GIS 4-20

SECTION 5: HYDRAULIC ANALYSIS 5-1

5.1 Methodology 5-1
5.2 Storm Drain Data 5-2
5.3 Roadway Capacity 5-3
5.4 Analysis of Existing Infrastructure 5-4
5.5 Disconnection from Irrigation 5-4

SECTION 6: ALTERNATIVE EVALUATION 6-1

6.1 Alternative Evaluation Methodology 6-1
6.2 Cost Estimate Methodology 6-1
6.2.1 Storm Drains 6-1
6.2.2 Channels 6-2
6.2.3 Retention Basins 6-2
6.3 Adequate Networks 6-3
6.3.1 Network 5B - Broadway Road 6-3
6.3.2 Network 7C - Southern Avenue and Dobson Road 6-3
6.3.3 Network 8C - Baseline Road and Alma School Road 6-3
6.3.4 Network 11C - McClellan Road 6-3

6.3.5 Network 15C - Alma School Road....6-3
6.3.6 Network 18D - Country Club Drive....6-3
6.3.7 Network 23A - Country Club Drive....6-3
6.3.8 Network 23A-2 - Westwood Road....6-4
6.3.9 Network 54B - 24th Street....6-4
6.3.10 Network 55A - Lindsay Road....6-4
6.3.11 Network 58B - Lindsay Road....6-4
6.3.12 Network 62A & 62A-2 - Consolidated Canal....6-4
6.3.13 Network 73D - Higley Road....6-4
6.3.14 Network 81B - McDowell Road....6-5
6.3.15 Network 85B - Higley Road....6-5
6.3.16 Network 85B-2 - Main Street....6-5
6.3.17 Network 87C - Southern Ave....6-5
6.3.18 Network 91D - Power Road....6-5
6.3.19 Network 96C - Baseline Road....6-5
6.3.20 Network 97D - McDowell Road....6-5
6.3.21 Network 98D - Hermosa Vista Drive....6-6
6.3.22 Network 111B - Baseline Road....6-6
6.3.23 Network 117D-2 - 97th Way....6-6
6.3.24 Network 127A - Crismon Road....6-6
6.3.25 Network 127-2 - Ellsworth Road....6-6
6.3.26 Network 143A - Signal Butte Road....6-6
6.4 Proposed Infrastructure Improvements....6-7
6.4.1 Network 4C - Dobson Road....6-7
6.4.2 Network 11B - Main Street....6-7
6.4.3 Network 31C - Mesa Drive....6-8
6.4.4 Network 31D – Baseline Road....6-9
6.4.5 Network 39C - Stapley Drive....6-9
6.4.6 Network 47C - Gilbert Road....6-10
6.4.7 Network 59B - Lindsay Road/Eastern Canal....6-11
6.4.8 Network 63A - Val Vista Drive....6-11
6.4.9 Network 70C - Eastern Canal South....6-12
6.4.10 Network 71C - Greenfield Road....6-13
6.4.11 Network 75B - McKellips Road....6-14
6.4.12 Network 76A - Ellsworth Road....6-15
6.4.13 Network 77C - University Drive....6-15
6.4.14 Network 86A - Power Road....6-16
6.4.15 Network 95B - Power Road....6-16
6.4.16 Network 113A - Oak Street Channel and Storm Drain....6-17
6.4.17 Network 117D - Ellsworth Road....6-17
6.4.18 Network 122B - Spook Hill Proposed Channel and Storm Drain....6-18
6.4.19 Network 123B - 94th Street Proposed Channel....6-18
6.4.20 Network 125C - Crismon Road....6-18
6.4.21 Network 133A - Signal Butte Road....6-19
6.4.22 Network 133B - University Drive....6-19
6.4.23 Network 312A - Guadalupe Road....6-19

6.4.24 Network 320B - 80th Street Proposed Channel 6-20
6.4.25 Network 336A - Loop 802 Proposed Channel 6-21
6.4.26 Network 336A-2 – Pacos Road Detention Basins: 6-22
6.4.27 Network 353B - Hawes Road Channel 6-22

SECTION 7: SUMMARY AND RECOMMENDATION 7-1

7.1 Recommended Changes to Regulations and Policies 7-1
7.2 Recommended Infrastructure Improvements 7-1
7.2.1 Storm Drain/Retention 7-1
7.2.2 Disconnection from Irrigation 7-1
7.3 GIS and Other Digital Deliverables 7-1
7.4 Implementation Plan 7-2

SECTION 8: REFERENCES 8-1

PLATES

FIGURES

APPENDIX A. DATA COLLECTION A-3

APPENDIX B. GENERAL DOCUMENTATION AND CORRESPONDENCE B-1

APPENDIX C. HYDROLOGY C-2

APPENDIX D. HYDRAULICS D-1

APPENDIX E. HYDRAULICS FOR ALTERNATIVES E-1

APPENDIX F. COST ANALYSIS F-1

APPENDIX G. PROPOSED DRAINAGE INFRASTRUCTURE G-2

APPENDIX H. ADEQUATE STORM DRAIN SYSTEM HYDRAULICS H-3

APPENDIX I. CD I-4

LIST OF TABLES

TABLE 3.1: SUMMARY OF GREEN DRAINAGE SOLUTIONS 3-3
TABLE 4.1: RUN-OFF COEFFICIENT 4-3
TABLE 4.2: JD CARD INPUTS 4-16
TABLE 5.1: FILE IDENTIFIER 5-2
TABLE 5.2: CONDUIT N - VALUES 5-3
TABLE 6.1: STORM DRAIN UNIT PRICES 6-1
TABLE 6.2: CHANNEL UNIT PRICES 6-2
TABLE 6.3: BASIN UNIT PRICES 6-2
TABLE 7.1: TRANSPORTATION/DRAINAGE PROJECTS 7-3
TABLE 7.2: DRAINAGE PROJECTS 7-3

LIST OF PLATES

Plate 1: Network ID Map 1 or 3
Plate 2: Network ID Map 2 or 3
Plate 3: Network ID Map 3 or 3

LIST OF FIGURES

Figure 1.1: Vicinity Map
Figure 2.1: Existing Infrastructure
Figure 2.2: Existing Drainage Issues
Figure 2.3: Limits of Prevision Studies
Figure 2.4: Focus Areas
Figure 2.5: Past Hydrologic Methodology Map
Figure 4.1: Assumed Retention Conditions
Figure 4.2: Hydrologic Boundaries
Figure 4.3: Land Use
Figure 4.4: Hydrology Schematics – Eastern & Consolidated Canal Model
Figure 4.5: Hydrology Schematics – Tempe Canal Model
Figure 4.6: Hydrology Schematics – Northeast East Mesa Model
Figure 4.7: Hydrology Schematics – Northwest East Mesa Model
Figure 4.8: Hydrology Schematics – Southeast Mesa Model
Figure 5.1: Storm Drain Irrigation Connections
Figure 7.1: Proposed Infrastructure
Figure 7.2: Hydraulic Prioritization of Networks

SECTION 1: INTRODUCTION

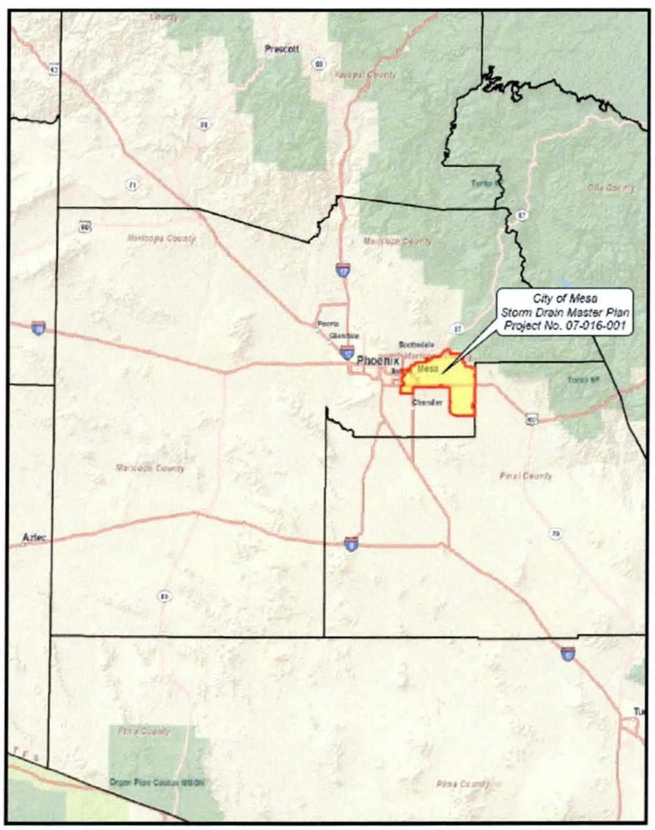
The information and analyses presented in this document are part of the scope of work performed by Entellus, Inc. for the City of Mesa (hereinafter referred to as the City) as part of the City of Mesa Storm Drain Master Plan Contract No. 07-016-001.

1.1 Project Location

This study covers the entire Corporate Boundary of the City of Mesa, Arizona. The City is located on the Eastern portion of Maricopa County bordered by the City of Tempe to the west, Town of Gilbert and City of Chandler to the south, and the Salt River to the north. The study area is approximately 160 square miles consisting of medium to dense residential, urban, and small amounts of agricultural land to the south with general runoff flows to the southwest. **Figure 1.1: Vicinity Map** shows the location of the area of study.

We further divided the study area into drainage watersheds and the storm drain systems within those watersheds. There are 7 modeling areas and numerous storm drain systems within those areas. See **Figure 4.2: Hydrologic Boundaries** and **Figure 2.1: Existing Infrastructure** which show the drainage watersheds and the location of the storm drain systems respectively. See **Plates 1-3: Network ID Maps** for location of modeled storm drains and corresponding network ID's.

FIGURE1.1
VICINITY MAP



1.2 Background

The purpose of this project is to evaluate the current City Storm Drain System and identify necessary improvements needed. The system was evaluated against the latest City drainage criteria and hydrologic modeling results developed by the City and the Flood Control District of Maricopa County.

The City completed a Storm Drain Master Plan in 1999 and has worked with the Flood Control District of Maricopa County to develop several area drainage master plans (ADMP). Several hydrological investigations have been performed within the City. This project evaluated the City's 1999 Storm Drain Master Plan, along with other pertinent master plans such as the Higley ADMP, the East Mesa ADMP, Spook Hills ADMP, East Maricopa ADMP and large private development drainage master plans. The project considered existing infrastructure, utilities, federal/state/local regulations and ordinances to develop a conceptual level strategic plan for the management of storm drainage as development occurs.

This Plan was developed in two phases. The first phase (Phase A) included data collection, evaluation, and the confirmation of the overall drainage system criteria and policies. Phase B included the compilation and development of an overall hydraulic model, evaluation of the existing storm drain infrastructure (storm drains, basins, channels, and roads) leading to the development of recommended storm drain system improvements.

This report presents the results of the hydrologic and hydraulic analyses and it documents the methodology, assumptions, problems and solutions encountered during the development of the study.

An intended and important bi-product from this study is that the results are all provided to the City in very useful electronic formats. A PDF of the complete report and the referenced data has been provided. Additionally, the hydrologic and hydraulic models are provided and all the existing and proposed Storm Drain Master Plan improvements are provided in an ESRI geographic information system (GIS) Format. The GIS information is entirely compatible with the City's Cityworks resource management software. This will ease the future use of all the valuable information collected and developed as part of this Storm Drain Master Plan.

1.3 Report Organization

This report is divided into 8 sections as follows:

- SECTION 1: INTRODUCTION
- SECTION 2: DATA COLLECTION
- SECTION 3: STANDARDS AND POLICY REVIEW
- SECTION 4: HYDROLOGIC ANALYSIS
- SECTION 5: HYDRAULIC ANALYSIS
- SECTION 6: ALTERNATIVE EVALUATION
- SECTION 7: SUMMARY AND RECOMMENDATION
- SECTION 8: REFERENCES

In addition it also includes 9 appendices of supporting documentation, reference materials, analysis results, and a preliminary plan and profile of the proposed improvements. A DVD of digital work products and information is also included.

SECTION 2: DATA COLLECTION

The data collection efforts for the City of Mesa Storm Drain Master Plan included gathering data specific to the project area. The information collected includes reports, documents, and electronic files related to hydrology, hydraulics, existing drainage infrastructure, planned infrastructure, development plans, planning studies, drainage problems, development guidelines, and other information relevant to the project. A complete listing of specific references is included in **Appendix A: Data Collection.** Also see **Figure 2.1: Existing Infrastructure** and **Figure 2.2: Existing Drainage Issues.**

2.1 Topographic and Aerial Mapping

Aerial mapping was provided by the Flood Control District at the request of the City. (See reference in **Appendix A: Data Collection**). The aerial resolution is 0.8 feet and covers the entire City limits.

2.2 As-Builts

As-built information was provided by the City on a specific location by location basis. Typically, as-builts were provided where data on existing infrastructure shown in the GIS quarter section maps was not adequate. This typically included storm drains, basins, and other significant drainage structures within the project area. A list of the 13 areas where as-builts were collected for this project is shown in **Appendix A-2: As-Built Log.** The actual as-builts are included in the CD.

2.3 Survey and GIS Data

Over the course of developing this storm drain master plan, three different horizontal datums were encountered.

From City of Mesa:

- NAD 1927 – With linear US feet

From Flood Control District Maricopa County:

- NAD 1983 HARN – With linear International Feet

Other Datums Encountered:

- NAD 1983 – With linear International Feet

For this project, Entellus imported all the information in its original datum then utilized GIS to specially project the information to the default datum NAD1983.

Multiple vertical datums were encountered in this project. The topographic information received from the FCDMC was in the vertical datum NAVD 88 elevations based on NGS benchmarks and are modeled using GEOID 03. A comparison was made of the published elevations on over 70 data points from the Flood Control District of Maricopa County, the City, and SRP for the

Consolidated Canal (see Elevation Checks in **Appendix D: Hydraulics**). This comparison showed that the elevations between the City and the Flood Control District were typically within one foot of each other in most cases. For this reason, and since most of the hydraulic information received was on the Flood Control District's NAVD 88 datum, all information that was provided was converted to this datum.

The GIS data used on this project was provided by the City. The GIS coverage's received are listed in the table in **Appendix A.1: Data Collection Log.** Entellus also developed new GIS coverage's which are included in the deliverables and discussed further in **Section 4.4: Compilation of Data into GIS.**

2.4 Existing Studies

Extensive investigation was performed to identify previous studies performed within the study area. Several sources where used to determine existing drainage reports in particular the City and the Flood Control District of Maricopa County (FCDMC). Relevant information for the study area includes drainage reports, Area Drainage Master Plans, and previous Storm Drain Master Plans. This project evaluated the City's 1999 Storm Drain Master Plan, along with other pertinent master plans such as the Higley ADMP, the East Mesa ADMP, Spook Hills ADMP, East Maricopa ADMP and large private development drainage master plans. The studies were reviewed, scanned, and compiled to establish an electronic database of drainage reports within the City (See **Appendix A.1: Data Collection Log, Figure 2.3: Limits of Previous Studies, Figure 2.4: Focus Areas** and **Figure 2.5: Past Hydrologic Methodology Map**).

2.4.1 Studies List

A list of some of the significant studies referenced is shown below:

- Tempe Canal Floodplain Delineation Study, 2006
- Technical Data Notebook Consolidated Canal FDS, 2003
- Hydrologic Analysis for Incorporation into Eastern Canal Floodplain Delineation Study, 1997
- Spook Hill Area Drainage Master Plan Level III Analysis-Recommended Alternative Report, 2002
- East Mesa Area Drainage Master Plan Recommended Design Report, 1998
- Southeast Mesa Area Drainage Master Plan, 1996
- Red Mountain Freeway (University to Southern Ave) Final Drainage report, 2005
- Mesa Drainage Report for Mesa Proving Grounds, 2008

2.5 Data Collection Deficiencies

Overall the majority of the information requested was able to be collected and documented. In regards to deficiencies, there was not a lack of information but more a lack of consistency and documentation between reports and actual hydrologic models.

In some cases, the hydrologic models did not match the report or had little to no documentation. As an effort to develop a complete picture and model, Entellus evaluated the missing information and made reasonable adjustments to provide complete and functional models.

SECTION 3: STANDARDS AND POLICIES REVIEW

3.1 Comparison of Standards and Policies

As part of the preparation of this master plan, a comparison was made of current City drainage regulations with the regulations of other communities. Entellus compared regulations from multiple municipalities within Arizona as well as the City of Denver, Colorado. The comparison was performed in April 2009 and revised again in June 2009. Please refer to **Appendix B.1: Drainage Regulation Memorandum** for a complete discussion and supporting data.

This analysis reviews the current Engineering and Design Standards for the City released in February 2009. Additional design standards were obtained from 15 agencies which included Phoenix, Scottsdale, and Peoria, Arizona, and Denver, Colorado. A spreadsheet was created comparing topics such as retention basin, street, drywell, storm drain and other regulations to the current City standards. Each topic was then investigated further and comparable subtopics were created to determine how they weighed against the current City regulations. Once the standards and regulations for the City and all other communities were documented, a color-coding scheme was created to visually determine if the comparisons were more (orange), equal (gray), or less (blue) strict than the current City regulations as shown in **Appendix B.1: Drainage Regulation Memorandum**.

By determining how the City compares to other communities, an assessment can be made to see if modifications to the City's current design standards are appropriate. Recommendations were then provided as a result of this comparison and are summarized below:

3.1.1 Retention/Detention:

Most agencies have very similar requirements to the City retention/detention methodology and criteria. The 100-year, 2-hour was the typical storm used to determine volume requirements. However, some agencies specified precipitation depth while the City specified runoff (precipitation depth minus losses). The current standard allows a maximum ponding depth of three and one-half-feet (3'5"). It is recommended that the City specify one foot (1') of freeboard.

The area where the City was strict, as compared to other agencies, was the side slope and the low flow system. The City required the side slopes not exceed 6:1 while most agencies allowed 4:1 and steeper side slopes in some situations. Also, the City required a 1% grade towards the drain within the basin while most agencies allow a gentler slope. It is recommended that the regulations may relax the minimum side slopes for locations adjacent to walls, fences or where there is no pedestrian access.

3.1.2 Street Drainage:

All the agencies reviewed had similar requirements for street drainage. Most agencies had very similar requirements for the 100-year storm. The City of Phoenix based many of their requirements on the 2-year storm instead of the 10-year storm as compared to other agencies. Although there are some differences between the City standards and other agencies, such as design storm event, the current standards are adequate, and the only change to the regulations recommended at this time is to include an allowed flow depth of no more than 2-inches above the top of curb during a 100-year storm. This is recommended to keep depth of flow reasonable in areas where the right-of-way may be steep which could allow excessive depth over the top of the curb. This will aid in providing emergency vehicle access during a large storm event.

3.1.3 Storm Drain:

The City storm drain requirements were very similar to other agencies. The main difference was the type of catch basins, the minimum pipe size allowed, manhole spacing, and velocities. The City allows a minimum pipe size of 15-inch mains while most of the other agencies required a minimum pipe size of 18-inches for maintenance purposes. It is recommended that the City adopt a minimum of 18-inch storm drain for maintenance purposes. Similarly, the City allows 12-inch laterals and it is recommended to increase it to a minimum of 15-inch laterals to facilitate maintenance.

The City has also allowed further manhole spacing than most other agencies, especially for larger diameter pipes, as well as higher velocities (up to 10-fps) and lower velocities (minimum of 2-fps) while 8-fps or 9-fps and 3-fps, respectively, are the typical limits in other agencies. It is recommended to reduce the required manhole spacing for pipes 60-inches and larger from the current 1,300 feet to 1,000 feet to allow for more frequent and easier access to the storm drain for maintenance.

3.1.4 Miscellaneous:

First flush requirements for retention/detention basins were not found in the City's drainage regulations or in other agencies, the only exceptions were the Town of Gilbert and the City of Denver, Colorado. It is recommended that the City institute the standards of the Arizona Pollutant Discharge Elimination System (AZPDES) for "first flush" or first half-inch of rain, requirements.

The City does not require pre vs. post drainage regulations. It is recommended that the City add to their regulation that the post-construction runoffs do not exceed the pre-construction runoff.

3.2 Investigation of Green Drainage Solutions

Entellus was requested to research, explore, and document environmentally friendly, "Green", solutions for storm water runoff to minimize environmental impacts. Research was carried out to explore several green features utilized by various agencies around the nation including ADOT and the FCDMC. Green features may consist of new regulations, specifications, guidelines, or methodologies that can be applied to minimize harm to the environment. A memorandum entitled Green Regulations was developed by Entellus for the City in May 2009, and is included in **Appendix B.2: Green Features Memorandum**.

The following green regulations were investigated and their associated recommended use is shown in **Table 3.1.**

TABLE 3.1: SUMMARY OF GREEN DRAINAGE SOLUTIONS			
Green Regulation	Advantages	Disadvantages	Recommendation
First Flush Regulation	Reduces potential for high concentration of pollutants to reach the storm drain system. It will comply with AZPDES.	Maintenance may increase.	Recommend that the City include a "First Flush" regulation in their standards.
Multiple Chamber Drywell	Reduce the amount of pollutants infiltrating the ground, increase performance, and longevity.	Maintenance and initial cost.	Require multiple chamber drywells for contributing areas that include runoff from paved areas.
Bio Retention	Natural way of reducing pollutants, increased green space, and provide storm runoff storage.	Maintenance and cost of vegetation preservation is high. Water consumption is high. Bio-retention in Arizona may not always be a sustainable feature because of the potential for high water consumption.	While the City should accept this, bio-retention may not always be a sustainable feature because of potential for high water consumption.
Porous Concrete	Reduce impervious areas, resembles natural conditions.	Periodic maintenance needs and reliability unproven. Higher initial cost.	It is recommended that the City allow but require a back-up system. Also, limit the area given credit for additional infiltration to prevent downstream adverse effects if it does fail to perform.
Underground Storm water Chambers	No extra footprint required for retention basins and no breeding ground for insects.	Construction cost is higher. Long-term performance and reliability are not proven. Difficult to inspect/maintain.	Recommend to allow but provide backup storage onsite.

TABLE 3.1: SUMMARY OF GREEN DRAINAGE SOLUTIONS			
Green Regulation	Advantages	Disadvantages	Recommendation
Runoff Harvesting	Provides water for multiple potential uses and reduces runoff collection system requirements.	Low annual precipitation in Arizona may not be sufficient to offset system cost.	Runoff harvesting for recharge/irrigation or non-potable uses may be feasible for large developments, especially for industrial/commercial developments. Runoff harvesting in the City needs to be reviewed on an individual basis to make sure it functions in a way that benefits the drainage system.
Green Roofs	Potential for reduction of runoff; therefore, reducing the need for storm drains infrastructure. Other beneficial functions associated with vegetation canopy.	Roof dead loads are typically significantly larger. Over-watering may cause additional runoff and nutrients are likely to be present in any runoff from these features	This could be a possibility for large industrial and commercial developments. Use of green roofs in the City would need to be reviewed on an individual basis to make sure it functions in a way that benefits the drainage system.
Construction of infrastructure with reused or recycled materials	Recycle or reduction of waste materials.	Limits the range of options available to contractor.	Does not have a direct effect on adequacy of drainage system but may have other benefits to the City and the environment. It is recommended that the City encourage the use of recycled or reused materials for drainage system infrastructure.

3.3 Drywell Regulations Evaluation

As part of the preparation of this master plan, a comparison was made of current City's drywell policy with the regulations of other communities to determine if modifications to the City's current regulations should be recommended. Entellus compared regulations from multiple municipalities within Arizona as well as the City of Denver, Colorado. A memorandum that fully reviews the current drywell regulations for the City and compares them to 15 other agencies is included in **Appendix B.3: Drywell Memorandum**.

Drywells are an underground structure that disposes of stormwater runoff by infiltrating it into the ground, where it merges with the local groundwater. For this reason, the Arizona Department of Environmental Quality (ADEQ) regulates existing or proposed drywell activity within the state of Arizona. Drywells are designed to only receive stormwater runoff. If other fluids are directed to drywells, they will be subjected to Aquifer Protection Permit (APP).

The following five changes to the City's drywell policy are recommended:

- Drywells require regular maintenance to function correctly. Reliability can vary widely depending on location, maintenance, amount of debris, and other considerations. Therefore, it is recommended discouraging the use of drywells and only allows its use where no other means of drainage is available.
- Pollutants and debris tend to accumulate within the drywell. The amount of pollutants/debris reaching drywells could be reduced by adding environmental regulations to control contaminants. It is recommended to add an environmental regulation to control contaminates entering the system. Regulation for stormseptors and minimum distance from potential pollution sources (paved areas could be considered pollution sources) may need to be evaluated. This may be consistent with the City's AZPDES municipal storm water system permit requirements.
- Agencies' credit for disposal rates ranged from 0.1 to 0.5 cfs per well or 50% of percolation test rate. The City of Mesa is on the high side. It is recommended changing the regulation to only allow 0.25 cfs per well for single chamber wells, and maintain the 0.5 cfs for dual chamber wells. The reason for recommending a lower amount for single chamber wells is they have a greater chance of clogging and consequently providing a lower performance.
- Placing grates above ground does reduce sediment entering the well. It is recommended changing regulation to require drywell grates to be installed at least 2-inches above the finish grade of the basin.
- Dual chamber drywells are more reliable. It is recommended including language into the City's drainage regulation to encourage the use a dual chamber drywell.

SECTION 4: HYDROLOGIC ANALYSIS

The Mesa Storm Drain Master Plan covers a very large geographic region, larger than a typical urban hydrology model covers. This area in fact is delineated by numerous hydrologic studies which have been created and edited over the years, of which seven were utilized for this master plan. See **Figure 4.2: Hydrologic Boundaries** for the general HEC-1 modeling boundaries. While direct integration of all the HEC-1 models into a single hydrologic model would be possible, with the size of the study area, complexity of the various models and with the current model configuration, this is not recommended and was not done. However, some integration exists between several of the models, and this was maintained in the form of the output of one model flows into and becomes the input of the subsequent model. The models and modeling details are given in the following sections.

4.1 Hydrologic Models

The base models utilized for the hydrologic modeling were as follows:

- Tempe Canal Model (TC) from the Tempe Canal Floodplain Delineation Study (FCD 2002-22), 100-year 24-hour model, last updated October 2006
- Consolidated Canal Model (CC) from the Consolidated Canal Floodplain Delineation Study (FCD 99-09), 100-year 24-hour model, last updated November 2001
- Eastern Canal Model (EC) from the Eastern Canal North Floodplain Delineation Study (FCD 98-36), 100-year 24-hour model, last updated October 2001
- Northeast Mesa Model (NE) from the East Mesa Area Drainage Master Plan, updated by ADOT for the Red Mountain Freeway analysis Phase II (NE200255.dat) 100-year 24-hour model, last updated April 2005
- Northwest Mesa Model (NW) from the East Mesa Area Drainage Master Plan 100-year 24-hour model, last updated May 2002
- Southeast Mesa Model (SE) from the Southeast Mesa Area Drainage Master Plan subsequently modified by Wood Patel for the Mesa Proving Grounds (MPG20RT2.dat) 100-year 24-hour model, last updated September 2008
- Spook Hill model (SH) from the Spook Hill Area Drainage Master Plan (FCD 99-43) 100-year 24-hour model, last updated April 2002

As this modeling exercise is part of a master planning document, it was important to utilize the fully developed conditions models whenever possible. In the cases of the TC, CC and EC models, the existing conditions are for the most part fully developed. Additionally, no other future conditions modeling had previously been performed for the areas in question so the existing conditions models were utilized as though they approximately represented the fully developed condition.

For the East Mesa models (NE, NW and SE), the future conditions models were utilized, and for the Spook Hills the recommended model with the fully implemented infrastructure was utilized. Hydrologic schematics were also produced for the proposed conditions for the EC, CC, TC, NE, NW and SE models. These schematics can be found in the following figures:

- Figure 4.4: Hydrology Schematics – Eastern & Consolidated Canal Model
- Figure 4.5: Hydrology Schematics – Tempe Canal Model

- Figure 4.6: Hydrology Schematics – Northeast East Mesa Model
- Figure 4.7: Hydrology Schematics – Northwest East Mesa Model
- Figure 4.8: Hydrology Schematics – Southeast Mesa Model

4.2 Future Conditions Hydrologic Model Modifications

One of the goals of this project was to utilize the existing models with as few modifications as possible. However, several modifications were needed to the various hydrologic models so that they could be adequately utilized for the Storm Drain Master Plan. The modifications made to the models are explained in the following sections.

4.2.1 Retention Modeling

Retention was originally modeled differently by each of the different hydrologic models. In general it was determined that to adequately model the storm drain it was important to model the existing storm water retention for all the subbasins. City regulations requiring the retention of the 50-year 24-hour run-off volume were adopted in 1977, which were based on 3 inches of precipitation. 100-year 2-hour requirements were adopted in the late 1980's and are based on 2.7 inches of precipitation.

For HEC-1 models that did not model retention, it was initially thought that identifying the areas constructed prior to 1977 would provide a basis for determining areas with and without retention. This proved to be very difficult to accomplish and instead, for the areas encompassed by the TC, CC, and EC models, it was decided that the determination of whether or not retention existed would be accomplished using current aerial photography, City GIS layers, local knowledge and previous hydrologic modeling documentation. An area and/or subdivision that appeared to have retention basins, or the City GIS layer showed retention basins, was counted as having the full 100-year 2-hour retention. At times the retention basins were not fully within an individual subbasin but located some distance downstream. These situations were treated on a case by case basis. If the distance to the retention basin was significant thus affecting a storm drain reach, retention was not counted for the individual subbasin but at the concentration point downstream of the actual retention basin location.

A significant portion of these watersheds utilize flood irrigation. Flood irrigation is an irrigation practice that consists of allowing water to flow over land to saturate the ground and provide water for lawns, trees, etc. Flood irrigation lots typically have a berm 8 to 12 inches high around the perimeter of the property to contain the irrigation waters. Even under fully irrigated conditions, which are typically in the range of approximately 6 inches of water, these flood irrigated properties have the potential of storing a significant amount of local precipitation, thus limiting the volume of run-off from them. Thus it was decided that areas of flood irrigation would be counted as though they had the full required 100-year 2-hour retention.

Subbasin retention was incorporated into the hydrologic models through the utilization of a diversion record following the subbasin record. It was assumed that all retention had an 80% efficiency. That is, at any given time only 80% of the subbasin run-off was assumed to be retained up to the maximum retention volume (City required retention volume) after which point the estimated retention would not provide any further protection. 80% is utilized to account for inefficiencies in the drainage system that would allow flow to escape the subbasin retention system.

The subbasin retention volume was estimated by utilizing the procedure outlined in the Flood Control District of Maricopa County's Drainage Manual (**Reference 3**) where volume is simply the product of drainage area, precipitation depth and a runoff coefficient. The precipitation depth utilized is the 100-year 2-hour event and comes from the City of Mesa Engineering and Design Standards (**Reference 5**) and is equal to 2.7 inches in all locations except along the downtown corridor where the standard is two-thirds the 100-year 2-hour precipitation, or 1.8 inches.

The run-off coefficient was determined based on the land use as they were utilized for the various original hydrologic models. No modifications were made to the original model to account for changes in land use since the models creation. See **Figure 4.3: Future Land Use** for the assumed land use for the EC, CC and TC modeling areas.

Some land use areas that were designated as agricultural lands by the original models have since been developed. In determining whether or not to include these locations as areas of retention one must look at the original model assumptions. Since the original models soil loss parameters reflect an agricultural land use, which are high relative to an urban land use, there is, in essence a certain degree of retention by means of lower run-off due to the land use designation. Additionally, future development would require retention which should mitigate any runoff increases that they might otherwise inflict on the area. Therefore, for the purpose of this ADMP no retention was modeled in areas with agricultural land use.

TABLE 4.1: RUN-OFF COEFFICIENT	
Land Use Type	Run-Off Coefficient
Commercial	0.80
Industrial	0.82
Agricultural	N/A
Lakes	N/A
Parks	0.22
Schools	0.31
Very Low Density Residential	0.35
Low Density Residential	0.45
Medium Density Residential	0.50
Multi-Family Residential	0.65

TABLE 4.1 summarizes the run-off coefficients utilized for the retention volume estimations. Specifics regarding the individual hydrologic model retention modeling can be found in the following sections. **Figure 4.1** shows the assumed retention conditions for the modeled areas.

4.2.1.1 Tempe Canal Retention Modeling

The retention volume modeling for the TC area was relatively straightforward. The original TC model only modeled large retention basins associated with large parks, schoolyards and large commercial areas.

The original TC model included retention for 33 of the 121 subbasins modeled. This was modified to include retention in some form for 120 of the subbasins. Details regarding the retention volume calculations can be found in **Appendix C: Hydrology**.

4.2.1.2 Consolidated Canal Retention Modeling

The original CC model modeled a considerable amount of retention. The CC model assumed many of the subdivisions had retention and accounted for them in some way. The model, however did not account for retention in flood irrigated lots. The retention for the CC model was estimated to include retention for both standard subdivision retention and areas with irrigated lots.

4.2.1.3 Eastern Canal Retention Modeling

The EC model modeled retention at 48 locations, the majority of which were following subbasins (individual subbasin retention). However, several of the retention locations modeled acted as regional retention basins. That is to say that various flows are routed, via street and storm drain to a retention basin. Each of the regional retention basin locations was examined to determine if it was indeed a regional type retention area. Those that were determined to be regional type retention basins were left unmodified, while individual subbasin retention was estimated for all other subbasin retention locations.

4.2.1.4 East Mesa ADMP Retention Modeling

Much of the East Mesa ADMP area, which includes the NW, NE and SE models, assumed future 100-year 2-hour retention. The majority of the retention volumes in these areas were left unmodified. The only modifications to the retention volumes occurred when the existing retention was estimated to be greater than what was being modeled. This was performed on a case by case basis. Additionally, all retention volumes were modified from being 100% efficient that is taking out 100% of the volume until the basin is filled to being 80% efficient to account for inefficiencies in the system. Modifications beyond those stated in this section will be discussed in subsequent sections.

4.2.1.5 Spook Hills Retention Modeling

No modification was made to the Spook Hills model regarding retention modeling.

4.2.2 Model Linking

There are two instances where the hydrologic models are hydrologically linked:

- EC, CC, TC
- NE, SE

These will be discussed in the following sections.

4.2.2.1 EC, CC, TC Model Linking

The EC, CC, and TC hydrologic models are hydrologically linked. However they were not prepared simultaneously and therefore the original output from one model does not necessarily correspond exactly to the input of the subsequent model. The model sequence is as follows: the EC model drains into the CC model which drains into the TC model. As a method of bringing in the flows from the upstream model, the original TC and CC models both utilized DSS files, as well as hard coded hydrographs into the models. In particular, pipe flows were hard coded in as a constant flow value equal to what was determined to be the pipe capacity.

In order for the added retention and other model modifications to be reflected in the downstream models, it was necessary for the models to be completely linked and eliminate the hard coded flow values. This was accomplished through the use of a DSS file. All locations where flow entered from either the EC or CC model were linked to the outflow from the appropriate model. For example, there are four locations where flow crosses the Eastern Canal exiting the EC model and entering the CC model area. These locations are denoted as PD25, PD26, PD64 and OUTABC. These four outflow hydrographs are written to a DSS file. When the CC model is run the DSS file is read to import the flows at the correct location in the CC model.

The CC model is then run and outputs to the same DSS file. The CC outputs will be retrieved by the TC model. There are 10 locations where flow crosses the Consolidated Canal exiting the CC model and entering the TC model: IPMAIN, IF44B, IF25, IFD36, IFD21, IF34, IFD48, IF51, IF67 and IF17. These 10 inflows are retrieved by the TC model at the appropriate location within the TC model via the DSS file.

As aforementioned, all hard coded flows (QI records) were removed from the models, with the exception of inflows from the Gilbert/Chandler ADMS, which enter the TC model. To facilitate the utilization of the linked DSS file between the TC, CC, and EC models, the 2 inflows from the Gilbert/Chandler ADMS were modified from being a DSS input to being hard coded hydrographs into the model. These two locations are denoted by the id's IFHC23 and IFDIVR.

Furthermore the TC model has several modeling logical loops that require special attention. A logical loop can occur when the storm drain flow travels one direction while the surface flow travels another. In particular, in the HEC-1 model, a diversion occurs at a location (storm drain flow), but because of the complexity of the model logic, the diversion must be retrieved in the model before it is initially diverted. The original model compensated for this looped affect by simply hard coding the flow at the capacity of the storm drain into the model. This would assume that the pipe is flowing full at all times. To overcome this overestimation of flow in the pipe and to facilitate the various alternatives and analyses that were run, these loops were modified to be DSS inputs and outputs.

The required order that these must occur in the model are: first the storm drain flow is retrieved from the DSS file (they will show up as no flow because the DSS has not yet been written for this particular location), secondly, the DSS file is written for a particular locations, and thirdly, the model is re-run and the storm drain flow is retrieved. In order to properly accomplish this, the TC model must be run two times consecutively.

As an example when the TC model is run the first time, the storm drain flow for P122 is pulled from the DSS file; however since the flow for P122 has not yet been added to the DSS file a flow of 0 cfs is retrieved. Later in the same model run the flow for P122 is added to the DSS file, thus when the TC model is run the second time the flow value for P122 is retrieved and the model is completed.

The correct order with which to run the linked models is as follows:

- Eastern Canal Model
- Consolidated Canal Model
- Tempe Canal Model
- Tempe Canal Model (re-run a second time)

4.2.2.2 NE, SE Model Linking

A similar linking of the NE and SE models occurs as described in the preceding section. In this case the NE model flows into the SE model. There are 5 locations where the DSS was utilized to retrieve flow from the NE model into the SE model: SOSS, CAP1A, CAP1B, ADOT-E and ADOT-W. A sixth location (CAP2) flows from the NE model to the SE model, but due to lack of information a hard coded hydrograph was utilized. No change was made to the way CAP2 as was previously modeled.

Additionally, similar to the TC model, the SE model has 3 locations where loops are created that require the model to be run 2 times consecutively. Those locations are for P62B (IP62B), P62D (IP62D) and DOUT88.

The correct order with which to run the linked models is as follows:

- Northeast East Mesa Model
- Southeast East Mesa Model
- Southeast East Mesa Model (re-run a second time)

4.2.2.3 NW Model

The NW model is not linked to other hydrologic models, but several loops occur in the modeling system similar to the TC model. There are 6 locations where the DSS is required: SD02, SD03, SD06, SD20.1, SD20.2, and SD20.3. Of these SD03 is dependent on SD02 which requires the model to be run an additional time for a total of 3 model runs.

The correct order with which to run the linked models is as follows:

- Northwest East Mesa Model
- Northwest East Mesa Model (re-run a second time)
- Northwest East Mesa Model (re-run a third time)

4.2.3 Eastern Canal Model Modifications

There were several modifications in addition to those already stated that needed to be made to properly model and retrieve storm drain flows for the EC model. The specific modifications made are discussed in the following sections and added details can be found in the ID cards at the beginning of the HEC-1 model and comment cards within the model.

4.2.3.1 Corrected Original Model Errors Encountered

Three errors were found in the original model. The first was an incorrect input stage–storage–discharge for PA97. HEC-1 is, in general, a fixed-format model allowing for 10 fields per line of code. PA97 was entered with 11 fields of code. This was corrected by wrapping the 11th column around and beginning a new line of code.

The second and third errors were incorrectly input diversions for DBDHB/DVDHB and DHVRV/DVDHV. In both of these cases an additional 2 spaces were placed in the first column of the DI and DQ records shifting all numbers to the right 2 spaces and causing HEC-1 to misread the input values.

4.2.3.2 Additional Eastern Canal Model Modifications

There were several other modifications that were needed in the eastern Canal model in addition to those already specified. In particular, several concentration points were added to determine the peak flows at various locations. These additional concentration points did not change the model logic or routing, they simply were utilized to combine the appropriate flows at a given location. For example, at a given intersection the existing concentration point might combine the flow from the south flowing storm drain, the west flowing storm drain and the adjacent subbasin. If the subbasin contributes to the west flowing storm drain a new concentration point was added to combine the subbasin and the west flowing storm drain and the existing concentration was modified to continue to combine the same flows. These new concentration points were given the prefix "MSD" for Mesa Storm Drain followed by a numeric value.

Several of the storm drain and street flow diversions as well as concentration points were renamed due to naming redundancy. Details regarding specifics of the model modifications can be found in the notes at the beginning of the HEC-1 model.

4.2.4 Consolidated Canal Model Modifications

There were several modifications in addition to those already stated that needed to be made to properly model and retrieve storm drain flows for the CC model. The specific modifications made are discussed in the following sections and added details can be found in the ID cards at the beginning of the HEC-1 model and comment cards within the model.

4.2.4.1 Corrected Original HEC-1 Error

An HEC-1 error that did not affect the outcome of the model was corrected. The error occurred upon the importation of the flows via DSS. The error was simply

"*** HEC1 ERROR 6 *** TRIED TO COMBINE MORE HYDROGRAPHS THAN AVAILABLE." While the model was not combining more hydrographs than were available, HEC-1 outputs this error when there is no associated subbasin area with the imported DSS flow. Additionally the imported hydrograph ID's (PD25 and PD26) do not show up on the HEC-1 output schematic diagram. Despite this, the model was functioning correctly. To correct this issue, a basin area card and an area of 0.00 sq miles was included as part of the DSS import.

4.2.4.2 HEC-1 Record Duplicate Name Modification

Several HEC-1 records were renamed due to the original HEC-1 model use of duplicate names. In particular this occurred at diversion locations. As an example, a concentration point was called CP41 and the following diversion card was likewise called CP41. As a result the HEC-1 output table would show two different flows for CP41, one for the concentration point and one for the diversion. This caused problems in extracting the HEC-1 output flows for certain locations. At these locations the letter "I" for inflow and "O" for outflow were added to the name as a suffix thus producing CP41I as the concentration point ID and CP41O as the diversion id.

4.2.4.3 Additional Consolidated Canal Model Modifications

Additional modifications include a reassessment of flows crossing the Consolidated Canal into the Tempe Canal Model.

The first location is along University Drive (D36W/36OUT). It was determined that during a flow event flow would not be able to cross over the bridge, but would instead empty into the canal. The modeling assumption is however that no flow enters the canals. The diversion at University and Gilbert was modified to allow flow to continue south along Gilbert Road. The modified diversion ID's are 33to36 and 36to36.

The second location is 8^{th} Street and the Consolidated Canal (CP25CO/25-OUT). The bridge appears to be elevated slightly and it is likely that flow would not cross. All flow is assumed to travel south along the canal to CP26.

The third location is along Gilbert Road and the Consolidated Canal (CP35/34-OUT). Under current conditions it does not appear as though flow would cross the bridge, but dump into the canal. Modifications to the bridge should be made to ensure that the flow crosses the bridge and not enter the Consolidated Canal. Flow was however assumed to continue across the bridge and into the Tempe Canal Model.

Additionally, several diversions were added for storm drains in the model. In particular the intersection of Lindsay and Broadway Roads was modified significantly to account for the various storm drains in the area.

4.2.5 Tempe Canal Model Modifications

There were several modifications in addition to those already stated that needed to be made to properly model and retrieve storm drain flows for the TC model. The specific modifications made are discussed in the following sections and added details can be found in the note cards at the beginning of the HEC-1 model.

4.2.5.1 Corrected Original HEC-1 Error

It was discovered that most of the Clark Unit hydrograph parameters for the 100-year 24-hour model did not match what was documented in the report. This was brought to the attention of the Flood Control District who was able to correct the data error in a timely fashion for this project. No modifications to the 100-year 24-hour Clark Unit hydrograph parameters were performed as part of this project.

4.2.5.2 Additional Modeling Area North of Tempe and Crosscut Canals

No adequate hydrology model existed between the Tempe Canal model boundary and the Salt River so 29 additional subbasins were delineated for this reach and incorporated into the Tempe Canal hydrology model. The land use and soils data as provided for the Tempe Canal model were utilized where available. In some locations, land use coverage was created based on what was utilized for the original model. DDMSW 2.1 was utilized to estimate the unit hydrograph parameters and retention modeling followed the same format as aforementioned. The DDMSW output files can be found in **Appendix C**.

Routes and concentration points were also added as needed to connect the new delineated areas with the Consolidated Canal and Tempe Canal models (the added areas are all completely within the Tempe Canal model). Typical route sections were taken from the Tempe Canal model for street routing, and some storm drain routing was performed for existing storm drains in the area. The general nomenclature for the added model data is as follows:

- S = Subbasin
- R = Route
- C = Concentration Point
- TC = Tempe Canal

All subbasins were designated a number beginning with 500, so a subbasin name might be STC570, with the accompanying concentration point and route of CTC570 and RTC570 respectively.

4.2.5.3 Added Concentration Points

Numerous concentration points were added to correctly model and determine the flows in the storm drain network for the TC model. The nomenclature follows what was discussed for the EC model, that is the prefix "MSD" was utilized to denote Mesa Storm Drain. Additionally, some storm drain flow diversions were also added to the model. Details regarding each individual modification can be found at the beginning of the HEC-1 model.

4.2.6 Northeast Mesa – East Mesa Model Modifications

Several modifications were required to the Northeast East Mesa hydrology model for this project. In addition to adding storm drains and additional concentration points to the HEC-1 model the following modifications were.

4.2.6.1 Combining Existing and Future Conditions Models

None of the available models was completely adequate for the purposes of this Master Plan. ADOT recently updated the existing conditions models to reflect the changes due to the Loop 202, but did not modify the future conditions model. The available future conditions model from the East Mesa ADMP in 1998 had not been updated to reflect the new Loop 202. These two models were essentially combined to produce a future conditions HEC-1 model that reflects the modifications due to the new Loop 202 freeway.

The existing conditions model (NE200255.dat) from the Loop 202 project served as the base model and was subsequently modified to reflect the future conditions. The future conditions parameters were taken from the 1998 East Mesa ADMP (model name NEBUILDA.dat, signifying Northeast Mesa Buildout, Version A). The main modifications to the Loop 202 existing conditions model were related to the subbasin parameters:

- S-Graph unit hydrograph
- Green and Ampt soil loss parameters
- Assumed 100-year 2-hour future subbasin retention

While many of the subbasin parameters were modified not all subbasins required modification for the future conditions. There were several locations where retention was already being modeled, and if modeled retention in the existing conditions model was greater than that of the future conditions model no update was made, otherwise the future conditions retention was added to the model. All retention was assumed to be 80% efficient unless it had been previously assumed to be less than 80% efficient in which cases no modification was made. Details regarding which subbasins were updated can be found in the job identification cards of the HEC-1 model.

4.2.7 Northwest Mesa – East Mesa Model Modifications

There were several modifications in addition to those already stated that needed to be made to properly model and retrieve storm drain flows for the NW model. The specific modifications made are discussed in the following sections and added details can be found in the note cards at the beginning of the HEC-1 model.

4.2.7.1 Added Storm Drains and Concentration Points

Numerous storm drains, channels and concentration points were added to the model that had not been previously modeled. Several of the storm drains caused loops in the logic of the HEC-1 model, thus causing the model to need to be run 3 times consecutively to produce proper output.

4.2.7.2 Modified Routing Methodology

Modified route RD14W from utilizing Muskingum methodology to Kinematic Wave. RD14W was the only route in the model that utilized Muskingum, and it caused a significant amount of attenuation in the pipe flow. No modification was made to the routing parameters, just the methodology.

4.2.7.3 Modified Subbasin Retention

In several locations, the assumed 100-year 2-hour retention appeared to be less than the existing available retention. In these instances, estimates were made based on the City of Mesa retention basin GIS data to estimate approximately what the available subbasin retention was. All instances are documented in the HEC-1 model.

4.2.8 Southeast Mesa – East Mesa Model Modifications

There were several modifications in addition to those already stated that needed to be made to properly model and retrieve storm drain and channel flows for the SE model. The specific modifications made are discussed in the following sections and added details can be found in the note cards at the beginning of the HEC-1 model.

4.2.8.1 Loop 202 and 802 Freeway Modifications

The base model was taken from the Mesa Proving Grounds modeling, and includes portions, but not the entire Loop 202 freeway. Slight modifications were made to the model at the north end to account for the Loop 202.

The proposed Loop 802 was added. No subbasins were subdivided directly in the model, but flows from the subbasins intersected by the proposed freeway alignment were accounted for on the proper side of the proposed alignment. This was done by diverting out a percentage of the subbasin flow based on contributing area. Channel routes were created along the upstream side of the 802 freeway representing a potential channel along the alignment.

4.2.9 Spook Hills Model Modifications

No modifications were required for the Spook Hills HEC-1 model.

4.2.10 10-Year 24-Hour Storm Modifications

Several modifications were required to convert the 100-year models to adequate 10-year models for the storm drain master plan. One of the major assumptions for the 10 year model is that all flow is contained within the storm drain network, and no street flow is allowed. This effectively eliminates street diversions and so for all modeled networks it was assumed that 100% of the flow followed the storm drain network and that no street flow diversion exists. This was performed by modifying the diversions so 100% of the flow follows the storm drain network. Details from each model are described in the following sections.

The precipitation utilized for the 10-year 24-hour storm was 2.2 inches for the EC, CC and TC models and 2.3 inches for the NE, NW and SE models.

4.2.10.1 10-Year Eastern Canal Model Modifications

The EC model utilizes the Clark Unit Hydrograph parameters which are storm specific. These parameters which are made up of the T_c (time of concentration) and R (storage coefficient) must be calculated for each frequency and storm duration. The previous report did not have the Clark parameters for the 10-year 24-hour storm, so these had to be generated. They were generated utilizing DDMSW 2.1 and taking output from available from the EC report. Necessary parameters that were extracted from the report include: K_b (watershed roughness coefficient), S (watershed slope), L (time of concentration length) and the Green and Ampt soil loss parameters. With an assumed rainfall value of 2.2 inches and utilizing DDMSW 2.1, the Clark Unit Hydrograph parameters were created. No verification was made as to the legitimacy of the EC report extracted values. It was assumed that they adequately represented the watershed characteristics.

There are two locations where hard coded hydrographs were used to represent flow entering the watershed. Both locations are along McKellips Road and the EMF, and they represent the breakout discharges from the watershed east of the Roosevelt Canal that are taken from the EMF study (by others). The HEC-1 id's are DIS16 and DO16A. While a diversion into the study area across the EMF might potentially exist during a 100-year event, for a 10-year event it was assumed that the EMF was sufficient and would not allow breakout flow over the structure. Therefore both hydrographs were set to 0 cfs for the 10-year storm events.

Additionally, several diversions were modified to maintain flow along the storm drain alignment. The diversion modifications made are as follows:

- Modified DMRVD, so 100% of flow goes west along McKellips Road and 0% continues south along Val Vista Drive.
- Modified DBRVD, so 100% of flow goes west along Brown Road and 0% continues south along Val Vista Drive.
- Modified DGRUD, so 100% of flow goes south along Greenfield Road and 0% continues west along University Drive.
- Modified DDMSGR, so 100% of flow goes south along Greenfield Road and 0% continues west along Main Street.
- Modified DSAHR, so 100% of flow goes west along Southern Avenue and 0% continues south along Higley Road.

- Modified DDSAGR, so 100% of flow goes south along Greenfield Road and 0% continues west along Southern Avenue.
- Modified DIS16, set the input hydrograph to 0 for the 10-year model.

4.2.10.2 10-Year Consolidated Canal Model Modifications

The Clark Unit Hydrograph parameters for the 10-year 24-hour model were previously calculated for the CC model. These parameters were simply inserted into the HEC-1 model. No additional calculations were made.

Several diversions were modified to maintain flow along the storm drain alignment. The diversion modifications made are as follows:

- Modified R7toR8, so 100% of flow goes west along McKellips Road and 0% continues south along Stapley Drive.
- Modified 32to33, so 100% of flow goes south along Gilbert Road and 0% continues west along 8th Street.
- Modified 39to45, so 100% of flow goes west along Main Street and 0% continues south along Lindsay Road.
- Modified 41to45, so 100% of flow goes west along Main Street and 0% continues south along Lindsay Road.
- Modified 45to46, so 100% of flow goes west along Broadway Road and 0% continues south along 32nd Street.
- Modified 64to46, so 100% of flow goes west along Broadway Road and 0% continues south along 32nd Street.
- Modified 55to56, so 100% of flow goes south along Val Vista Drive and 0% continues west along Broadway Road.
- Modified Rto59, so 100% of flow goes south along Val Vista Drive and 0% continues west along Pueblo
- Modified 57to59, so 100% of flow goes south along Val Vista Drive and 0% continues west along Pueblo.
- Modified 60to62, so 100% of flow goes west along Southern Avenue and 0% continues south along Val Vista Drive.
- Modified 61to62, so 100% of flow goes west along Southern Avenue and 0% continues south along Val Vista Road
- Modified 63to68, so 100% of flow goes south along 32nd Street and 0% continues west along Southern Avenue.

4.2.10.3 10-Year Tempe Canal Model Modifications

The Clark Unit Hydrograph parameters for the 10-year 24-hour model were previously calculated for the TC model. However with the complications with the

T_c and R values, the values utilized in the TC report were not utilized. Once the FCDMC modified the Clark parameters, the resultant table contained all the necessary Clark unit hydrograph parameters, and it was this table that was utilized for the Tempe Canal modifications.

There are two locations where flow enters the watershed from the south and a hard coded flow is utilized. The hard coded hydrographs were previously part of a DSS file retrieved from the Gilbert-Chandler ADMS (1994) model, but were converted to hard coded hydrographs for this project. For the 10-year storm it was assumed that the 10-year flow was 35% of the 100-year flow for all hydrograph ordinates. This was modified for HEC-1 id's IFHC23 and IFDIVR.

Several diversions were modified to maintain flow along the storm drain alignment. The diversion modifications made are as follows:

- Modified S204W, so 100% of flow goes north along Alma School Road and 0% continues west along 8th Street.
- Modified S210W, so 100% of flow goes south along Alma School Road and 0% continues west along University Drive.
- Modified S215W, so 100% of flow goes west along Main Street and 0% continues south along Extension Road.
- Modified S214W, so 100% of flow goes west along Main Street and 0% continues south along Country Club Drive.
- Modified S115W, so 100% of flow goes west along Main Street and 0% continues south along Mesa Drive.
- Modified S114W, so 100% of flow goes west along Main Street and 0% continues south along Horne.
- Modified S113W, so 100% of flow goes west along Main Street and 0% continues south along Stapley Drive.
- Modified S111W, so 100% of flow goes west along Main Street and 0% continues south along Gilbert Road.
- Modified S208W, so 100% of flow goes south along Country Club Drive and 0% continues west along University Drive.
- Modified S104W, so 100% of flow goes south along Horne and 0% continues west along University Drive.
- Modified S102W, so 100% of flow goes south along Stapley Drive and 0% continues west along University Drive.
- Modified S229W, so 100% of flow goes west along Broadway Road and 0% continues south along Dobson Road.
- Modified S236W, so 100% of flow goes south along Dobson Road and 0% continues west along 8th Avenue.

- Modified S243W, so 100% of flow goes west along Southern Avenue and 0% continues south along Dobson Drive.
- Modified S242W, so 100% of flow goes west along Southern Avenue and 0% continues south along Longmore.
- Modified S227W, so 100% of flow goes south along Alma School Road and 0% continues west along Broadway Road.
- Modified S234W, so 100% of flow goes south along Alma School Road and 0% continues west along 8th Avenue.
- Modified S241W, so 100% of flow goes south along Alma School Road and 0% continues west along Southern Avenue.
- Modified S232W, so 100% of flow goes south Country Club Drive and 0% continues west along 8th Avenue.
- Modified S123W, so 100% of flow goes south along Broadway Road and 0% continues west along Mesa Drive.
- Modified S131W, so 100% of flow goes south along Mesa Drive and 0% continues west along 8th Avenue.
- Modified S129W, so 100% of flow goes south along Stapley Drive and 0% continues west along 8th Avenue.
- Modified S138W, so 100% of flow goes south along Horne, and 0% continues west along Southern Avenue.
- Modified S137W, so 100% of flow goes west along Southern Avenue and 0% continues south along Stapley Drive.
- Modified S136W, so 100% of flow goes west along Southern Avenue and 0% continues south along Harris Drive.
- Modified S116, so 100% of flow goes west into the pipe, and 0% continues south along Center Street.
- Modified S218, so 100% of flow goes into the pipe, and 0% continues west along Main Street.
- Modified S213, so 100% of flow goes into the pipe, and 0% continues west along University Drive.
- Modified S240W, so 100% of flow goes north along Alma School Road and 0% continues west along 8th Street.
- Modified S231, so 100% of flow goes into the pipe, and 0% continues south along Railroad.

4.2.10.4 10-Year Northeast Mesa – East Mesa Model Modifications

The NE model utilizes S-Graphs, so no modifications were needed for the subbasin parameters. The model does utilize the multiple storm scenarios (JD-cards), as all of the East Mesa ADMP models do. Because of this a new set of JD cards was utilized for the NE, NW and SE models:

TABLE 4.2: JD CARD INPUTS	
Precipitation Depth [Inches]	Area [Sq. Miles]
2.30	0.01
2.29	1.00
2.23	5.00
2.16	10.00
2.07	30.00
1.98	60.00
1.95	90.00

Four diversions were modified to maintain flow along the storm drain alignment. The diversion modifications made are as follows:

- Modified 202A. The input hydrograph was set equal to 35% of 100-year hydrograph.
- Modified 202B. The input hydrograph was set equal to 35% of 100-year hydrograph.
- Modified 202C. The input hydrograph was set equal to 35% of 100-year hydrograph.
- Modified 202D. The input hydrograph was set equal to 35% of 100-year hydrograph.

4.2.10.5 10-Year Northwest Mesa – East Mesa Model Modifications

In addition to the precipitation and JD card modification already mentioned, ten diversions were modified to maintain flow along the storm drain alignment. The diversion modifications made are as follows:

- Modified DIV02, so 100% of flow goes west along McKellips Road and 0% continues south along Recker Road.
- Modified DIV03, so 100% of flow goes west along McKellips Road and 0% continues south along Higley Road.
- Modified DIV05, so 100% of flow goes west along Brown Road and 0% continues south along Power Road.
- Modified DC5, so 100% of flow goes west along Brown Road and 0% continues south along Power Road.
- Modified DIV06, so 100% of flow goes west along Brown Road and 0% continues south along Recker Road.

- Modified DIV6, so 100% of flow goes west along Brown Road and 0% continues south.
- Modified DIV12, so 100% of flow goes south along Power Road and 0% continues west along university Drive.
- Modified DC12, so 100% of flow goes south along Power Road and 0% continues west along university Drive.
- Modified SD13B, so 100% of flow goes west along Southern Avenue and 0% continues south along Higley Road.
- Modified DIV34A, so 100% of flow goes south along Power Road and 0% continues west along Southern Avenue.

4.2.10.6 10-Year Southeast Mesa – East Mesa Model Modifications

In addition to the precipitation and JD card modification already mentioned, there is a single hard coded hydrograph that was modified. CAP2 represents one of the CAP structures. It was previously assumed (by others) that this pipe culvert would deliver a steady flow equal to the pipe capacity for the duration of the storm. For the 10-year storm it was assumed that the 10-year flow was 35% of the 100-year flow.

Additionally, three diversions were modified to maintain flow along the storm drain alignment. The diversion modifications made are as follows:

- Modified DIV61B, so 100% of flow goes west along Guadalupe Road and 0% continues south along Ellsworth Road.
- Modified DIV62B, so 100% of flow goes west along Baseline Road and 0% continues south along Hawes Road.
- Modified DIV62D, so 100% of flow goes west along Guadalupe Road and 0% continues south along Hawes Road.

4.3 Proposed Hydrologic Model Modifications

The modified models described above served as the base for the proposed infrastructure model. These proposed models incorporate the proposed infrastructure, wherever needed, into the HEC-1 models. Due to how interrelated the storm drain systems are, a modification to one system can have significant affects on other systems. Despite this the proposed model modifications are presented by storm drain network. The modifications to the 100-year 24-hour and 10-year 24-hour models were identical. See **Plates 1-3: Network ID Maps** for location of modeled storm drains and corresponding network ID's.

The SE, NE and Spook Hill models did not require significant modification due to the fact that the proposed East Mesa ADMP and Spook Hill's ADMP infrastructure was already modeled. The model modifications are presented below.

4.3.1 Eastern Canal Model Modifications

63A:

- Modified retention modeling at Brown and the Eastern Canal. All flow is brought to the intersection and the first 35cfs is allowed to bypass the retention basin PA26, and all remaining flow and volume enters the retention basin.
- No diversion was allowed over the Eastern Canal at Brown (CPD26/PD26).
- Added a storm drain route along the Eastern Canal (SD26A).
- Increased the capacity of storm drain OUTC which exits the watershed.

71C:

- A diversion was added near Broadway and Greenfield (DGRB1/DGRBO) representing 20 acre-ft of storage that is routed to the impoundment area PA94. PA94 is proposed to be increased to account for the added storage volume.
- Storm drain SD98 was increased to account for an additional parallel pipe along Greenfield Rd.

4.3.2 Consolidated Canal Model Modifications

11B:

- Added proposed off-line basin of 3.5 acre-ft north of University off of Gilbert Rd. (PRE33/PCC33). The first 60 cfs is allowed to by-pass the offline retention basin.
- Increased the capacity of storm drain 45-SD along Main St. due to proposed parallel storm drain.

4.3.3 Tempe Canal Model Modifications

11B:

- Increased the capacity of storm drains P111, P112 and P113 along Main St. due to proposed parallel storm drain.
- Increased the capacity of storm drain P103 along Horne due to proposed parallel storm drain.

31C

- Increased the capacity of storm drain P131 along Mesa Drive due to proposed parallel storm drain.
- Increased the capacity of storm drain P139 along Southern Ave. due to proposed parallel storm drain.
- Increased the capacity of storm drain P140 along Center St. due to proposed parallel storm drain.

- Added proposed storm drain P123A (not currently modeled) along Broadway Rd. to Mesa Dr.

39C:

- Added offline retention at Skate Park along Williams and Broadway (PRE119/PTC119). A total of 11 acre-ft is proposed. The first 35 cfs is allowed to bypass the retention basin.
- Added new proposed storm drain along Broadway (P121A) with a continuation along Horne (P122A & P130). Flow for this storm drain was taken out proportionally with P122. The flow diverted to P121 was limited to the upstream capacity of P122 (14cfs).
- Modified surface flow diversion at Broadway and Stapley to force all flow west along Broadway.
- Increased the capacity of storm drain P129 along Stapley due to proposed parallel storm drain. Also added concentration point MSD129.
- Increased the capacity of storm drain P136 and P135 along Southern due to proposed parallel storm drains.
- Added new proposed offline retention at Lindberg School along Stapley south of 8^{th} Ave. A total of 6 acre-ft is proposed. The first 50 cfs is allowed to bypass the retention basin.
- Increased the capacity of storm drain P138 along Horne due to proposed parallel storm drain.

47C:

- Increased the capacity of storm drain P127 along Gilbert Rd. due to proposed parallel storm drain.
- Added proposed 11 acre-ft of online storage to Silvergate Park (D134/RET134). The total volume of online retention for subbasin SB134 is 24 acre-ft. Additionally it was assumed that the efficiency of the retention basin would be increased from 80% (the general assumption) to 85%.

4.3.4 Northeast Mesa – East Mesa Model Modifications

133B:

- Diverted all flow to the west (DC45A) at Meridian and University Dr. It is proposed that the flow be picked up by the proposed storm drain along University Dr.

4.3.5 Northwest Mesa – East Mesa Model Modifications

75B:

- Proposed online retention for subbasin 2 (RET2) at Skywalk Village 1 AMD subdivision, approximately ¼ mile north of McKellips Road and approximately 1/3 mile west of Power Rd.. The online retention basin adds an additional 16 acre-ft of online retention beyond what is already modeled.

77C:

- Proposed offline retention (P6t13B/D6t13B) of 3 acre-ft along the Powerline Corridor west of Recker Rd. between Brown Rd. and University Dr. The first 110 cfs is allowed to bypass the retention basin
- Proposed online retention for subbasin 14 (RET14) at along the Powerline Corridor between Recker Rd. and Higley Rd. The online retention basin adds an additional 12 acre-ft of online retention beyond what is already modeled.

86A:

- Proposed online retention for subbasin 12 (RET12) on City of Mesa property along Adobe St. just west of Sun Valley Blvd. It is proposed to add 10 acre-ft of retention to the site.

95B:

- Proposed offline retention (DS126/DS126O) of 8 acre-ft at Jefferson Park at 70th St. and Jefferson Ave. The first 250 cfs is allowed to bypass the retention basin.

4.3.6 Southeast Mesa – East Mesa Model Modifications

802:

- Added channel along proposed 802 freeway. This extends the entire length of the proposed 802 freeway and includes routes R802_0, R802_1, R802_2 and R802_3.

336A:

- Some of the model logic was modified to model the proposed 336A system including subbasin 85 and 70B.
- Modified route 69T71 to be a constructed channel.

4.3.7 Spook Hills Model Modifications

122B:

- A previously proposed offline retention basin (SS340B) is proposed to be an online retention basin. This modification increases the size of the proposed retention basin by 27 acre-ft to 75 acre-ft total volume.

4.4 Compilation of Data into GIS

Hydrologic Data was received in various paper and electronic format. The individual models sometimes included AutoCAD files for the basin boundaries, shape or ASCII files for the HEC input data, and other electronic information. GIS was utilized to import and resolve all watershed basin boundaries creating an overall composite of the hydrologic watersheds in the city of Mesa. This data was compiled in GIS and was provided to the City of Mesa as part of the deliverables.

Additional data that was received as a shape file is also included as a GIS deliverable.

SECTION 5: HYDRAULIC ANALYSIS

5.1 Methodology

The methodology used to develop and evaluate existing infrastructure was based on the City's design standards and followed for the storm drain design outlined in the City or Mesa's General Engineering Requirements Manual **(Reference 5).** As a part of this study, storm drains of 36 inches or larger were analyzed using the computer program, *StormCAD V8i Edition, by Bentley Systems, Inc.* (**Reference 4**). Flows were extracted from their corresponding HEC-1 models using an inflow grid of approximately one-half (1/2) mile represented total flows along the storm drain for the downstream ½-mile reach. The Inflow nodes were typically located at major intersection or points of interest to determine if the existing infrastructure is adequate and meets the City's current guidelines and regulations.

The City's criterion for a 10-year storm event, the spread is limited to one lane per direction on major roadways and within the top of curb for local streets. For the 100-year storm event, the runoff shall be confined within the right-of-way. Both the 10-year criteria and the 100-year criteria were evaluated and the most stringent, or controlling, criteria was used for the storm drain design. In most cases, the 100-year criteria governed. Street flows capacities were estimated using the Manning's equation within the computer program, *FlowMaster V8 Edition, by Bentley Systems, Inc* **(Reference 6).** The required flow in the pipe (Qp) was determined by subtracting the street capacity of a typical street cross–section (Qs) from the total flow (Qt). See **Section 5.3** for more detail on street capacity calculations. For analysis, the type, size, and location of the inlets were not a part of this study. The design of the inlets will be a part of the design phase when the recommended alternative is selected.

The storm drain design criteria are outlined in the City of Mesa's General Engineering Requirements Manual which includes maintaining the HGL at least one foot below the ground level at manholes and catch basins. The storm drain HGL was evaluated using StormCAD. This program allowed analysis of the flows entering the storm drain during the 10-year and 100-year storm events. It was assumed in StormCAD that the flow out the pipe outlet was flowing full when discharged. All StormCAD profiles for each alternative are included in **Appendices G and H.**

The analyses of the hydraulic results for this project were checked using Manning's equation in an Excel spreadsheet. Manning's equation, as it was used in the spreadsheet, is as follows:

$$Q = \left(\frac{1.49}{n}\right) * A * R^{\left(\frac{2}{3}\right)} * So^{\left(\frac{1}{2}\right)}$$

The same inputs that were entered into StormCAD were entered into the spreadsheet. For all the formula calculations in the spreadsheet, graphs were created to give a graphical representation and comparison between StormCAD and the spreadsheet. This graphical and numerical comparison provided a simple check of the hydraulic results and is presented in **Appendix E: Hydraulics for Alternatives**. Additionally, the results from the Excel spreadsheets for the individual system checks that were performed are provided in the DVD in this report.

5.2 Storm Drain Data

Storm drain network data was provided by the City in Geodatabase format for the entire study area. These files consist of storm drain mains, non-standard mains, culverts, channels, manholes, catch basins, headwalls, connections, junctions and many others. Each file contains corresponding necessary information such as file type, geometry, and invert elevation essential to for the network modeling. The storm drain data was evaluated and approximately 20% to 30% of the information was missing or inadequate (inverts, diameter, material type, etc.). The missing data had to be generated via as-builts, matching neighboring values, or interpolation between known values. All changes were documented d and can be found in **Appendix D: Hydraulics**. The storm drain data was then formatted into five (5) categories so the information can be uploaded into StormCAD (see **Table 5.1: File Identifier**).

TABLE 5.1: FILE IDENTIFIER		
C.O.M. File Name	GIS Name	StormCAD
dchanl	SD Channel Lined	Conduit
dchanu	SD Channel Unlined	Conduit
dculvert	SD Culvert	Conduit
dlater	SD Lateral	Conduit
dmain	SD Main	Conduit
dmainns	SD Main NS	Conduit
dmainp	SD Main PRV	Conduit
dmanho	SD Manhole	Manhole
dclean	SD Cleanout	Transition Node
dconne	SD Connect	Transition Node
dinter	SD Inter-Tie	Transition Node
djunct	SD Junction	Transition Node
dmainc	SD Main Change	Transition Node
dplug	SD Plug	Transition Node
dscupp	SD Scupper	Transition Node
dstpipe	SD ST Pipe	Transition Node
dtap	SD Tap	Transition Node
dturns	SD Turnout Structure	Transition Node
dvalve	SD Valve	Transition Node
dcatba	SD Catch Basin	Transition Node/Inflow
dinflow	SD Inflow	Transition Node/Inflow
dpump	SD Pump	Transition Node/Inflow
ddryw	SD Drywell	Transition Node/Outfall
dheadw	SD Headwall	Transition Node/Outfall
dirrig	SD Irrigation Facilities	Transition Node/Outfall

Once the data was organized into their appropriate categories, additional data was assigned to each item such as n-values, material type, conduit shape, network ID's and various others; see **Table 5.2** for a list of different material used and corresponding their n-values.

TABLE 5.2: CONDUIT N - VALUES	
Conduit Material	n - Value
Concrete	0.013
CMP	0.024
Corrugated HDPE	0.015
PVC	0.010
Rough Earth	0.035

In order to assess the existing infrastructure, individual storm drain systems or networks were created. Each system was identified by the number of the quarter section where the network's outfall was located. See **Plates 1-3: Network ID Maps** for location of modeled storm drains and corresponding network ID's..

5.3 Roadway Capacity

Five typical street cross-sections were modeled to estimate the street flow capacity based upon the current City of Mesa street flow regulations. The roadway cross-sections consists of a six (6) lane arterial with and without raised median, four (4) lane arterial with and without raised median, and a two (2) lane collector. The roadway geometry was generated following the *Mesa Standard Details & Specifications*, 2009 (**Reference 7**), Typical cross-sections and locations and locations of existing number of lanes are included in **Appendix D: Hydraulics**. .

The current street hydraulic criteria states:

- 10-Year Peak Flows: Arterial streets and major collectors, flow shall be limited to a spread of one traffic lane in each direction.
- 100-Year peak flows: Arterial streets and major collectors, flow shall be limited between the right-of-way lines.

The computer program, FlowMaster V8 **(Reference 6)** was used to estimate the street flow capacity for both the 10-year and 100-year storms based upon the above criteria. The methodology used in FlowMaster was normal depth. Longitudinal street slopes vs. street capacity (flow) rating curves were generated for all 5 typical cross sections for both the 10-year and 100-year events with the following input parameters:

- n-values of 0.013 (for roadway), 0.030 (for medians).
- Typical street cross-sections with roadway cross slope of 2.0%, assumed 1.5% sidewalk slopes.

Known water surface elevation (For a 10-year storm, the water surface elevation was set so the spread will cover one lane per direction with 2.0% roadway cross slope. For the 100-year storm, the water surface elevation was set based on keeping the flow within the ROW).

In areas where detailed mapping was not available and the longitudinal roadway slope was less than 0.002ft/ft, a minimum street or gutter slope of 0.002ft/ft (0.20%) was used as defined by the City's design standards. Typical cross-sections and roadway capacity rating curves are included in **Appendix D: Hydraulics**.

5.4 Analysis of Existing Infrastructure

The analysis determined whether the system was adequate or not. In the case the system was not adequate, infrastructure improvement alternatives were developed to bring the system up to City's standards for the controlling storm. These alternatives and their evaluation are listed in **Section 6** of this report. For those systems that were found to be adequate, profiles showing the existing infrastructure and hydraulic grade lines are located in **Appendix H: Adequate Storm Drain Systems Hydraulics**.

In some cases, there were existing storm drains sized 36-inches or larger but for various reasons were deemed not to be modeled. For examples, if a storm drain only conveyed localized flows, it was not modeled.

5.5 Disconnection from Irrigation

One of the scope of work tasks for this project was to evaluate and make recommendations for disconnection from irrigation. The main connections to local irrigation systems are with the Salt River Project Irrigation (SRP) and the Roosevelt Water Conservation District (RWCD). During the course of this study, it was determined that "Proposed Irrigation Disconnections" should be from the RWCD system only and "Recommended Irrigation Disconnections" in locations were the interties are in close proximity to new proposed infrastructure, see **Appendix D: Hydraulics** for a list of all irrigation connections.

A total of 14 interconnections were found between RWCD and the City's storm drain system. Of those, only four locations are connections where storm water from the City would flow to the RWCD irrigation system as previously determined from a study performed by the City of Mesa's Engineering Division (See **Appendix D: Hydraulics**). See **Figure 5.1: Storm Drain Irrigation Connections** showing the irrigation interties.

For two of the four locations where the City connects to RWCD, disconnection solutions were developed, analyzed, and were incorporated into the drainage infrastructure improvements in the area of the cross connection. The storm drain network that provided these solutions is 71C in the vicinity of University Drive and Roanoke (Vicinity of 48^{th} Street) and Main Street and 48^{th} Street; see **Section 6.4.10** for more details about the disconnection. For the other two cross connections, in the vicinity of Southern Avenue just east of Greenfield Road and Greenfield Road north of the US60, it is recommended that the cross connections be removed by connecting into the nearby City of Mesa drainage facility. No significant major drainage infrastructure is needed to remove the cross connection.

SECTION 6: ALTERNATIVE EVALUATION

6.1 Alternative Evaluation Methodology

The hydrologic and hydraulic methodology for alternative evaluation generally followed the methodology listed in **Sections 4** and **5** of this report. Where needed, some changes were made to the hydrology to account for the effects of the proposed infrastructure improvements.

The process used to develop alternatives generally looked at providing additional storm drain capacity, adding additional retention, routing flows to areas of additional system capacity, or combinations of the above. We evaluated the hydraulic performance of each alternative and developed relative costs. We reviewed the assumptions and merits of the alternatives with the City's staff and provided our recommendation as presented later in this section.

Please refer to **Figure 7.1 through 7.3, Recommended Capital Improvements program and Phasing** for the approximate locations and layout of the existing and Proposed Drainage Infrastructure. Additionally, refer to **Appendix E: Hydraulics for Alternatives** and **Appendix H: Adequate Storm Drain Systems Hydraulics** for hydraulic profiles of the systems that were found to be adequate by virtue of meeting both Mesa's 100 year and 10 year drainage criteria. Refer to **Appendix G: Proposed Drainage Infrastructure** which contains plan and profile drawings showing the recommended Improvements for those systems that were found to be inadequate in meeting the City's drainage performance criteria.

6.2 Cost Estimate Methodology

Cost estimates were developed using unit prices for the three main types of infrastructure proposed: storm drains, channels, and retention basins. Entellus utilized recent bid tabulations and contacted pipe suppliers to verify the latest material costs to set unit prices for the proposed infrastructure. In addition to the unit prices for construction, the cost estimates included in **Section 7** also included a 20 percent contingency and a 15 percent for design and inspection.

6.2.1 Storm Drains

The unit prices for storm drains were developed on a per foot basis for each pipe size proposed. The unit price included the costs for pipe material, roadway excavation, backfill and compaction, pavement removal and replacement, and also

TABLE 6.1: STORM DRAIN UNIT PRICES

Pipe Diameter [Inches]	MH & Catch Basin Cost [Dollars]	Total Cost per LF [Dollars]
18	$84	$164
24	$84	$180
27	$84	$182
30	$84	$197
33	$84	$215
36	$84	$222
42	$84	$248
48	$84	$271
54	$84	$296
60	$84	$339
66	$84	$372
72	$84	$404
78	$84	$372
84	$84	$485
90	$84	$538
96	$84	$590

included the costs for manholes (500 feet on center) and catch basins (500 feet on center). See **Table 6.1** that contains the unit prices for Storm Drains used for this Master Plan. These costs estimates always assumed no ROW is required since the new storm drain was proposed to be constructed within the street ROW. Backup information on the development of unit prices is included in **Appendix F: Cost Analysis.**

6.2.2 Channels

The unit prices for channels were developed on a per foot basis for each channel size proposed. The unit price included the costs for excavation, backfill and compaction, Landscaping and erosion control. See **Table 6.2** that contains the unit prices for Channels used for this Master Plan. These costs estimates typically assumed the ROW was required since the new channel was proposed to be constructed outside or adjacent to the street ROW. Backup information on the development of unit prices is included in **Appendix F: Cost Analysis.**

TABLE 6.2: CHANNEL UNIT PRICES		
Channel Top Width [Feet]	Total Cost per LF with Right of Way [Dollars]	Total Cost per LF with Right of Way [Dollars]
10	$24	$70
15	$37	$106
20	$52	$144
30	$76	$214
40	$100	$284
50	$125	$354
60	$148	$424
70	$173	$494
80	$196	$564
90	$220	$634
100	$245	$704
110	$269	$774
120	$293	$844
130	$317	$914
140	$341	$984
150	$365	$1,054

6.2.3 Retention Basins

The unit prices for Retention Basins were developed on a per acre-foot basis regardless if the basin was a new basin or if it was to be an expansion of an existing facility. The unit price included the costs for excavation, backfill and compaction, Landscaping and erosion control. See **Table 6.3** below that contains the unit prices for Basins used for this Master Plan. These costs estimates were highly influenced by ROW costs and assumptions for need of ROW varied from location to location. Backup information on the development of unit prices is included in **Appendix F: Cost Analysis.**

TABLE 6.3: BASIN UNIT PRICES	
Retention with ROW [ac-ft]	$113,000
Retention without ROW [ac-ft]	$13,000
Regional Retention without ROW [ac-ft]	$38,000

6.3 Adequate Networks

This section lists and briefly describes the storm drain networks that were deemed to be adequate in meeting the City of Mesa drainage standards.

6.3.1 Network 5B - Broadway Road

This network is roughly 1 mile long, flows eastbound along Broadway Road beginning at Dobson and outfalls into the Loop 101 Freeway channel.

6.3.2 Network 7C - Southern Avenue and Dobson Road

This network is composed of two main systems, one flowing along Southern Avenue between Alma School Road and Dobson Road, and the other flowing southward along Dobson Road from Catalina Avenue to Southern Avenue. There is also a small stretch flowing westward along 8th Street starting midway between Sycamore and Dobson Road, to Dobson Road.

6.3.3 Network 8C - Baseline Road and Alma School Road

This network is roughly 1.5 miles long, flows southward on Alma School Road just south of the US-60 Freeway. At the intersection of Alma School Road and Baseline Road, the system heads westward and ultimately outfalls into the Dobson Ranch development.

6.3.4 Network 11C - McClellan Road

This network is roughly 1.75 miles long located on McClellan Road between Center Street and Alma School. There is a small segment of storm drain approximately 1,300 feet long on Center Street, north of McClellan Road.

6.3.5 Network 15C - Alma School Road

This network flows south along Alma School starting just south of Broadway Road and continues to the outlets at the US-60 channel. This network also has a contributing system on Southern flowing westward starting at Cherry Street and connecting to Alma School Road.

6.3.6 Network 18D - Country Club Drive

This network consists of two main storm drain branches. The first segment is in Country Club Drive for roughly 2.5 miles. It begins at University Drive, continues across Loop 202, and ultimately outfalls into the Salt River. The second segment is roughly 2 miles long on McKellips Road and runs from Stapley Drive to Country Club Drive.

6.3.7 Network 23A - Country Club Drive

This southerly flowing network is located on Country Club Drive between Broadway Road and the US 60. It flows south towards the US 60, at which it turns west and outlets in the Fiesta Lakes Golf Course. This network includes two contributing roadway networks, one from Pueblo Avenue, and the other from Southern Avenue. The Pueblo Avenue system flows westward from Center Street to Country Club Drive. The Southern Avenue segment begins just west of Center Street and joins the mainline at Country Club Drive. There is a railroad corridor in this area that acts as an embankment preventing stormwater runoff from crossing. It runs from west to east in an alignment just north of Broadway Road, it then turns south just west of Center Street. The hydrology model therefore shows no flow crossing Broadway Road or Center Street along the railroad alignment.

6.3.8 Network 23A-2 - Westwood Road

This network is located at Westwood Road and flows south to Holmes Avenue where it outlets into the Fiesta Lakes Golf Course. This network includes two contributing roadway networks, one from Grove Avenue, and the other from Holmes Avenue. The Grove Avenue system flows eastward from the inlet just west of Alma School Road to Westwood Road, and also from the east, flowing west starting at Extension to Westwood Roads. The Holmes Avenue segment begins just west of the Fiesta Lakes Golf Course and joins the mainline at Westwood Road.

6.3.9 Network 54B - 24th Street

This network is located on 24th Street and starts at Capri Ave. and flows south to Pueblo Avenue where it turns west along Pueblo Avenue to Briar Street. The segment at Briar Street flows south to the outlet at Silvergate Park. This network includes a second branch that flows northward from 24th Street along Fairview and north on Briar Street to the outlet at Silvergate Park.

6.3.10 Network 55A - Lindsay Road

This network is roughly 1 mile long located on Lindsay Road between Southern Avenue and the US 60. It flows southward towards Southern Avenue, where it then turns west running parallel to the US60 Freeway and outlets into a retention basin located within Kingsborough Park.

6.3.11 Network 58B - Lindsay Road

This network is located on Lindsay Road between McDowell and McKellips Roads. It flows southward and ultimately outfalls into a large retention basin just north of McKellips Road.

6.3.12 Network 62A & 62A-2 - Consolidated Canal

These networks are parallel to the Consolidated Canal between Allred Avenue and Lindsay Road. It flows southward and ultimately outfalls into a large retention basin just east of Lindsay Road. This network prevents flows from crossing the Consolidated Canal.

6.3.13 Network 73D - Higley Road

This network is approximately 1 mile in length from inlet to the network outlet and runs north along Higley Road beginning just north of Hermosa Vista Drive. The network turns westward near Longbow Parkway and outlets into an existing basin north of Longbow Parkway.

6.3.14 Network 81B - McDowell Road

This network flows along McDowell Road starting at Diego Circle, west of Recker Road, flows westward and ultimately outlets in the Longbow Golf Course. This network also has a branch from Recker Road flowing north where it then connects with the McDowell Road line. This network is considered adequate if the proposed retention is installed for network 75B north of McKellips Road.

6.3.15 Network 85B - Higley Road

This network flows southward on Higley Road from University Drive to the EMF intersection near Main Street and is located downstream of the 77C network. The network is adequate if all proposed improvements are made upstream.

6.3.16 Network 85B-2 - Main Street

This network flows along Main Street running westward from Recker Road to the outlet just east of Higley Road. The network is adequate if all proposed improvements are made upstream.

6.3.17 Network 87C - Southern Ave

This network is roughly 0.5 miles in length and is located on Southern Avenue. It begins at 61st Street and flows westward to the outlet at Leisure World Country Club.

6.3.18 Network 91D - Power Road

This network is roughly 1.5 miles long, runs southward along Power Road from McKellips Road to Brown Road where it then heads westbound along Brown and outlets in to an existing basin on the northeast corner of 64th Street and Brown Road.

6.3.19 Network 96C - Baseline Road

This network runs primarily westward on Baseline Road. It begins on Sossaman Road just north of Southern Avenue and flows south to Baseline Road. At the intersection of Baseline Road and Sossaman Roads, the network runs westward to the outlet at the Superstition Springs Golf Club.

6.3.20 Network 97D - McDowell Road

This network is located in the Spook Hills area and flows westbound along McDowell Road starting at the basin located on the northeast corner of McDowell and Hawes Roads and flowing into the outlet channel located on the northwest corner of McDowell and Sossaman Roads. This system was modeled based on design plans and the 100-year, 24-hour flows given by the design consultant.

6.3.21 Network 98D - Hermosa Vista Drive

This network is located in the Spook Hills area and flows westbound starting at McDowell and Ellsworth Roads within the Madrid basin and then flows out into the Loop 202 channel at Hermosa Vista Drive. This system was modeled based on design plans and the 100-year, 24-hour flows given by the design consultant.

6.3.22 Network 111B - Baseline Road

This network runs westbound along Baseline Road carrying storm flows from just west of Ellsworth Road to an existing channel along Sossaman Road. The current data shows the system crossing the Loop 202 along Baseline Road. It was assumed that the system west of the Loop 202 will not cross the freeway and a new system will start on Baseline road west of the Loop 202. The system west of the loop 202 is currently comprised of a single pipe and turns into a dual pipe system starting at 80th Place heading westward to the existing outlet.

6.3.23 Network 117D-2 - 97th Way

This is a relatively small network located between a system of channels running from the CAP Canal to Broadway Road. The network itself consists of one pipe culvert crossing beneath Balsam Avenue just east of 97th Street.

6.3.24 Network 127A - Crismon Road

This network runs southbound along Crismon Road from Coralbell Avenue to the US60. This network includes a couple of channels along Crismon Road as well as the US60 channel that empties into the basin on the northeast corner of the US60 and Ellsworth Road.

6.3.25 Network 127-2 - Ellsworth Road

This network runs southbound along Ellsworth Road starting at Southern Avenue to the outlet just north of the US60.

6.3.26 Network 143A - Signal Butte Road

This network runs along Signal Butte Road to the south where it outlets just before the US60. This network also connects to a channel system that flows south to the US60.

6.4 Proposed Infrastructure Improvements

6.4.1 Network 4C - Dobson Road

This network begins at the intersection of Main Street and Sycamore where it flows west for approximately 0.25 of a mile towards Dobson Road. It then flows north for roughly 1.5 miles until it outflows into the Salt River. The upstream section of the network is comprised of 54-inch pipes along Dobson Road until University Drive where there is a size reduction to a 48-inch pipe before crossing the Tempe Canal.

Main Street:

- **Alternative 1 (Recommended Alternative):** System is adequate at this reach.

Dobson Road:

- **Alternative 1 (Recommended Alternative):** Keep existing infrastructure and add a proposed parallel between University Drive and the Tempe Canal pipe to maintain the hydraulic 100-year storm flow grade line below existing grade.

Recommended Alternative Cost: $202,000

6.4.2 Network 11B - Main Street

This network is comprised of several storm drain branches. The first and main storm drain segment is located along Main Street between Lindsay Road and Alma School Road traveling west for approximately 5 miles. At the intersection of Main Street and Alma School Road, the storm drain then travels north for approximately 1.5 miles for a total of about 5.5 miles before entering a lined channel and ultimately outfalls at the Salt River just north of Loop 202. The second branch is roughly 1.5 miles and is located on Gilbert Road between Brown Road and Main Street. The third storm drain branch is roughly 0.5 of a mile, located on Stapley Drive between University Drive and Main Street. The fourth segment is located on Horne approximately 1.25 miles between 10th Street and Main Street. There is segment located on University Drive from Center Street to Country Club Drive. At Country Club Drive, the storm drain turns south and ultimately meets with the Main Street system. There is a smaller branch, approximately 0.5 of a mile long on Extension Road from University to Main Street. All were found to be adequate except the sections on Main Street, Gilbert Road and Horne.

Main Street:

- **Alternative 1 (Recommended Alternative):** Add new infrastructure on main Street between Lindsay road and Val Vista Drive extending the upstream section of the system. Keep existing infrastructure and add parallel pipes the storm drain system to convey existing flows.
- **Alternative 2:** Add underground retention in the current K-Mart parking lot on the corner of Lindsay Road and Main Street to minimize volume and peak flow from subbasin 43 of the Consolidated Canal model.

- **Alternative 3:** Add retention in the current Food City parking lot on the corner of Stapley Drive and Main Street to minimize volume and peak flow from subbasin 113 of the Tempe Canal model.

Gilbert Road:

- **Alternative 1:** Keep existing infrastructure and add parallel pipes the storm drain system to convey existing flows.

- **Alternative 2 (Recommended Alternative):** Add retention in the current east-west Power line corridor crossing Gilbert Road, north of Colby Street to minimize volume and peak flow from subbasin 32 of the Consolidated Canal model. Added card PRE33 after card 33to34 to represent storage of 3.5 ac-ft in proposed basin in the power line corridor.

Horne Road:

- **Proposed Alternative:** Keep existing infrastructure and add parallel pipes to the storm drain system to convey existing flows. Additional infrastructure is required starting south of 8th Street to University Drive to compensate for little to no retention east of Horne Road. System is adequate south of University Drive.

Recommended Alternatives Cost: $7,271,000

6.4.3 Network 31C - Mesa Drive

This network's main segment is located along Mesa Drive from Broadway Road to Southern Avenue where it then flows westward to Center Street, then south to the outlet into the Heritage Park basin north of US60. Two systems that contribute are from Southern Avenue and from Sirrine Road. The Southern Avenue system runs westward from Hobson to Mesa Drive where it connects to the mainline. The Sirrine Road system starts at 10th Avenue and flows southward to Southern Avenue where it connects to the mainline system.

Mesa Drive:

- **Alternative 1:** Keep the existing infrastructure and add parallel pipes to keep the hydraulic grade line for the 100-year storm event flows below the existing ground.

- **Alternative 2:** Keep the existing infrastructure and add parallel pipes to keep the hydraulic grade line of the 100-year storm event flows below the existing ground. Also includes the addition of storage north of Broadway Road along Mesa Drive.

- **Alternative 3 (Recommended Alternative):** Keep the existing infrastructure and add parallel pipes to keep the hydraulic grade line of the 100-year storm event flows below the existing ground.

Broadway Road

- **Alternative 3 (Recommended Alternative):** New infrastructure is proposed along Broadway Road running eastward from Sirrine Road to Mesa Drive to mitigate flooding in the area. This is valid if all proposed changes are made upstream of the network. It is recommended that current storm drain systems on Sirrine Road and Hibbert Road be connected to the new infrastructure to terminate current flooding problems in the vicinity.

Southern Avenue:

- **Alternative 1 & 2:** Keep the existing infrastructure and add parallel pipes to keep the hydraulic grade line for the 100-year storm event flows below the existing ground.
- **Alternative 3 (Recommended Alternative):** Keep the existing infrastructure and add parallel pipes to keep the hydraulic grade line for the 100-year storm event flows below the existing ground. This is valid if all proposed changes are made upstream of the network.

Sirrine Road:

- This segment is adequate under all alternatives.

Recommended Alternatives Cost: $4,337,000

6.4.4 Network 31D – Baseline Road

The main outfall for this network is located on Lewis Road just east of Country Club Drive. It has two main contributing branches both on Baseline Road from Country Club to Lewis Road and from 24th Street to Lewis Road.

- **Alternative 1 (Recommended Alternative):** Keep the existing infrastructure and add parallel pipes to keep the hydraulic grade line for the 100-year storm event flows below the existing ground.

Recommended Alternatives Cost: $499,000

6.4.5 Network 39C - Stapley Drive

The main branch of this network is located on Stapley Drive between Broadway Road and Southern Avenue for approximately 1 mile, where it then travels along Southern Avenue from Oracle to Horne for approximately 1.3 miles, and along Horne from Southern Avenue to the outlet near the US60 for approximately 0.4 of a mile. It requires additional infrastructure on the three sections mentioned, the Stapley Drive segment, the Southern Avenue segment, and the Horne segment.

Stapley Drive:

- **Alternative 1:** Keep existing infrastructure in Broadway Road, and replace existing pipes to keep the hydraulic grade line for the 100-year flows below the existing surface. This requires large diameter pipes to convey all existing flow and bring up to City standards.
- **Alternative 2:** Keep the existing infrastructure in Broadway Road, and replace existing pipes to keep the hydraulic grade line for the 100-year flows below the existing surface. Adding proposed offline retention on the existing Skate Park along Broadway Road to make up for the lack of retention between Main Street and

Broadway Road. Also, additional retention on the Lindberg Elementary School fields to minimize proposed infrastructure along Stapley Drive.

- **Alternative 3 (Recommended Alternative):** This alternative includes the proposed retentions mentioned in alternative 2. It will also include additional pipes along Broadway Road running westward to Horne, then south until it connects with the existing system. This will dramatically reduce the runoff from north of Broadway Road and mitigate storm water impacts.

Southern Avenue:

- **Alternative 1 & 2:** Keep the existing infrastructure and add parallel pipes to keep the hydraulic grade line for the 100-year storm event flows below the existing ground.

- **Alternative 3 (Recommended Alternative):** Keep the existing infrastructure and add parallel pipes to keep the hydraulic grade line for the 100-year storm event flows below the existing ground.

Broadway Road:

- **Alternative 1 & 2:** No proposed infrastructure along Broadway Road.

- **Alternative 3 (Recommended Alternative):** New infrastructure is proposed on Broadway Road from west of Gilbert Road to Horne to make up for the lack of retention between Main Street and Broadway Road. The Proposed infrastructure will then head south along Horne from Broadway Road to Southern Avenue where it then connects to the existing infrastructure.

Horne:

- **Alternative 1 & 2:** The existing infrastructure is adequate for this alternative.

- **Alternative 3 (Recommended Alternative):** New infrastructure is proposed from Broadway Road to Southern Avenue along Horne where it then connects to the existing infrastructure. On Horne from Southern Avenue to US-60, keep the existing infrastructure and add parallel pipes to keep the hydraulic grade line for the 100-year storm event flows below the existing ground.

Recommended Alternatives Cost: $12,292,000

6.4.6 Network 47C - Gilbert Road

Gilbert Road:

- **Alternative 1:** Keep existing infrastructure and add parallel pipes the to the storm drain system to convey existing flows.

- **Alternative 2:** Add retention in empty lot on the corner of Chestnut and Balsam Avenue to minimize volume and peak flow from development north of Broadway Road that has little to no existing retention.

- **Alternative 3:** Includes Alternative 2 and additional 11 ac-ft of online retention in Silver Gate Park. Current retention basin will need to be re-graded to provide the additional proposed retention volume.
- **Alternative 4 (Recommend Alternative):** Additional 11 ac-ft of online retention in Silver Gate Park and no retention north of Broadway Road.

Broadway Road

- **Alternative 1 & 2:** Keep existing infrastructure and add parallel pipes to the storm drain system to convey existing flows. Hydraulic grade line at Gilbert Road needs to be below 1240.5 feet at the intersection of Gilbert and Broadway Roads to keep the hydraulic grade line on Broadway Road below existing grade.
- **Alternative 3:** Add retention in empty lot on the corner of Broadway Road and Williams to minimize volume and peak flow from subbasin 119 of the Tempe Canal model.
- **Alternative 4 (Recommend Alternative):** Keep existing infrastructure on Broadway Road, west of Gilbert Road and add new infrastructure on Broadway Road between Gilbert Road and the Consolidated Canal.

Recommended Alternatives Cost: $2,015,000

6.4.7 Network 59B - Lindsay Road/Eastern Canal

This network includes two main storm drain branches. The first segment is located along McKellips Road between the Eastern Canal and Val Vista Drive. The second segment is located along Lindsay Road, starts at McKellips Road and travels south parallel to the Eastern Canal. All system components appear to be adequate other than the branch along McKellips Road, east of Lindsay Road.

McKellips Road: This branch was modeled and appears to be deficient between Lindsay Road and 32nd Street for both the 100 – year and 10 – year storm event.

- **Recommended Alternative:** Keep existing infrastructure and add parallel pipes the storm drain system to convey existing flows generated by the governing 10 – year storm event.

Recommended Alternatives Cost: $534,000

6.4.8 Network 63A - Val Vista Drive

This network primarily runs along the east bank of the Eastern Canal and along Val Vista Drive from Brown Road to Southern Avenue and ultimately outfalls at Harmony Park just north of the US-60. There is one contributing branch to the Val Vista Drive segment on University Drive. The segments on Brown Road, east of the Eastern Canal and the segment on University drive, east of Val Vista Drive will be adequate for both the 10 and 100-year storm events if the downstream improvements are in place.

Eastern Canal:

- **Alternative 1:** Keep existing infrastructure and add parallel pipes to keep the hydraulic grade line for the 100-year flows below the existing surface.
- **Alternative 2 (Proposed Alternative) :** Keep existing infrastructure and add parallel pipes from for approximately 2,600 feet north of Val Vista Drive to accommodate the 100-year hydraulic grade line. Additional diversions were added, as well as restricted in order reduce flows entering the storm drain. It is also recommended that the existing retention basin on the north-east side of the intersection of the Eastern Canal and Brown Road be re-graded and laterals added to increase efficiency of basin.

Val Vista Drive:

- **Alternative 1 & 2 (Proposed Alternative):** Keep existing infrastructure and add parallel pipes to keep the hydraulic grade line for the 100-year flows below the existing surface.

Recommended Alternatives Cost: $2,695,000

6.4.9 Network 70C - Eastern Canal South

This network runs primarily along the east side of the Eastern Canal from Main Street to the Greenfield Park basin on Pueblo Avenue. It is composed of a series of channels and pipes. Two storm drain branches flow into the mainline parallel to the Eastern Canal, the Main Street system and the Broadway Road and 40th Street systems. The Main Street system flows from New Haven westward to the Eastern Canal for a total modeled length of 0.6 miles. The Broadway Road and 40th Street system captures diverted flows from the Eastern Canal system, flows eastward to 40th Street, where it then flows south back into the Eastern Canal system. All channels were adequate, therefore most proposed modifications are along existing storm drain pipes.

Eastern Canal:

- **Alternative 1&2 (Proposed Alternative):** Keep existing infrastructure and add parallel pipes to keep the hydraulic grade line for the 100-year flows below the existing surface.

Main Street:

- **Alternative 1 (Proposed Alternative):** Keep existing infrastructure and add parallel pipes to keep the hydraulic grade line for the 100-year flows below the existing surface.
- **Alternative 2:** Keep existing infrastructure Additional offline basin located on Chelsea Park on 40th south of Main Street to minimize proposed.

Broadway Road and 40th Street:

- **Alternative 1 & 2 (Proposed Alternative):** Keep existing infrastructure and add parallel pipes to keep the hydraulic grade line for the 100-year flows below the existing surface.

Recommended Alternatives Cost: $849,000

6.4.10 Network 71C - Greenfield Road

This network primarily runs along on Greenfield Road between University Drive and the US-60. The Greenfield Road branch has a total modeled length of 2.25 miles. This network has three main branches that flow into the Greenfield Road system which are located on Main Street, Broadway Road, and Southern Avenue. The Main Street segment is relatively short, 2,500 feet, 600 feet of which were modeled from 17th Avenue to Greenfield Road. The Broadway Road segment begins at Via Bonita and flows westward to Greenfield Road. The Southern Avenue segment starts at Higley Road and flows westward to Greenfield Road.

University

- The University Drive segment is adequate for both the 10 and 100-year storm events, therefore alternatives were not proposed for this stretch. At the intersection of University Drive and Roanoke (west of the RWCD Canal), there is a City of Mesa to RWCD irrigation connection. It is proposed that a storm drain be added on University Drive from Roanoke to Greenfield Road and the irrigation intertie disconnected. See **Figure 5.1: Storm Drain Irrigation Connections** for the irrigation connection location.

Greenfield Road:

- **Alternative 1:** Keep existing infrastructure and add parallel pipes to keep the 100-year flows hydraulic grade line below the existing surface.

- **Alternative 2 (Proposed Alternative):** Keep existing infrastructure and add parallel pipes combined with an additional 20 ac-ft of retention to the Greenfield Park basin by building up the edge of the basin along the Eastern Canal and on the north between the existing development and the basin.

Main Street:

- The Main Street segment is adequate for both the 10 and 100-year storm events, therefore alternatives were not proposed for this stretch. East of 48th Street on Main Street, there is a City of Mesa to RWCD irrigation connection. It is proposed that the storm drain on Main Street be extended and the irrigation tie disconnected. See **Figure 5.1: Storm Drain Irrigation Connections** for the irrigation connection location.

Broadway Road:

- **Alternative 1:** Keep existing infrastructure and add parallel pipes to keep the hydraulic grade line for the 100-year flows below the existing surface.

- **Alternative 2 (Proposed Alternative):** Keep existing infrastructure and add parallel pipes as well as extending the storm drain eastward from Via Bonita to Fairchild. There are several RWCD to City of Mesa storm drain connections located on

Broadway road. It is recommended that these connections be terminated to avoid additional flow that may occur in a large storm event.

Southern Avenue:

- The Southern Avenue segment is adequate for both the 10 and 100-year storm events, therefore alternatives were not proposed for this stretch. East of Greenfield Road on Southern Avenue, there is a City of Mesa to RWCD irrigation connection. It is proposed that the irrigation tie be disconnected and connected to the existing storm drain system. See **Figure 5.1: Storm Drain Irrigation Connections** for connection location.

Recommended Alternatives Cost: $6,664,000

6.4.11 Network 75B - McKellips Road

This network is located primarily along McKellips Road between Power and Greenfield Roads. A main contributing line flows in from the north on Greenfield Road transporting storm flow from along McDowell Road and Greenfield Road to the outlet at the East Maricopa Floodway.

McKellips Road:

- **Alternative 1 (Recommended Alternative):** Keep existing infrastructure and add parallel pipes to maintain the 100-year event storm flow hydraulic grade line below the existing grade along McKellips Road. It is also recommended to expand the existing small retention basin in the empty lot located on the south east corner of Leonard Street and 64th Street, north of McKellips Road. The addition, the retention basin will minimize the volume and peak flow runoff from the current development to the north and south of the improvements.

Greenfield Road:

- The existing infrastructure is adequate for proposed conditions if all recommended infrastructure is added upstream.

Higley Road:

- The existing infrastructure is adequate for proposed conditions if all recommended infrastructure is added upstream.

McDowell Road:

- The existing infrastructure is adequate for proposed conditions if all recommended infrastructure is added upstream.

Recker Road:

- The existing infrastructure is adequate for proposed conditions if all recommended infrastructure is added upstream.

Recommended Alternative Cost: $2,191,000

6.4.12 Network 76A - Ellsworth Road

This network flows eastbound along Brown Road starting at 64th Street to the EMF near 46th Street. A small stretch of pipe lies along 64th Street prior to flowing onto Brown Road. The beginning of the network is comprised of a channel system that runs along Brown Road from 64th Street to 61st Place before flowing into the existing storm drain system.

64th Street:

- The existing infrastructure is adequate for proposed conditions if all recommended infrastructure is added upstream.

Brown Road:

- **Alternative 1 (Recommended Alternative):** Keep existing infrastructure and add parallel pipes to maintain the 100-year storm flow hydraulic grade line below the existing grade on Brown Road.

Recommended Alternative Cost: $2,861,000

6.4.13 Network 77C - University Drive

This network flows westbound along University Drive starting at Recker Road and flowing into the EMF east of the intersection of University Drive and Greenfield Road. Two segments flowing into the University Drive mainline are the Higley Road segment and the Recker Road Segment.

University Drive:

- **Alternative 1:** Keep existing infrastructure and add proposed parallel pipes to maintain the 100-year storm event flow hydraulic grade line below the existing ground level.
- **Alternative 2 (Recommended Alternative):** Keep existing infrastructure and add proposed online retention along the Powerline Corridor between Higley Road and Recker Road, north of University Drive including several laterals to convey the flow to the proposed basins. In addition, to maximize the reduction of peak flow on University Drive, an offline basin is proposed along Recker Road. This will dramatically reduce peak flow runoff and avoid additional infrastructure not only along University Drive but in all downstream systems.

Higley Road:

- **Alternative 1:** Keep existing infrastructure and add proposed parallel pipes to maintain the 100-year storm event flow hydraulic grade line below the existing ground level.
- **Alternative 2 (Recommended Alternative):** The existing infrastructure is adequate for proposed conditions if all recommended infrastructure is added upstream.

Recker Road:

- **Alternative 1 & 2 (Recommended Alternative):** The existing infrastructure is adequate for proposed conditions if all recommended infrastructure is added upstream.

Recommended Alternative Cost: $1,031,000

6.4.14 Network 86A - Power Road

This network's main segment consists of a multiple barrel box culvert located along Broadway Road from 70th Street to the EMF. There are four main branches that contribute to the Broadway Road branch along 70th Street, Power Road, 64th Street and a drainage easement 0.25 of a mile east of Recker Road. The most upstream branch contributing to Broadway Road segment starts along University Drive flows south along 72nd Street down a lined channel for roughly 2,000 feet, transitions to the 70th Street alignment where it heads south towards Broadway Road where it connects to the mainline. The Second branch starts along Adobe Street between Sun Valley Boulevard and Power Road where it then flows south to the Broadway Road segment. The third and fourth branch both start on Main Street flowing westward. There is a split along 64th Street flowing south, the rest continues west on Main Street for roughly 1,200 feet where it then turns southbound towards Broadway Road where it connects to the mainline system.

70th Street:

- **Alternative 1 & 2 (Recommended Alternative):** This system is currently comprised of adequate channels with multiple road crossings. There are two locations where the road crossings were determined to be inadequate. The first is located on 70th street and Arbor Avenue where the channel transitions from the east side of the road to the west. The second is located at the intersection of 70th Street and Broadway Road. Currently, the existing lined channel transitions to a multiple barrel box culvert via a single 30-inch pipe. It is recommended that the pipes be removed and replaced with infrastructure adequate to convey the required flow.

Power Road

- **Alternative 1:** Keep existing infrastructure and add proposed parallel pipes to maintain the 100-year storm event flow hydraulic grade line below the existing ground level.
- **Alternative 2 (Recommended Alternative):** Keep existing infrastructure and add proposed online retention along Adobe Street, West of Sun Valley including several laterals to convey the flow to the proposed basins.

Recommended Alternative Cost: $692,000

6.4.15 Network 95B - Power Road

This network's main segment consists of channel located north of the US-60 from Sossaman Road to the EMF. There are four main branches that flow to the ADOT channel along Sossaman Road, Amulet, 72nd Street and Power Road. This network also includes various incorporated culverts and channels especially along 72nd Street and Sossaman Road.

Main Street:

- **Alternative 1 & 2 (Recommended Alternative):** Keep existing infrastructure and add proposed parallel pipes to maintain the 100-year storm event flow hydraulic grade line below the existing grade along Main Street.

72nd Street:

Alternative 1: Keep existing infrastructure and add proposed parallel pipes to maintain the 100-year storm event flow hydraulic grade line below the existing grade along 72nd Street.

Alternative 2 (Recommended Alternative): Keep existing infrastructure and add proposed offline retention in Jefferson Park on Broadway Road to make up for the lack of retention in the development between 76th Street and 72nd Street. In addition, infrastructure will be required to convey the flow from the intersection of 72nd Street and Broadway road to the proposed basin. This will dramatically reduce peak flow runoff and avoid additional infrastructure not only along 72nd Street but to all downstream systems.

Recommended Alternative Cost: $1,248,000

6.4.16 Network 113A - Oak Street Channel and Storm Drain

This proposed network consists of a channel that flows southbound along Hawes Road and a storm drain system running westbound along Oak Street. This network was originally proposed and pre-designed by another sub-consultant hired by the Flood Control District of Maricopa County.

Hawes Road:

- This proposed channel lies along Hawes Road beginning at Range Rider Trail and carries flows south to the proposed retention basin on the northeast corner of Hawes Road and Oak Street.

Oak Street:

- This proposed storm drain runs westbound along Oak Street and carries storm flow from 87th Street to the basin on the northeast corner of Hawes and Oak Street. A bypass segment of the same size was extended to Hawes Road where the flows are proposed to be conveyed across and into an existing 404 wash.

Proposed Network Cost: $2,629,000

6.4.17 Network 117D - Ellsworth Road

This network is located along Ellsworth Road and flows southbound between University Drive and Main Street.

Ellsworth Road:

- **Alternative 1 (Recommended Alternative):** Keep existing infrastructure and add parallel boxes in order to maintain the 100-year storm event flow hydraulic grade line below the existing ground along Ellsworth Road.

Recommended Alternative Cost: $500,000

6.4.18 Network 122B - Spook Hill Proposed Channel and Storm Drain

This proposed network consists of a channel that flows westbound along McKellips Road from Crismon to Ellsworth Roads and a storm drain system flowing southbound along Ellsworth Road between Nance Street and Brown Road.

McKellips Road:

- This segment consists of a proposed channel to be located along McKellips Road, beginning at Crismon Road and transporting flow westbound to a proposed basin on the northeast corner of Ellsworth and McKellips Roads.

Ellsworth Road:

- This segment consists of a proposed storm drain system capturing flow beginning at the intersection of Nance Street and Ellsworth Road and transporting the storm flow southbound to the intersection of Brown and Ellsworth Roads where it connects to the existing Signal Butte Floodway.

Recommended Alternative Cost: $13,109,000

6.4.19 Network 123B - 94th Street Proposed Channel

This proposed network consists of a small channel along 94th Street between Jasmine Circle and McClellan Road.

94th Street:

- This segment is a proposed channel along 94th Street which will channelize flows to keep the flows from overtopping the existing unpaved roadway which is the only access road for many of the residents. It will run along the eastern edge of 94th Street from the existing wash outlet near 94th Street and Jasmine Circle to an existing branch of the same wash near Indigo Street.

Recommended Alternative Cost: $188,000

6.4.20 Network 125C - Crismon Road

This network is located along Crismon Road between Brown Road and University Drive. The network proposed flows into an existing channel on University Drive.

Crismon Road:

- **Alternative 1 (Recommended Alternative):** Proposing infrastructure along Crismon Road starting at Brown Road flowing south to University Drive, then continuing westward on University Drive to an existing channel.

Recommended Alternatives Cost: $2, 757,000

6.4.21 Network 133A - Signal Butte Road

The majority of this network is proposed and runs along Signal Butte Road and then flows south to Cholla Street where it flows into an existing channel which outlets into an existing retention basin located at Akron and Crismon Road. A small segment runs below University Drive connecting the upstream and downstream parts of the outlet channel.

Signal Butte Road:

- **Alternative 1 (Recommended Alternative):** Proposing infrastructure along Crismon Road to the existing channel at Cholla Street.

University Drive:

- **Alternative 1 (Recommended Alternative):** Proposing infrastructure along University Drive between the existing channel outlet north of University and inlet south of University.

Recommended Alternatives Cost: $1,592,000

6.4.22 Network 133B - University Drive

This network runs westward along University starting at Meridian Road and then to Signal Butte where it flows south to Main Street and turns east to Cheshire Street. This proposed network is continuous until it reaches Main Street just east of Cheshire Street where it outflows into an existing series of pipes.

University Drive:

- **Alternative 1 (Recommended Alternative):** Proposing infrastructure along University Drive the entire stretch starting at the inlet on University Drive and Meridian Road to University Drive and Signal Butte Road.

Signal Butte Road:

- **Alternative 1 (Recommended Alternative):** Proposing infrastructure along Signal Butte Road starting at University Drive then running south to Main Street.

Main Street:

- **Alternative 1 (Recommended Alternative):** Proposing infrastructure along Main Street starting at Signal Butte Road to the connection with existing infrastructure east of Cheshire Street.

Recommended Alternatives Cost: $5,048,000

6.4.23 Network 312A - Guadalupe Road

This network begins along Hawes and Main Street and flows southbound past the US60 to Guadalupe Road where it joins the westerly running segment flowing to an existing channel along Sossaman Road. Four main segments exist within this network, three of which connect to the main alignment along Guadalupe Road, one segment runs along Hawes Road, another along Southern Avenue, and the final stretch at Palo Verde Street.

Guadalupe Road:

- **Alternative 1 (Recommended Alternative):** Keep existing infrastructure and add proposed parallel pipes along Guadalupe Road before it intersects with the Loop 202 to maintain the 100-year storm event flow hydraulic grade line below the existing ground level on Guadalupe Road. At the intersection with the Loop 202, it is proposed to divert all of the flow into the existing ADOT channel running southbound on the eastern side of the Loop 202 alignment.

Hawes Road:

- **Alternative 1 (Recommended Alternative):** If all proposed infrastructure is added upstream, then this system is adequate.

Southern Avenue:

- **Alternative 1 (Recommended Alternative):** If all proposed infrastructure is added upstream, then this system is adequate.

Palo Verde Street:

- **Alternative 1 (Recommended Alternative):** If all proposed infrastructure is added upstream, then this system is adequate.

Recommended Alternative Cost: $2,250,000

6.4.24 Network 320B - 80th Street Proposed Channel

This proposed channel network flows along 80th Street and Warner Road. The network begins at the intersection of 80th Street and Paloma Avenue, from which it flows southbound to Warner Road. At Warner Road the network then heads westbound to the outlet at the Eastern Maricopa Floodway.

80th Street:

- This proposed channel network includes the addition of a new channel along 80th Street carrying southbound flow between Paloma Avenue to Warner Road where it connects to the next proposed channel segment.

Warner Road:

- This proposed channel network includes the addition of a new channel along Warner Road carrying westbound flow between 80th Street and the Eastern Maricopa Floodway.

Proposed Network Cost: $10,658,000

6.4.25 Network 336A - Loop 802 Proposed Channel

This proposed channel network includes multiple channels located within the area bounded by Elliot, Germann, Meridian, and Ellsworth Roads. The main roadways that will run alongside the proposed channel segments are Signal Butte Road, Ellsworth Road, Meridian Road, Frye Road, Pecos Road, Germann Road, and Crismon Road.

Ellsworth Road:

- This proposed channel network includes the addition of a new channel along Ellsworth Road flowing northward between Pecos Roads and Germann.
- This proposed channel network includes the addition of a new channel along Ellsworth Road between Mesquite Street and Ray Road.

Crismon Road:

- This proposed channel network includes the addition of a new channel along Crismon Road between Pecos Roads and Germann.

Germann Road:

- This proposed channel network includes the addition of a new channel along Germann between Signal Butte and Crismon Roads.

Pecos Road:

- This proposed channel network includes the addition of a new channel along Pecos Road flowing westbound between Mountain Road (west of Meridian Road) and Ellsworth Roads.

Signal Butte Road:

- This proposed channel network includes the addition of a new channel along Signal Butte Road between Mesquite Street and Bella Via Avenue.

Meridian Road:

- This proposed channel network includes the addition of a new channel along Meridian Road flowing northbound between Germann and Pecos Roads into a proposed basin on along Meridian Road.
- This proposed channel network includes the addition of a new channel along Meridian Road flowing south between the future Loop 802 Freeway and Pecos Roads into a proposed basin on along Meridian Road.
- This proposed channel network includes the addition of a new channel along Meridian Road between Erie Street (North of Williams Field Road) to Frye Road and outfall at a proposed retention basin at the intersection of Frye Road and Meridian Road north of the future Loop 802 Freeway.

Frye Road:

- This proposed channel network follows the Loop 802 planned alignment starting at the intersection of Frye and Meridian Roads and flowing in a northwesterly direction until it connects to the existing Loop 202 channel.

Proposed Network Cost: $37,650,000

6.4.26 Network 336A-2 – Pacos Road Detention Basins:

- This network includes a proposed retention basin to be built by ADOT at the intersection of Meridian Road and just north of the future Loop 802 Freeway.
- This network includes a proposed retention basin to be built by ADOT at the intersection of Meridian Road Pacos Road.

Proposed Network Cost: $14,570,000

6.4.27 Network 353B - Hawes Road Channel

Hawes Road:

- This proposed channel network includes the addition of a new channel flowing southbound along Hawes Road between Pecos and Germann Roads.

Germann Road:

- This proposed channel network includes the addition of a new channel flowing eastbound along Germann Road between Hawes and Sossaman Road.

Proposed Network Cost: $4,304,000

SECTION 7: SUMMARY AND RECOMMENDATION

7.1 Recommended Changes to Regulations and Policies

As part of the preparation of this Master Plan, a comparison was made of current City drainage regulations and Drywell policies with those of other communities. Additionally, the possibility of incorporating Green or environmentally friendly drainage solutions into the Mesa system was investigated.

The results of these comparisons and investigation are summarized below and more fully in **Section 3: Standards and Policies Review** and in **Appendix B.**

The recommended changes to the Drainage Regulations include changes to the requirements for depth and slopes in retention/detention basins, the depth of flow allowed in City Streets, the minimum storm drain sizes and manhole spacing, and first flush requirements for AZPDES.

The recommendations for inclusion of green drainage solutions include, again, first flush requirements, multiple chamber drywells, bio-retention, porous concrete, underground storm water chambers, runoff harvesting, green roofs, and construction with recycled materials.

Drywell policy changes recommended include: Allow the use of drywells only as a last resort, adding environmental regulations to control contaminants, a reduction in the allowable disposal rate for single chamber drywells, requiring grates to be above ground, and encouraging the use of a dual drywell chamber.

7.2 Recommended Infrastructure Improvements

7.2.1 Storm Drain/Retention

Several infrastructure improvements were recommended to and approved by the City of Mesa that included: storm drains, channels, basins, and other drainage infrastructure improvements. These improvements are listed in Section 6.4, are illustrated in **Figures 7.1, Proposed Infrastructure** and **Figure 7.2: Hydraulic Prioritization of Networks**, and plan and profile sheets are included in **Appendix G: Proposed Drainage Infrastructure**.

7.2.2 Disconnection from Irrigation

This study identified and addressed four storm drains to RWCD Irrigation system cross-connections. It was decided to disregard the City of Mesa or SRP Irrigation System connections with storm drain infrastructure. The solution to the four connections is discussed in **Section 5.5: Disconnection from Irrigation**.

7.3 GIS and Other Digital Deliverables

As part of this study Entellus obtained and generated a significant amount of digital data. These data included many previous studies and infrastructure information. All the information generated digitally for this project is included in the DVD included in **Appendix I.**

Some of the more significant and useful data provided includes:

- HEC 1 models
- Storm Cad models
- Proposed infrastructure in GIS shape file
- Modified existing infrastructure shape files
- IIP Spreadsheet
- Drainage complains shape files linked to pictures
- Digitized study boundaries and methodology for analysis

7.4 Implementation Plan

Major considerations for prioritizing and implementing the improvements identified in this study include: safety, protection of property, maintenance of traffic, cost, minimizing disruption during construction, and other criteria and benefits not necessarily listed in order of importance.

In order to achieve these goals while implementing these improvements, the timing and priority of construction is initially dependent upon hydraulic benefit and need. Additionally, as a pragmatic matter, the timing of construction for the drainage infrastructure proposed by this study is highly affected by the timing of future Roadway Improvements, Flood Control District Projects, and future development. For this reason, the implementation plan took each of the proposed improvements and placed them into one of two categories.

The two categories for Prioritization and detailed Tables of improvements are included below:

1) Drainage Improvements to be funded by Transportation Bonds. The City of Mesa 20 Year Roadway CIP was evaluated and drainage improvements in the same Roadway segment were assigned to be built concurrently. The cost shown in **Table 7.1: Transportation/Drainage Projects** includes, in addition to the unit cost, a 20 percent contingency and 15 percent increase for design and inspection.

2) Drainage Improvements to be funded by Storm Drain Bonds. The proposed system and network infrastructure was evaluated and prioritized using hydraulic criteria and distributed across a 20 year time period. The projects that are likely to be co-sponsored by the Flood Control District of Maricopa County are noted in the column in **Table 7.2: Drainage Only Projects** and the cost was reduced to reflect anticipated financial participation by the District. Again, the cost shown in the tables below includes, in addition to the unit cost, a 20 percent contingency and 15 percent increase for design and inspection.

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Table 7.1 Transportation/Drainage Projects

Network	Street	Location (Reach)	Type	Nom Size	Length/Vol	Budgetary Cost	FCDMC Share	Mesa Cost	Construction year
11B	Main St.	Lindsay Rd. to Val Vista Dr.	Pipe	36	3760	$1,126,872		$1,126,872	2020 to 2024
11B	Main St.	Lindsay Rd. to Val Vista Dr.	Pipe	42	1600	$535,680		$535,680	2020 to 2024
11B	Main St.	Gilbert Rd. to Lindsay	Pipe	42	750	$251,100		$251,100	2020 to 2024
11B	Main St.	Gilbert Rd. to Lindsay	Pipe	48	3000	$1,097,550		$1,097,550	2020 to 2024
11B	Main St.	Stapley Dr. to Gilbert Rd.	Pipe	42	2600	$870,480		$870,480	2020 to 2024
11B	Main St.	Stapley Dr. to Gilbert Rd.	Pipe	48	2830	$1,035,356		$1,035,356	2020 to 2024
11B	Main St.	Horne to Stapley Dr.	Pipe	48	280	$102,438		$102,438	2020 to 2024
11B	Main St.	Horne. to Stapley Dr.	Pipe	54	2450	$979,020		$979,020	2020 to 2024
11B	Horn	8th to Main St.	Pipe	36	2300	$689,310		$689,310	2020 to 2024
11B	Gilbert Rd.	Lateral Piping	Pipe	24	200	$48,600		$48,600	2020 to 2024
11B	Gilbert Rd.	Retention or other Improvements.	Retention	RET w/land [ac-ft]	3.5	$533,925		$533,925	2020 to 2024
31C	Southern Ave.	Hobson to Center St.	Pipe	42	1440	$482,112		$482,112	2010 to 2014
31C	Southern Ave.	Hobson to Center St.	Pipe	48	1160	$424,386		$424,386	2010 to 2014
31C	Broadway Rd.	Center St. to Mesa Dr.	Pipe	36	1815	$543,956		$543,956	2010 to 2014
31C	Center St.	Southern Ave. to US60	Pipe	60	2110	$965,642		$965,642	2010 to 2014
31C	Mesa Dr.	Broadway Rd. to Southern Ave.	Pipe	48	5250	$1,920,713		$1,920,713	2010 to 2014
59B	McKellips Rd.	Lindsay Rd. to Val Vista Dr.	Pipe	36	1780	$533,466		$533,466	2020 to 2024
63A	Val Vista Dr.	Eastern Canal to Main St.	Pipe	48	1250	$457,313		$457,313	2013
63A	Val Vista Dr.	Main St. to Broadway Rd.	Pipe	48	1100	$402,435		$402,435	2013
63A	Val Vista Dr.	Lateral Piping	Pipe	24	200	$48,600		$48,600	2013
71C	Greenfield Rd	Broadway Rd. to Southern Ave.	Pipe	48	2000	$731,700		$731,700	2014
71C	University Dr.	Irrigation Disconnection	Pipe	24	2600	$631,800		$631,800	2021
75B	McKellips Rd.	Higley to Greenfield Rd.	Pipe	36	2400	$719,280		$719,280	2020 to 2024
75B	McKellips Rd.	Lateral Piping	Pipe	24	4900	$1,190,700		$1,190,700	2020 to 2024
75B	McKellips Rd.	Retention SE CORNER OF 64TH ST. and LEONARD	Retention	RET wo/land [ac-ft]	16	$280,800		$280,800	2020 to 2024
95B	Main St.	Sossaman to Power	Pipe	36	2800	$839,160		$839,160	2021
113A	Hawes Rd.	Range Rider Trail to Oak Street	Channel	50	1300	$621,595	$310,797	$310,797	2023
125C	Crismon Rd.	Brown Rd. to University Dr.	Pipe	42	2600	$870,480		$870,480	2020
125C	Crismon Rd.	Brown Rd. to University Dr.	Pipe	54	1570	$627,372		$627,372	2020
125C	Crismon Rd.	Brown Rd. to University Dr.	Pipe	60	1057	$483,736		$483,736	2020
125C	University Dr.	Crismon Rd to CAP	Pipe	66	1543	$774,895		$774,895	2022
133A	Signal Butte	Brown Rd. to Cholla	Pipe	42	3860	$1,292,328		$1,292,328	2023
133A	University Dr.	Crismon to Signal Butte	Pipe	72	548	$298,879		$298,879	2022
133B	University Dr.	Meridian to Signal Butte	Pipe	54	1726	$689,710		$689,710	2022
133B	University Dr.	Meridian to Signal Butte	Pipe	84	2669	$1,747,528		$1,747,528	2022
133B	Signal Butte	University to Main St.	Pipe	84	2557	$1,674,196		$1,674,196	2023
133B	Main St..	Crismon to Signal Butte	Pipe	84	1430	$936,293		$936,293	2023
312A	Guadalupe Rd.	Mesquite Canyon to Ellsworth	Pipe	48	2613	$955,966		$955,966	2016
312A	Guadalupe Rd.	Ellsworth to Loop 202	Pipe	72	2371	$1,293,143		$1,293,143	2016
320B	Warner Rd.	EMF to 1/2 mile east of Sossaman	Channel	90	6000	$5,136,463		$5,136,463	2017
336A	Ellsworth Channel	South Pecos Rd. to Germann Rd.	Channel	60	2500	$1,431,571	$715,785	$715,785	2013
336A	Ellsworth Channel	South Pecos Rd. to Germann Rd.	Channel	90	1950	$1,669,351	$834,675	$834,675	2013
336A	Crismon Channel	Pecos Rd. to Germann Rd.	Channel	130	5300	$6,540,297		$6,540,297	2021
336A	Germann Channel	Signal Butte Rd. and Crismon Rd.	Channel	40	6150	$2,359,495		$2,359,495	2022
336A	Pecos Channel	Crismon to Ellsworth	Channel	100	5350	$5,085,545	$2,542,773	$2,542,773	2012
336A	Pecos Channel	Signal Butte to Mountain Rd.	Channel	50	2750	$1,314,912	$657,456	$657,456	2012
336A	Pecos Channel	Crismon to Signal Butte	Channel	80	5350	$4,074,553	$2,037,277	$2,037,277	2012
336A	Ellsworth GM channel	Mesquite St. and Ray Rd.	Channel	30	8000	$2,313,434		$2,313,434	2013
336A	Signal Buttes GM Channel	Mesquite St. and Bella Via Ave.	Channel	70	4950	$3,302,245		$3,302,245	2024
336A	Meridian Rd.	Germann Rd. to Pecos Rd. South	Channel	120	2300	$2,620,910	$1,310,455	$1,310,455	2018

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Table 7.1 Transportation/Drainage Projects

Network	Street	Location (Reach)	Type	Nom Size	Length/Vol	Budgetary Cost	FCDMC Share	Mesa Cost	Construction year
336A	Meridian Rd.	802 to Pecos Rd	Channel	150	3000	$4,268,966	$2,134,483	$2,134,483	2018
336A	Meridian Rd.	Williams Field Rd. to Frye Rd. (ADOT)	Channel	150	0	$0	$0	$0	2018
336A	Frye Rd.	Pecos Rd. South to Pecos Rd. North (along Basin)	Channel	70	4000	$2,668,481	$1,334,240	$1,334,240	2018
353B	Germann Rd.	Hawes to Sossaman	Channel	70	5100	$3,402,313		$3,402,313	2020
Total						**$75,897,048**	**$11,877,942**	**$64,019,106**	

Priority	Fiscal Year
1	2010 to 2014
2	2015 to 2019
3	2020 to 2024
4	2025 to 2029

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Table 7.2 Drainage Only Projects

Network	Street	Location (Reach)	Type	Nom Size	Length/Vol	Budgetary Cost	FCDMC Share	Mesa Cost	Flow Depth	Priority
4C	Dobson Rd.	University Dr. to Tempe Canal	Pipe	48	550	$201,218		$201,218	0.69	3
31D	Lewis	Baseline Blv. to Outlet	Pipe	60	450	$205,943		$205,943	1.16	1
31D	Baseline Blv.	24th St. to Lewis	Pipe	48	800	$292,680		$292,680	0.68	3
39C	Southern Ave.	Gilbert Rd. to Stapley Dr.	Pipe	36	1200	$359,640		$359,640	0.68	3
39C	Southern Ave.	Gilbert Rd. to Stapley Dr.	Pipe	42	600	$200,880		$200,880	0.68	3
39C	Southern Ave.	Gilbert Rd. to Stapley Dr.	Pipe	48	2200	$804,870		$804,870	0.68	3
39C	Stapley Dr.	Broadway Rd. to Southern Ave.	Pipe	36	1300	$389,610		$389,610	0.89	2
39C	Stapley Dr.	Broadway Rd. to Southern Ave.	Pipe	48	2000	$731,700		$731,700	0.89	2
39C	Broadway Rd.	Gilbert Rd. to Stapley Dr.	Pipe	48	900	$329,265		$329,265	0.93	2
39C	Broadway Rd.	Gilbert Rd. to Stapley Dr.	Pipe	66	3160	$1,586,952		$1,586,952	0.93	2
39C	Broadway Rd.	Stapley Dr. to Horne	Pipe	72	2670	$1,456,218		$1,456,218	0.85	2
39C	Horne	Broadway Rd. to Southern Ave.	Pipe	72	5330	$2,906,982		$2,906,982	1.06	1
39C	Horne	Southern Ave. to US-60	Pipe	54	2090	$835,164		$835,164	1.32	1
39C	Broadway Rd./ Stapley Dr.	Lateral Piping for Offline Basin	Pipe	24	400	$97,200		$97,200	-	1
39C	Broadway Rd.	Retention or other Improvements. Reed Park	Retention	RET w/land [ac-ft]	11	$1,678,050		$1,678,050	-	1
39C	Stapley Dr.	Retention or other Improvements. Lindbergh Elementary School	Retention	RET w/land [ac-ft]	6	$915,300		$915,300	-	2
47C	Gilbert Rd.	Broadway Rd. to Southern Ave.	Pipe	48	2640	$965,844		$965,844	0.85	2
47C	Broadway Rd.	East of Gilbert Rd.	Pipe	42	2410	$806,868		$806,868	0.69	3
47C	Broadway Rd.	Lateral Piping	Pipe	24	200	$48,600		$48,600	-	3
47C	Gilbert Rd.	Retention at SILVERGATE PARK	Retention	RET wo/land [ac-ft]	11	$193,050		$193,050	-	2
63A	Eastern Canal	Brown Rd. to University Dr.	Pipe	42	1000	$334,800		$334,800	0.00	4
63A	Eastern Canal	University Dr. to Val Vista Dr.	Pipe	42	1600	$535,680		$535,680	0.69	3
63A	Brown Rd.	Retention or other Improvements	Retention	RET w/land [ac-ft]	6	$915,300		$915,300	-	4
70C	Eastern Canal	Lateral Piping	Pipe	24	310	$75,330		$75,330	-	4
70C	Main St.	New Haven to Eastern Canal	Pipe	42	1861	$623,063		$623,063	0.68	3
70C	40th St.	Broadway Rd. to Eastern Canal	Pipe	36	500	$149,850		$149,850	0.98	2
71C	Broadway Rd.	Fairchild to Greenfield Rd.	Pipe	36	750	$224,775		$224,775	0.69	3
71C	Broadway Rd.	Fairchild to Greenfield Rd.	Pipe	48	1810	$662,189		$662,189	0.69	3
71C	Broadway Rd.	Fairchild to Greenfield Rd.	Pipe	54	1370	$547,452		$547,452	0.69	3
71C	Main St.	Irrigation Disconnection	Pipe	24	2300	$558,900		$558,900	-	4
71C	Greenfield Rd	Offline Retention Connection	Pipe	48	700	$256,095		$256,095	-	3
71C	Greenfield Rd	Retention or other Improvements. Greenfield Park.	Retention	RET w/land [ac-ft]	20	$3,051,000		$3,051,000	-	3
76A	Brown Rd.	Recker to Higley	Pipe	42	3650	$1,222,020		$1,222,020	0.68	3
76A	Brown Rd.	Higley to Eastern Canal	Pipe	48	1310	$479,264		$479,264	0.66	4
76A	Brown Rd.	Higley to Eastern Canal	Pipe	54	2900	$1,158,840		$1,158,840	0.66	4
77C	University Dr.	Lateral Piping	Pipe	24	1050	$255,150		$255,150	-	4
77C	University Dr.	Lateral Piping	Pipe	24	1150	$279,450		$279,450	-	4
77C	University Dr.	Lateral Piping	Pipe	24	526	$127,818		$127,818	-	3
77C	University Dr.	Retention IN SRP POWERLINE CORRIDOR	Retention	RET wo/land [ac-ft]	21	$368,550		$368,550	-	3
86A	Broadway Rd.	70th St. to Power (Triple 48 Lx3)	Pipe	48	921	$336,948		$336,948	0.80	3
86A	70th St.	Main St. to Broadway Rd. (Triple 48 L*3)	Pipe	48	390	$142,682		$142,682	0.71	3
86A	70th St.	Lateral Piping	Pipe	36	120	$35,964		$35,964	-	3
86A	Power Rd.	Retention BY SHARP SCHOOL	Retention	RET wo/land [ac-ft]	10	$175,500		$175,500	-	3
95B	Broadway Rd.	Retention by Jefferson Park	Retention	RET wo/land [ac-ft]	8	$140,400		$140,400	-	2
95B	Broadway Rd.	Lateral Piping	Pipe	42	800	$267,840		$267,840	-	2
113A	Oak St.	87th Street to Hawes	Pipe	72	2070	$1,128,978	$564,489	$564,489	1.17	1
113A	Oak St.	Retention or other Improvements.	Retention	RET wo/land [ac-ft]	50	$877,500	$438,750	$438,750	-	1
122B	Ellsworth Rd.	McDowell Rd. to McKellips Rd.	Pipe	66	4620	$2,320,164	$1,160,082	$1,160,082	1.07	1
122B	Ellsworth Rd.	McKellips Rd. to Brown Rd.	Pipe	72	5650	$3,081,510	$1,540,755	$1,540,755	1.17	1
122B	McKellips Rd.	Crismon to 96th St.	Channel	40	2500	$959,144	$479,572	$479,572	0.79	3

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Priority	Fiscal Year
1	2010 to 2014
2	2015 to 2019
3	2020 to 2024
4	2025 to 2029

Table 7.2 Drainage Only Projects

Network	Street	Location (Reach)	Type	Nom Size	Length/Vol	Budgetary Cost	FCDMC Share	Mesa Cost	Flow Depth	Priority
122B	McKellips Rd.	96th St. to 94th Pl.	Channel	60	1050	$601,260	$300,630	$300,630	0.84	2
122B	McKellips Rd.	Basin - Ellsworth and McDowell	Retention	RET w/land [ac-ft]	30.4	$4,637,520	$2,318,760	$2,318,760	-	2
122B	McKellips Rd.	Basin - at COMesa Property- McKellips and Ellsworth	Retention	RET wo/land [ac-ft]	86	$1,509,300	$754,650	$754,650	-	2
123B	94th St.	Jasmin Cir. To McLellan	Channel	30	650	$187,967		$187,967		4
320B	80th St.	Warner to Mesquite Street	Channel	120	2600	$2,962,768	$1,481,384	$1,481,384	1.46	1
320B	80th St.	Mesquite Street to Paloma Avenue	Channel	50	5350	$2,558,101	$1,279,051	$1,279,051	2.41	1
336A-2	Pecos North Detention Basin	ADOT basin	Retention	RET MAJOR	0	$0		$0	-	1
336A-2	Pecos South Detention Basin	0	Retention	RET MAJOR	284	$14,569,200	$7,284,600	$7,284,600	-	1
336A-2	Pecos West Detention Basin	Removed	Retention	RET MAJOR	0	$0		$0	-	1
353B	Hawes Rd.	Pecos to Germann	Channel	40	2350	$901,596		$901,596	1.11	1
Total						**$64,225,899**	**$17,602,723**	**$46,623,176**		

SECTION 8: REFERENCES

1. *Drainage Design Manual Hydrology Volume 1* by Flood Control District of Maricopa County November 2003 (draft)
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4. *StormCAD V8 XM Edition* Bentley Systems, Inc. Copyright©2007
5. City of Mesa, Engineering & Design Standards, by City of Mesa, 2009
6. *FlowMaster V8* Bentley Systems, Inc. Copyright©2008
7. City of Mesa, Standard Details & Specifications, by City of Mesa, 2009

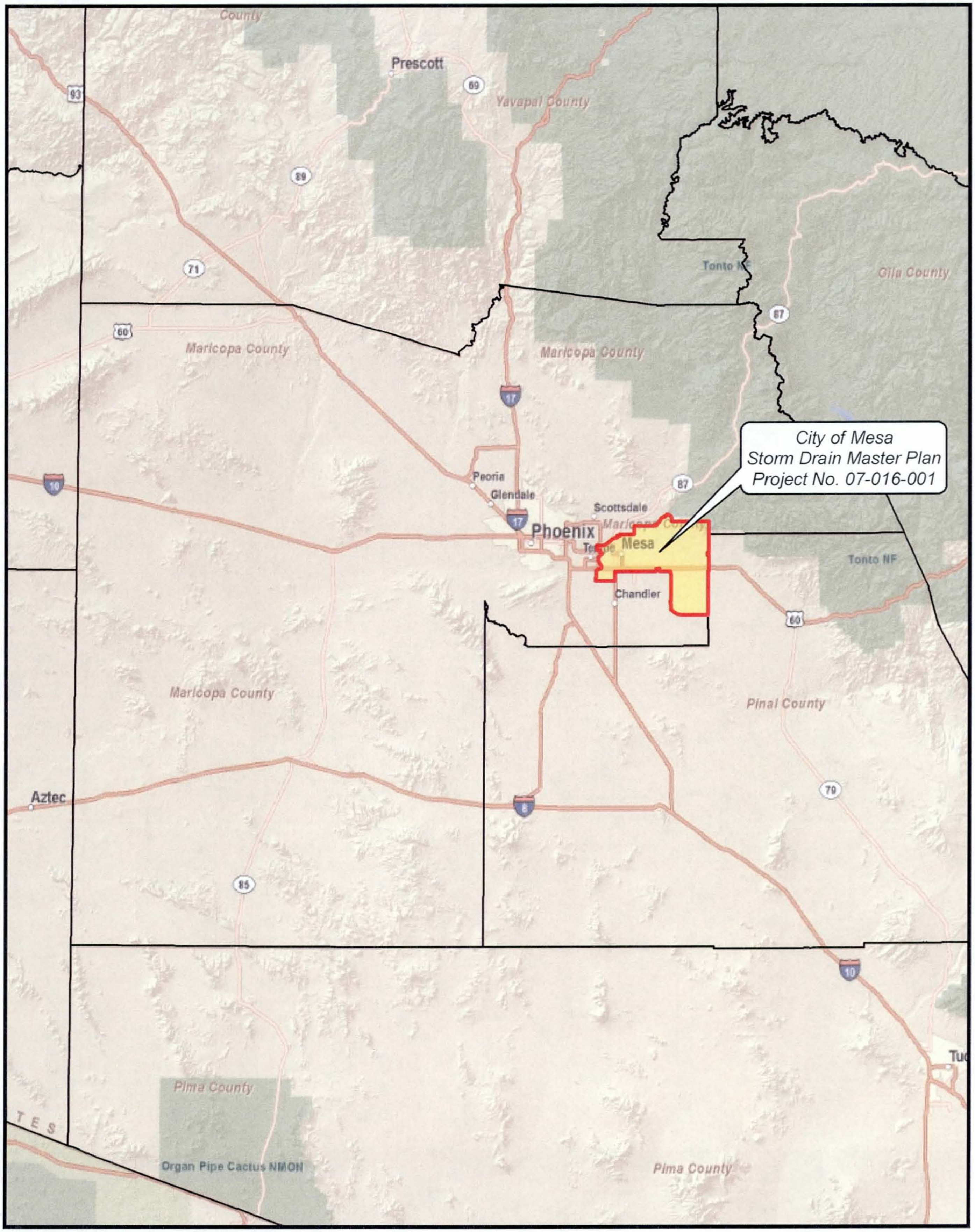
PLATES

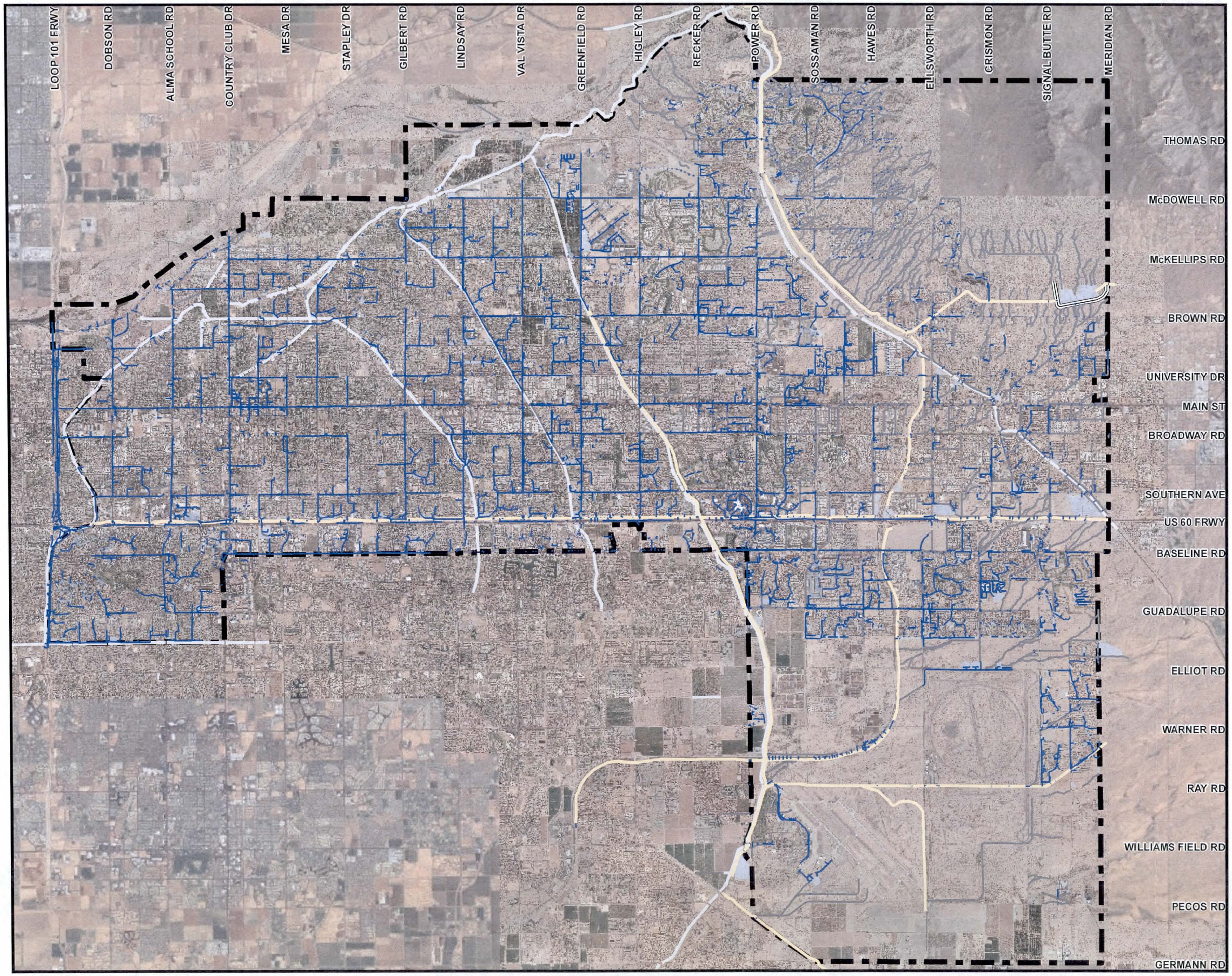
Plate 1: Network ID Map 1 or 3
Plate 2: Network ID Map 2 or 3
Plate 3: Network ID Map 3 or 3

FIGURES

Figure 1.1: Vicinity Map
Figure 2.1: Existing Infrastructure
Figure 2.2: Existing Drainage Issues
Figure 2.3: Limits of Prevision Studies
Figure 2.4: Focus Areas
Figure 2.5: Past Hydrologic Methodology Map
Figure 4.1: Assumed Retention Conditions
Figure 4.2: Hydrologic Boundaries
Figure 4.3: Land Use
Figure 4.4: Hydrology Schematics – Eastern & Consolidated Canal Model
Figure 4.5: Hydrology Schematics – Tempe Canal Model
Figure 4.6: Hydrology Schematics – Northeast East Mesa Model
Figure 4.7: Hydrology Schematics – Northwest East Mesa Model
Figure 4.8: Hydrology Schematics – Southeast Mesa Model
Figure 5.1: Storm Drain Irrigation Connections
Figure 7.1: Proposed Infrastructure
Figure 7.2: Hydraulic Prioritization of Networks

FIGURE1.1
VICINITY MAP





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STORM DRAIN MASTER PLAN
PROJECT No. 07-016-001

LEGEND

- Existing Storm Drain
- Existing Canal
- Existing Channel
- Existing Major Channel
- Existing Hydraulic Structure
- Existing Basin
- Mesa Planning Area Boundary

NORTH

0 1 2 Miles

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Fax. 602.244.8947
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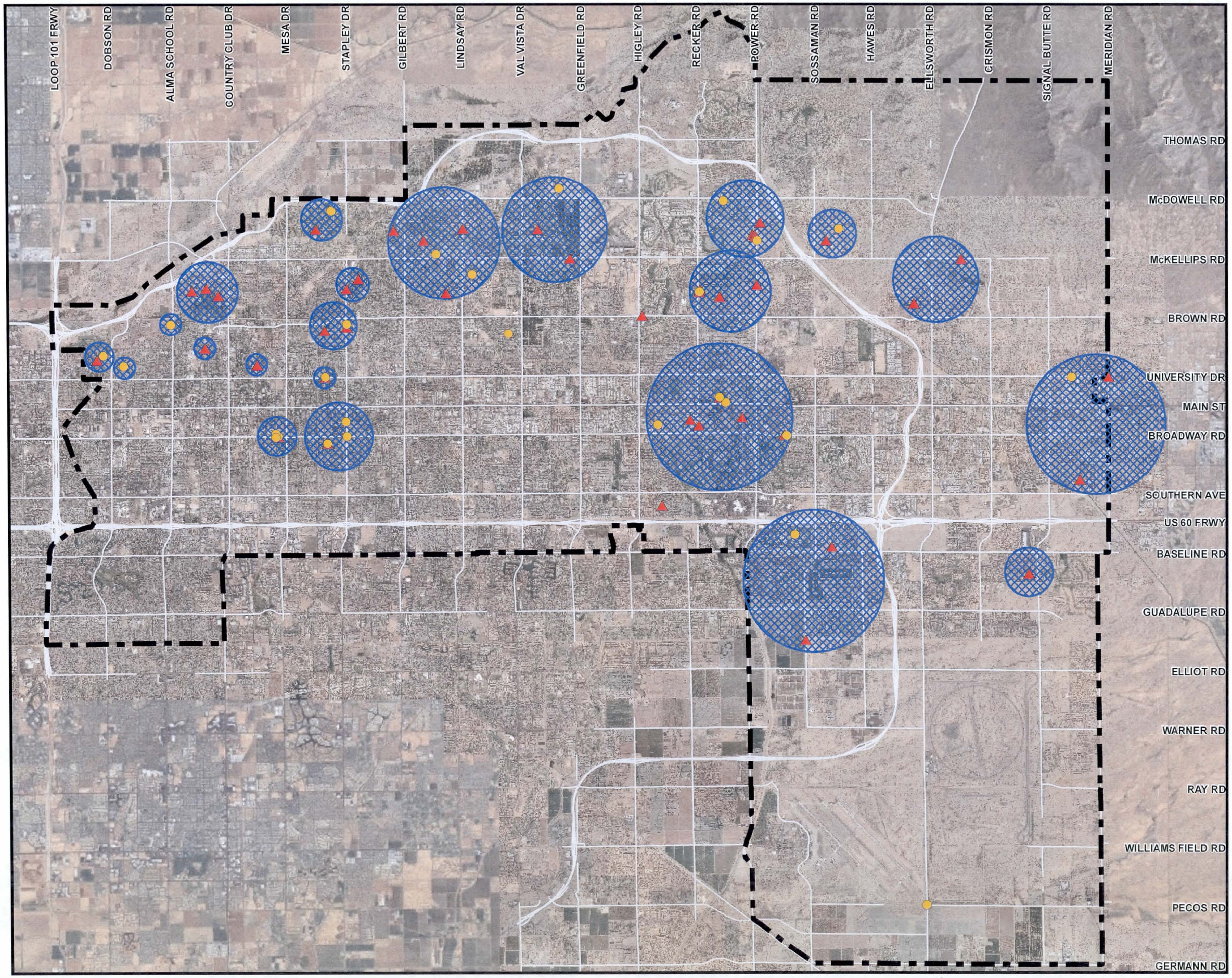
FIGURE 2.1
EXISTING INFRASTRUCTURE

mesa·az

STORM DRAIN MASTER PLAN
PROJECT No. 07-016-001



LEGEND

- Drainage Complaints With Photo
- Drainage Complaints Without Photo
- Identified Drainage Issue Areas
- Mesa Planning Area Boundary

NORTH

0 1 2 Miles

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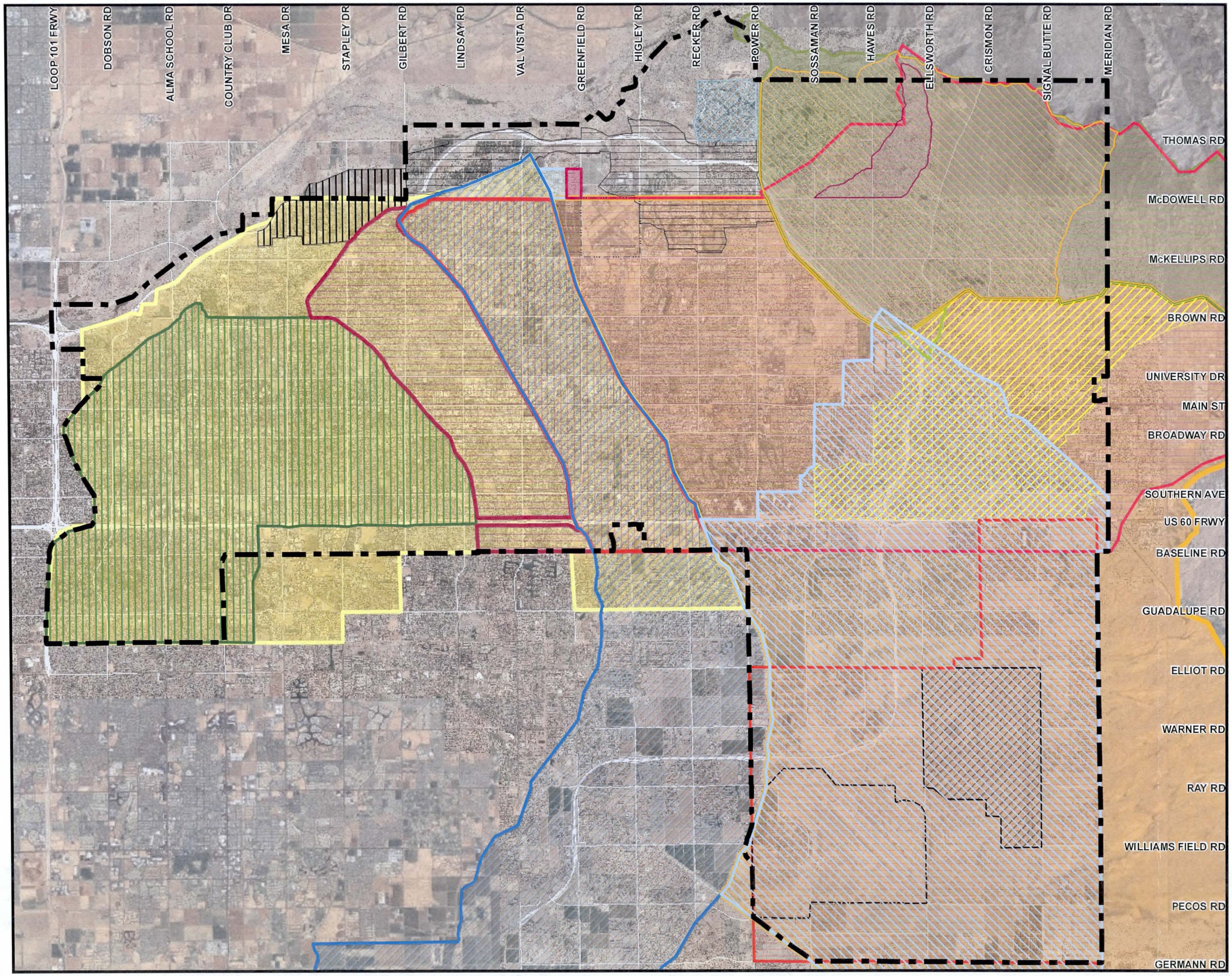
FIGURE 2.2
EXISTING DRAINAGE ISSUES



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STORM DRAIN MASTER PLAN
PROJECT No. 07-016-001

LEGEND

Study Boundaries

- City of Mesa SE Arterials Drainage Study
- Consolidated Canal - Flood Delineation Study
- Drainage Report Commons Industrial Park at Falcon View Unit 1
- East Mesa ADMP Recommended Design Report
- East Mesa ADMP Hydrologic Analysis
- East Side Stormwater Drainage Study for The City of Mesa
- Eastern Canal North - Flood Delineation Study
- Flacon Field Drainage Plan
- Higley ADMP Recommended Design Report
- Hydrology Report for Dove Industrial Park Unit Two
- Master Drainage Plan for Red Mountain Ranch
- Williams Gateway Airport, Master Plan Report
- McDowell Road Basin and Storm Drain Design Book
- Mesa Drainage Report for Mesa Proving Grounds
- Red Mountain Freeway SR202L-Country Club Dr. to Gilbert Rd.
- Red Mountain Freeway SR202L-Gilbert Rd. to Higley Rd.
- Red Mountain Freeway SR202L-Power to University
- Red Mountain Freeway SR202L-University Dr. to Southern Ave.
- Spook Hill ADMP
- Spook Hill ADMP L-III Analysis-Recommended Alternative Report
- Stormwater Drainage for The City of Mesa
- Tempe Canal Floodplain Delineation Study Technical Notebook

- Mesa Planning Area Boundary

NORTH

0 1 2 Miles

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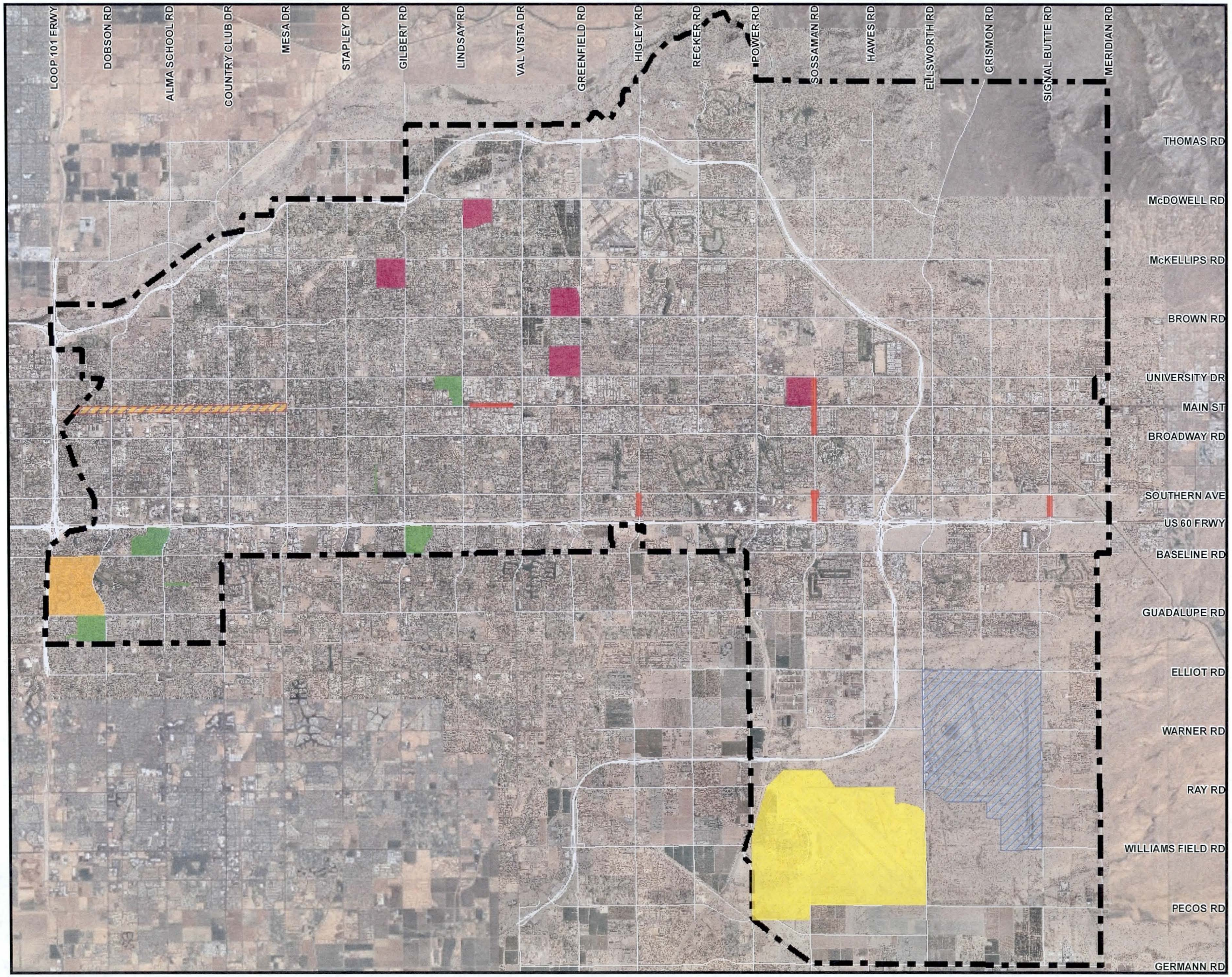
FIGURE 2.3
LIMITS OF PREVIOUS STUDIES



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STORM DRAIN MASTER PLAN
PROJECT No. 07-016-001

LEGEND

Focus Areas

- 2009/2010 Arterial Street Overlay
- 2009/2010 Residential Street Overlay, Phase III
- 2009/2010 Residential Street Overlay, Phase II
- 2009/2010 Residential Street Overlay, Phase I
- Williams Gateway Airport
- Mesa Proving Grounds
- Light Rail Alignment
- Mesa Planning Area Boundary

NORTH

0 1 2 Miles

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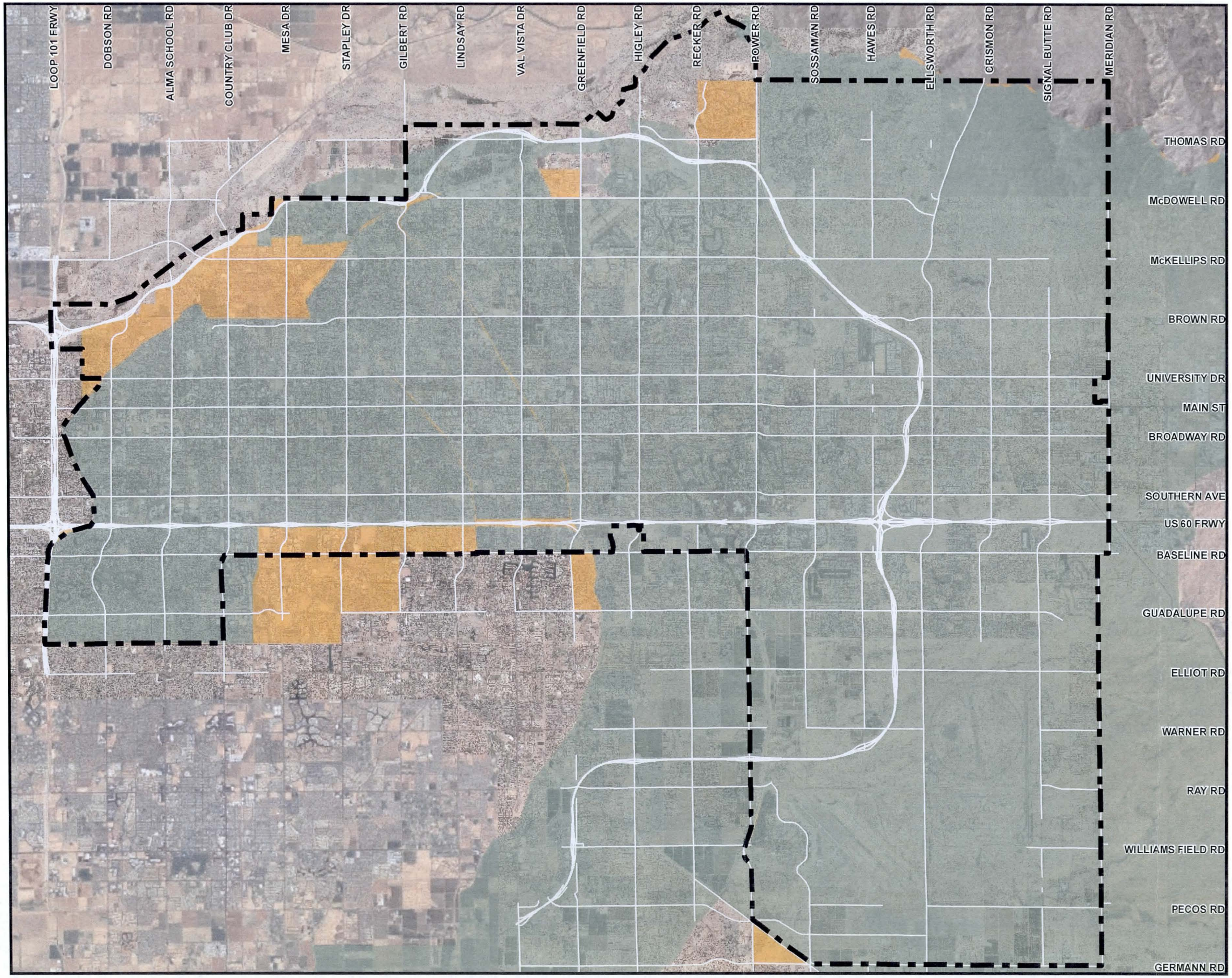
FIGURE 2.4
FOCUS AREAS



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STORM DRAIN MASTER PLAN
PROJECT No. 07-016-001

LEGEND

Past Study Hydrologic Methodology

- Hec-1 Model Using Green-Ampt
- Modified Rational

- Mesa Planning Area Boundary

NORTH

0 1 2 Miles

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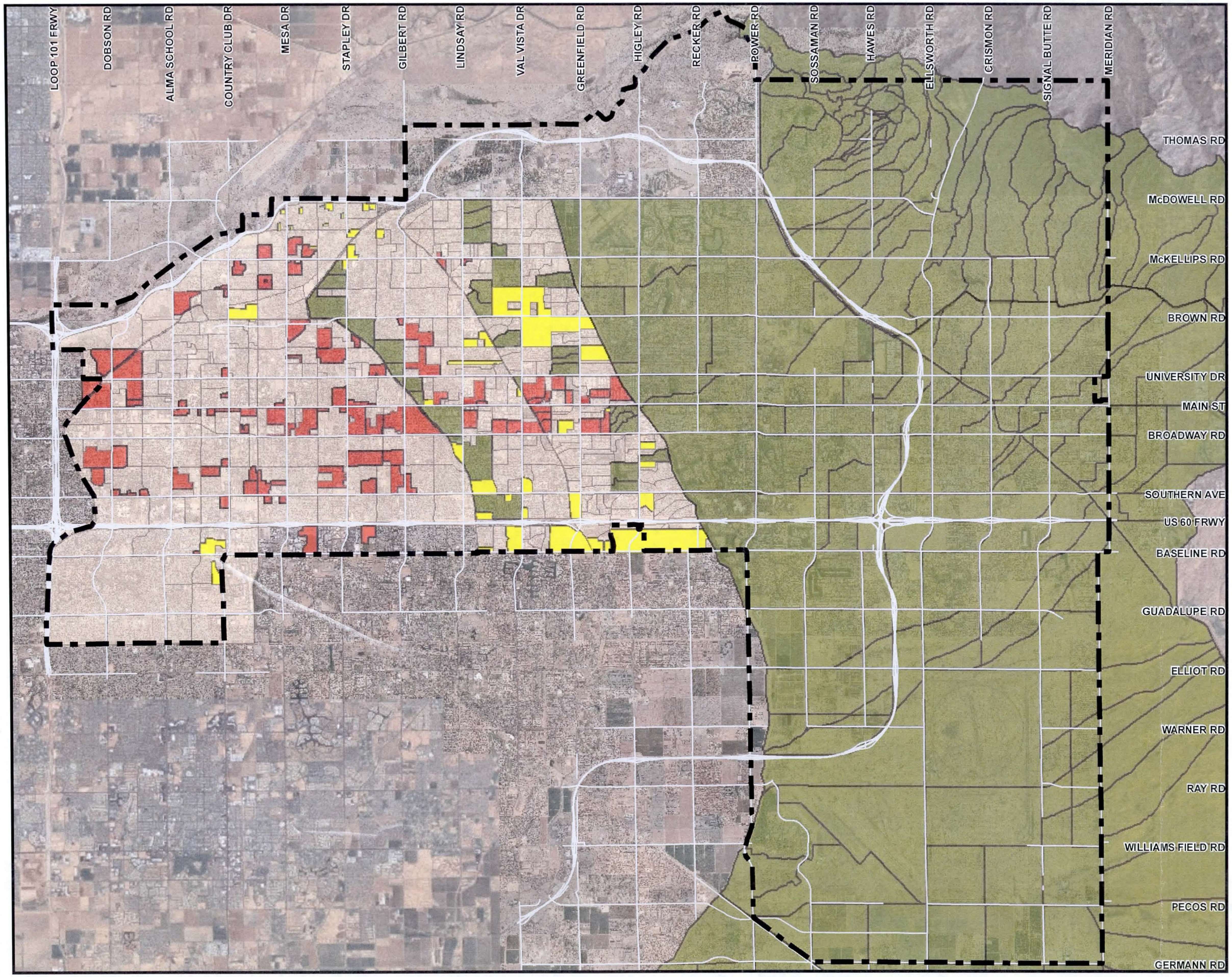
FIGURE 2.5
PAST HYDROLOGIC METHODOLOGY



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STORM DRAIN MASTER PLAN
PROJECT No. 07-016-001

LEGEND

- New 100Yr-2Hr Retention Modeled
- No Retention Found/Modeled
- No Retention Modifications to Original HEC-1 Model
- No Retention Modeled (Agricultural Land)
- Mesa Planning Area Boundary

NORTH

0 1 2 Miles

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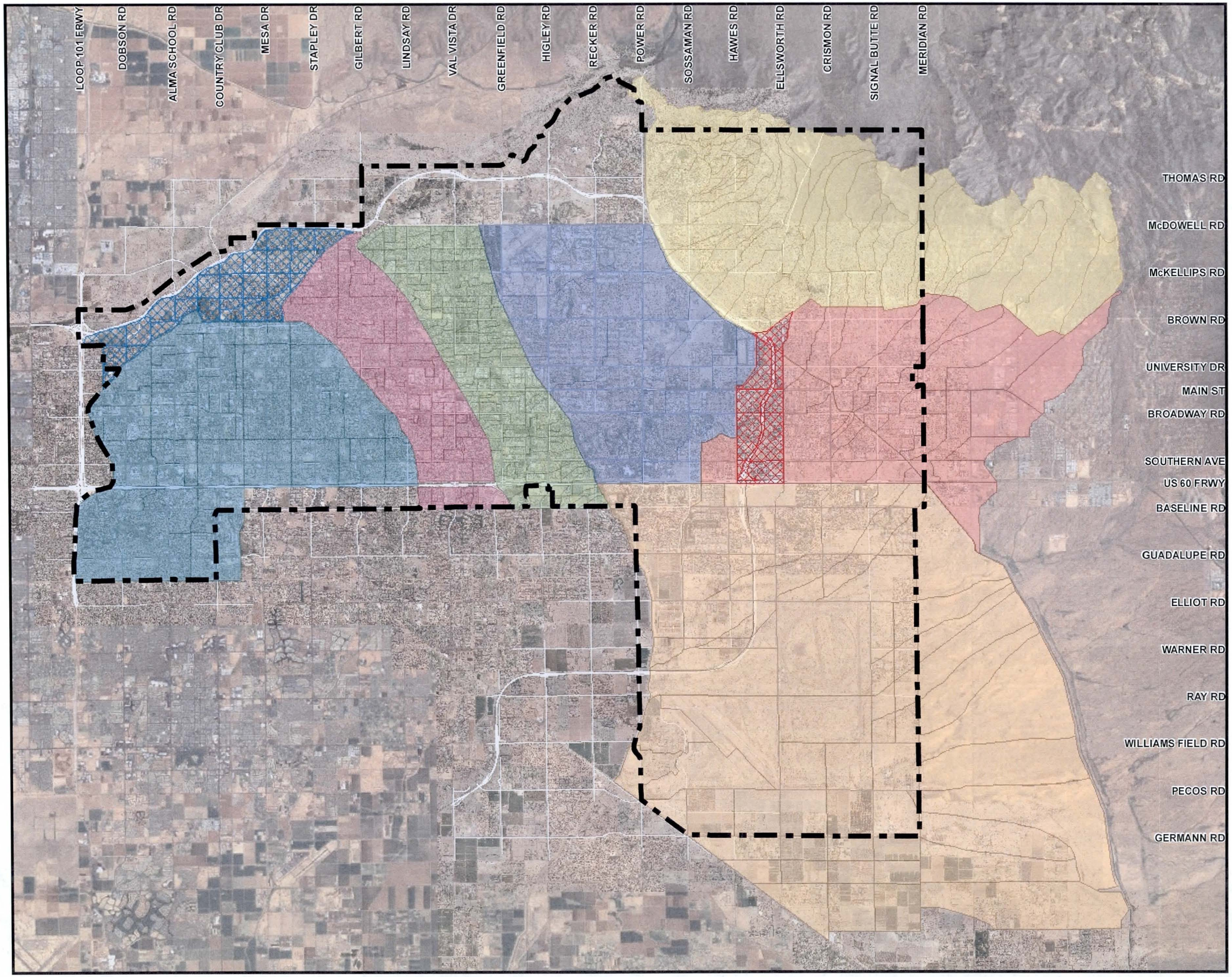
FIGURE 4.1
ASSUMED RETENTION CONDITIONS

P:\100113038_storm_drain_master_plan\Global_Data\GIS\MXD\Phase_B_Exhibits\Figure 4.1 Assumed Retention Conditions.mxd 1/4/2010 @ 1:28:07 PM



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STORM DRAIN MASTER PLAN
PROJECT No. 07-016-001

LEGEND

- East Mesa - Northeast Model - Loop 202 subbasins
- East Mesa - Northeast Model
- East Mesa - Southeast Model
- East Mesa - Northwest Model
- Eastern Canal Subbasins
- Consolidated Canal Subbasins
- Tempe Canal Subbasins
- New Entellus Generated Subbasins
- Spook Hill Subbasins
- Mesa Planning Area Boundary

NORTH

0 1 2 Miles

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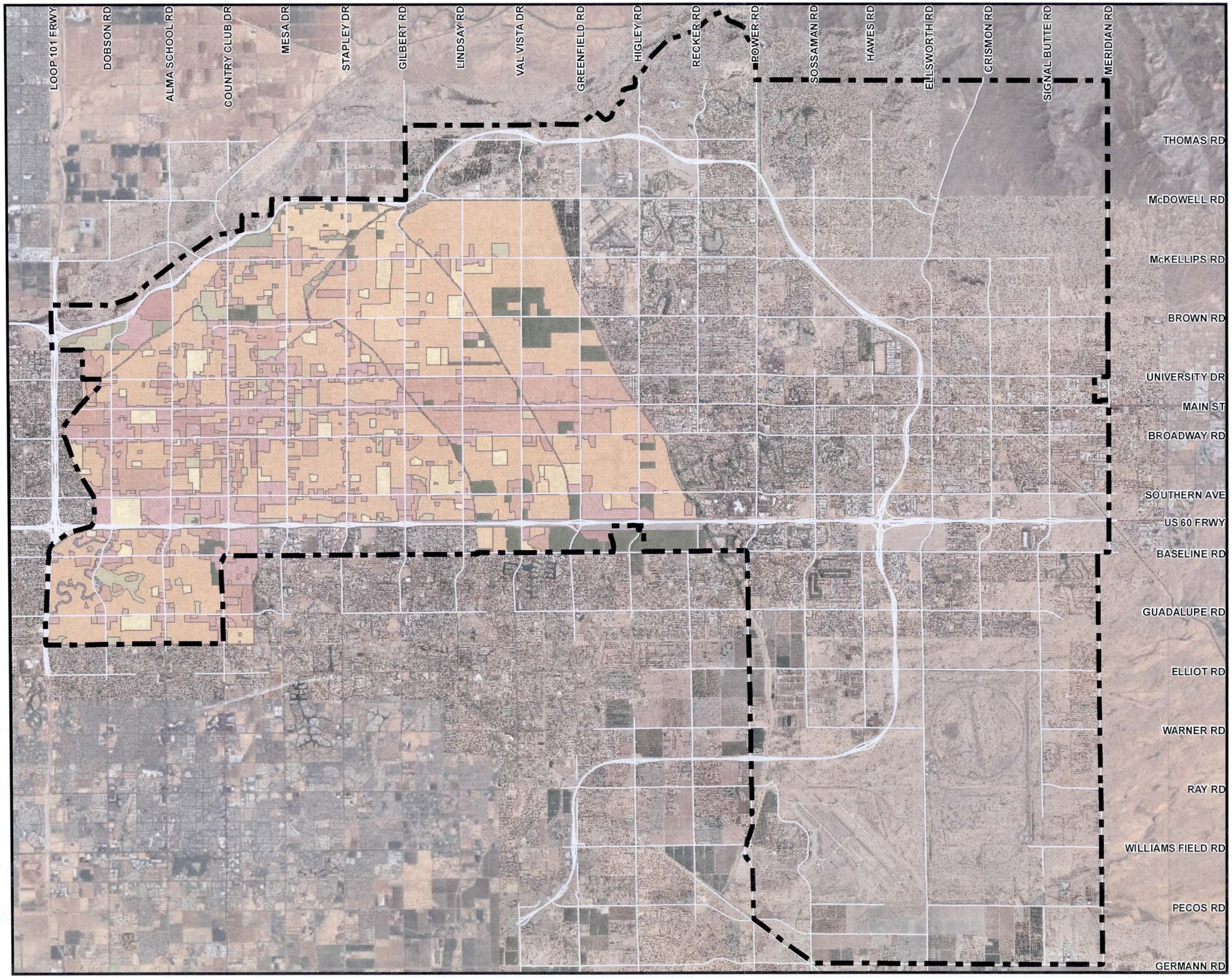
FIGURE 4.2
HYDROLOGIC BOUNDARIES



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STORM DRAIN MASTER PLAN
PROJECT No. 07-016-001

LEGEND

Future Land Use

- AGRICULTURAL
- OPEN SPACE
- PARKS
- SCHOOLS
- VERY LOW DENSITY
- LOW DENSITY RES
- MEDIUM DENSITY RES
- MULTI-FAMILY RES
- INDUSTRIAL
- COMMERCIAL
- TRANSPORTATION
- LAKES

Mesa Planning Area Boundary

NORTH

0 1 2 Miles

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FIGURE 4.3
FUTURE LAND USE

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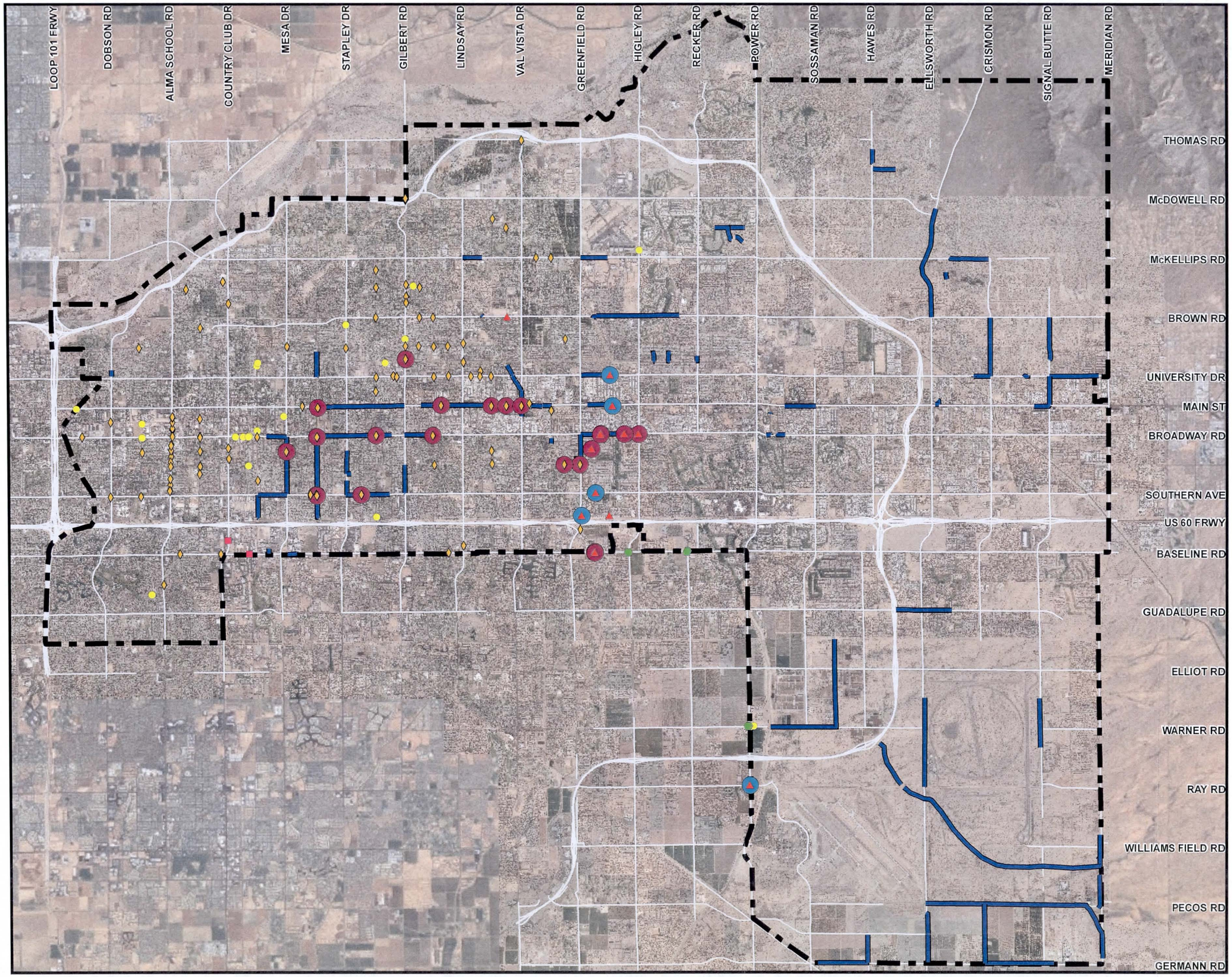
STORM DRAIN MASTER PLAN
PROJECT No. 07-016-001



LEGEND

Storm Drain / Irrigation Connection

Owner

- City of Mesa
- Private
- RWCD
- SRP
- Town of Gilbert

- Proposed Irrigation Disconnect
- Recommended Irrigation Disconnect
- SDMP Proposed Infrastructure
- Mesa Planning Area Boundary

NORTH

0 1 2 Miles

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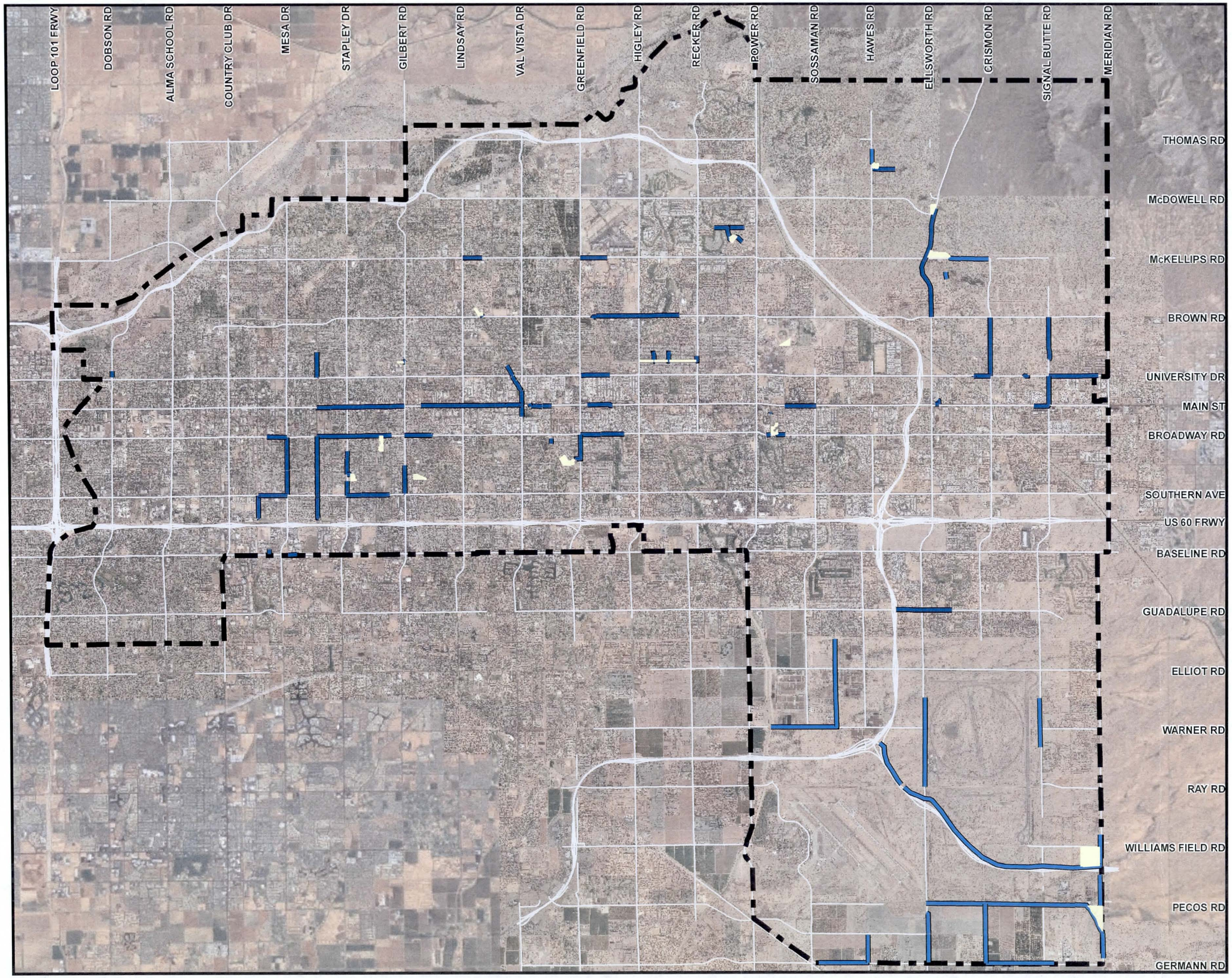
FIGURE 5.1
STORM DRAIN IRRIGATION CONNECTIONS



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STORM DRAIN MASTER PLAN
PROJECT No. 07-016-001

LEGEND

- Proposed Storm Drain
- Proposed Channel
- Proposed Retention Basin
- Mesa Planning Area Boundary

NORTH

0 1 2 Miles

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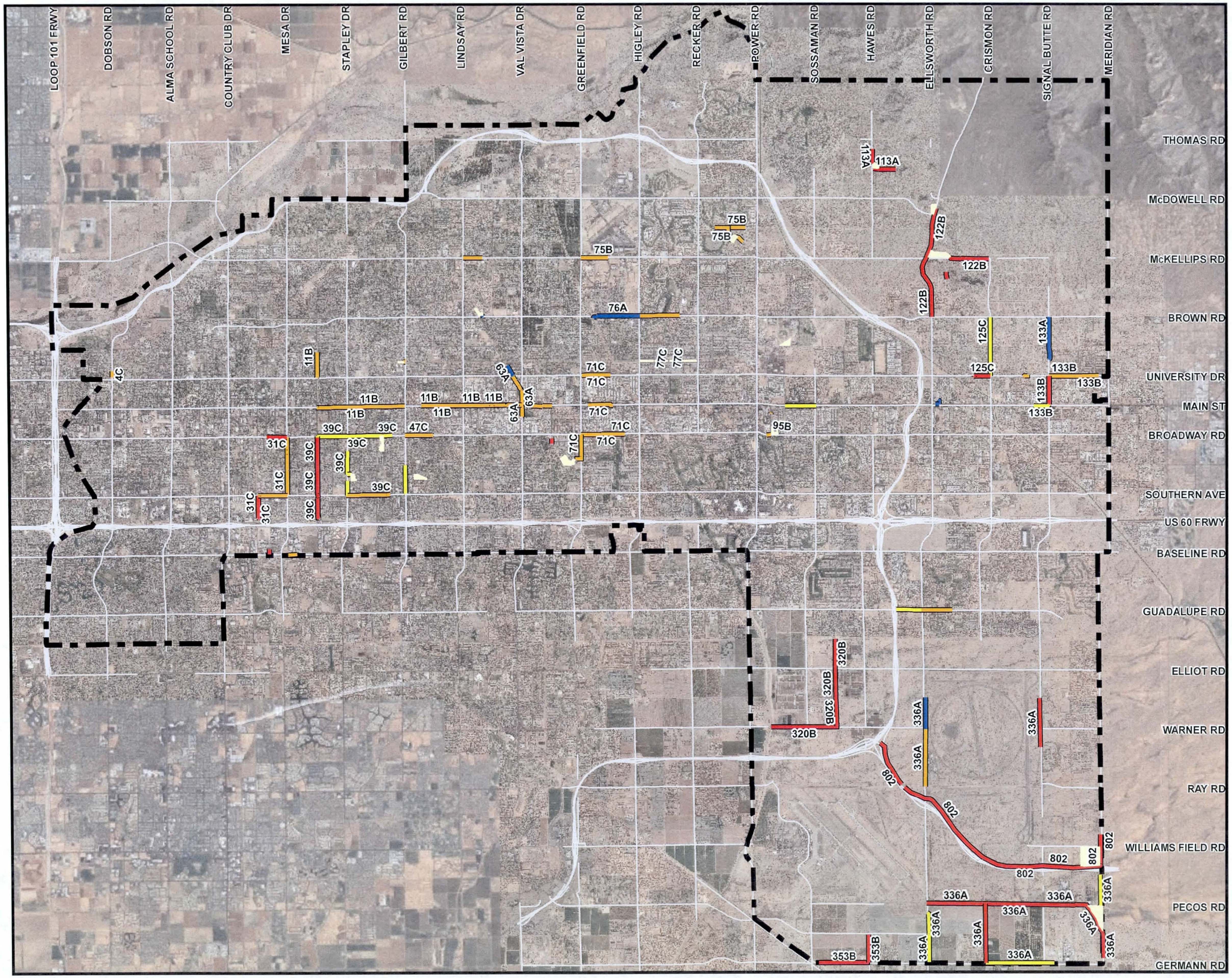
FIGURE 7.1
PROPOSED INFRASTRUCTURE

P:\100113038_storm_drain_master_plan\Global_Data\GIS\MXD\Phase_B_Exhibits\Figure 7.1_Proposed Infrastructure.mxd 1/4/2010 @ 3:49:34 PM



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STORM DRAIN MASTER PLAN
PROJECT No. 07-016-001

LEGEND

11B = Network ID

Proposed Storm Drain Priority
(Based on Flow Depth)

- 1 (12" and Deeper)
- 2 (10" to 12")
- 3 (8" to 10")
- 4 (Less than 8")

Proposed Retention Basin

Mesa Planning Area Boundary

NORTH

0 1 2 Miles

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FIGURE 7.2
HYDRAULIC PRIORITIZATION
OF NETWORKS

APPENDIX A. DATA COLLECTION

A-1: Data Collection Log

A-2: As-Built Log

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City of Mesa Storm Drain Master plan
Data Collection Log
Entellus No. 130.038

ID	Report Title	Data Description	Prepared by	Submitted To	Date Prepared	Requested from	Date received	Status/Location	Company
1	City of Mesa Storm Drainage Report		City of Mesa	City of Mesa	Apr, 1961	FCDMC	8/25/08	Electronic Copy	Entellus
2	Stormwater Drainage for The City of Mesa	FCD#71-6	Yost and Gardner Engineers	FCDMC	Nov, 1973	City of Mesa	8/18/08	Electronic Copy	Entellus
3	East Side Stormwater Drainage Study for The City of Mesa	FCD#81-04	Yost and Gardner Engineers	FCDMC	May, 1981	City of Mesa	8/18/08	Electronic Copy	Entellus
4	Eastern Maricopa County Area Drainage Master Study	FCD#84-26	A-N West, Inc.	FCDMC	Jan, 1987	City of Mesa	8/19/08	Electronic Copy	Entellus
5	The Multi-Frequency for the Eastern Maricopa County Area Drainage Master Study	Eastern Maricopa County Area Drainage Master Study Addendum FCD#84-26	A-N West, Inc.	FCDMC	Jun, 1987	City of Mesa	8/19/08	Electronic Copy	Entellus
6	Higley Area Drainage Master Plan, Recommended Design Report	Area Drainage Master Plan, Oct 2000 FCD#98-13	Dibble & Associates	FCDMC	Oct, 2000	City of Mesa	8/20/08	Electronic Copy	Entellus
7	Downtown Redevelopment Drainage Study for The City of Mesa	Drainage study of the downtown redevelopment area	Tetra Tech, Inc.	FCDMC	Jan, 2001	City of Mesa	8/20/08	Electronic Copy	Entellus
8	East Maricopa Floodway Capacity Mitigation Study Report	FCD#98-26	Huitt-Zollars	FCDMC	Feb, 2000	City of Mesa	8/20/08	Electronic Copy	Entellus
9	City of Mesa Drainage System Evaluation	Storm Drain Master Plan	Tetra Tech, Inc.	FCDMC	Sep, 1999	City of Mesa	8/20/08	Electronic Copy	Entellus
10	Delineation of Spillway Flows for Signal Butte Flood Retarding Structure	FCD#98-17	A-N West, Inc.	FCDMC	Aug, 1999	FCDMC	8/25/08	Electronic Copy	Entellus
11	Eastern Maricopa County Area Drainage Master Study		FCDMC	FCDMC	1990	City of Mesa	8/20/08	Electronic Copy	Entellus
12	Mesa Drainage Report for Mesa Proving Grounds		Wood, Patel & Associates, Inc.	FCDMC	Jul, 2008	FCDMC	8/25/08	Electronic Copy	Entellus
13	Drainage Report for Grayfox at Las Sendas		Wood, Patel & Associates, Inc.	City of Mesa	Jan, 1999	FCDMC	8/25/08	Electronic Copy	Entellus
14	East Maricopa Floodway-Chandler Heights Basin-Rittenhouse Basin Failure Mode and Consequence Analyst		Kirkham Michael and Associates, Inc.	FCDMC	Jan, 2001	FCDMC	8/25/08	Electronic Copy	Entellus
15	East Maricopa Floodway-Chandler Heights Basin Design-Predesign Study		Kirkham Michael and Associates, Inc.	FCDMC	Jan, 2001	FCDMC	8/25/08	Electronic Copy	Entellus
16	East Maricopa Floodway Capacity Assessment-Final Study Report Volume-1of 2	Final Study FCD#97-06	HNTB	FCDMC	Jan, 1999	FCDMC	8/25/08	Electronic Copy	Entellus
17	East Maricopa Floodway Capacity Assessment-Final Study Report Volume-2of 2	Final Study FCD#97-06	HNTB	FCDMC	Jan, 1999	FCDMC	8/25/08	Electronic Copy	Entellus
18	East Mesa Area Drainage Master Plan-Hydrologic Analysis Volume 1 of 2	Hydrologic Analysis	FCDMC	FCDMC	Oct, 1998	FCDMC	8/25/08	Electronic Copy	Entellus
19	East Mesa Area Drainage Master Plan-Hydrologic Analysis Volume 2 of 2	Hydrologic Analysis	FCDMC	FCDMC	Oct, 1998	FCDMC	8/25/08	Electronic Copy	Entellus
20	East Mesa Candidate Assessment Report	FCD#91-17	HDR	FCDMC	Apr, 2004	FCDMC	8/25/08	Electronic Copy	Entellus
21	East Mesa Area Drainage Master Plan Recommended Design Report	FCD#95-32	Dibble & Associates	FCDMC	Jul, 1998	FCDMC	8/25/08	Electronic Copy	Entellus
22	McDowell Road Basin and Storm Drain Design Project Book-Final Data Design Book Volume 1 of 2	FCD#2006C010	Kimley-Horn and Associates, Inc.	FCDMC	Feb, 2007	FCDMC	8/25/08	Electronic Copy	Entellus
23	McDowell Road Basin and Storm Drain Design Project Book-Final Data Design Book Volume 2 of 2	FCD#2006C011	Nynyo & Moore	FCDMC	Jan, 2006	FCDMC	8/25/08	Electronic Copy	Entellus

City of Mesa Storm Drain Master plan
Data Collection Log
Entellus No. 130.038

ID	Report Title	Data Description	Prepared by	Submitted To	Date Prepared	Requested from	Date received	Status/Location	Company
24	Pre-Design Concept Study Report for Siphon Draw Drainage Improvements-Assignment No. 4	FCD#2003C019	Wood, Patel & Associates, Inc.	FCDMC	Jul, 2005	FCDMC	8/25/08	Electronic Copy	Entellus
25	Southeast Mesa Area Drainage Master Plan Data Collection Report	FCD#2003C019	Dibble & Associates	FCDMC	May, 1997	FCDMC	8/25/08	Electronic Copy	Entellus
26	Southeast Mesa Area Drainage Master Plan	By FCDMC	FCDMC	FCDMC	Feb, 1996	FCDMC	8/28/08	Electronic Copy	Entellus
27	Spook Hill Area Drainage Master Plan	Master Drainage Plan for Spook hill-FRS Watershed, Phase FCD#84-25	Parson Brinckerhoff Quade & Douglas, Inc.	FCDMC	Feb, 1987	City of Mesa	8/19/08	Electronic Copy	Entellus
28	Spook Hill Area Drainage Master Plan Supplement	FCD#2004C054	Wood, Patel & Associates, Inc.	FCDMC	Oct, 2005	FCDMC	8/25/08	Electronic Copy	Entellus
29	Spook Hill Area Drainage Master Plan Level III Analysis-Recommended Alternative Report	FCD#99-43	Wood, Patel & Associates, Inc.	FCDMC	Sep, 2002	FCDMC	8/25/08	Electronic Copy	Entellus
30	Spook Hill Area Drainage Master Plan-LevelIII Analysis Executive Summary	FCD#99-43	Wood, Patel & Associates, Inc.	FCDMC	Sep, 2002	FCDMC	8/25/08	Electronic Copy	Entellus
31	Spook Hill Area Drainage Master Plan update Existing Condition Sedimentation Analysis	FCD#99-43	Wood, Patel & Associates, Inc.	FCDMC	Mar, 2000	FCDMC	8/25/08	Electronic Copy	Entellus
32	Buckhorn-Mesa Structures-Emergency Action Plan	FCD#2005C016	LTM Engineering, Inc.	FCDMC	Jun, 2006	FCDMC	8/25/08	Electronic Copy	Entellus
33	Buckhorn-Mesa Structures-Emergency Action Plan-Final Report	FCD#2005C016	LTM Engineering, Inc.	FCDMC	Jun, 2006	FCDMC	8/25/08	Electronic Copy	Entellus
34	Buckhorn-Mesa Structures-Emergency Action Plan (Update)	FCD#2005C016	LTM Engineering, Inc.	FCDMC	Jun, 2007	FCDMC	8/25/08	Electronic Copy	Entellus
35	Red Mountain Freeway 202L Power Road to University Drive Spook Hill FRS Flood Inundation Study Final Report	202L-Power Rd. to University Dr.	Stanley Consultants	ADOT	Aug, 2005	FCDMC	8/25/08	Electronic Copy	Entellus
36	Stormwater Management Master Plan Update		HDR		Jan, 2006		8/26/08	Library	Entellus
37	Red Mountain Freeway SR202L-Country Club Drive to Gilbert Road	202L-Country Club Dr. to Gilbert Rd.	AZTEC Engineering	ADOT	Mar, 2000	City of Mesa	8/25/08	City of Mesa	City of Mesa
38	Red Mountain Freeway SR202L-Gilbert Road to Higley Road	202L-Gilbert Rd. to Higley Rd.	Premier Engineering Corporation	Entranco	Apr, 2001	City of Mesa	8/25/08	City of Mesa	City of Mesa
39	Red Mountain Freeway SR202L-Higley Road to Power Road	202L-Higley Rd.to Power Rd.	Premier Engineering Corporation	Entranco	Apr, 2003	City of Mesa	8/25/08	City of Mesa	City of Mesa
40	Red Mountain Freeway SR202L-Power Road to University Drive	202L- Power Rd. to University Dr.	Stanley Consultants	ADOT	Apr, 2005	City of Mesa	8/25/08	City of Mesa	City of Mesa
41	Red Mountain Freeway SR202L-University Drive to Southern Avenue Volume 1 of 2	202L-University Dr. to Southern Av.	Parson Brinckerhoff	ADOT	Jun, 2005	City of Mesa	8/25/08	City of Mesa	City of Mesa
42	Santan Freeway SR202L-Elliot Road to Baseline Road Final Drainage Report-Volume 1 or 2	202L-Elliot Rd. to Baseline Rd.	Stanley Consultants Inc.	ADOT	Apr, 2003	City of Mesa	8/25/08	City of Mesa	City of Mesa
43	Santan Freeway SR202L-Elliot Road to Baseline Road Final Drainage Report-Volume 2 or 2	202L-Elliot Rd. to Baseline Rd. (Appx. A-D)	Stanley Consultants Inc.	ADOT	Apr, 2003	City of Mesa	8/25/08	City of Mesa	City of Mesa
44	Falcon Field Master Drainage Plan	Master Plan Report	Dibble & Associates	City of Mesa	Oct, 1997	City of Mesa	8/25/08	City of Mesa	City of Mesa
45	McDowell Road Basin and Storm Drain Design Project Book, Final Data Design Book Volume 1 of 2	FCD#2006C010	Kimley-Horn and Assoc.		Feb, 2007	FCDMC	8/28/08	Electronic Copy	Entellus
46	McDowell Road Basin and Storm Drain Design Project Book, Final Data Design Book Volume 2 of 2	FCD#2006C010	Kimley-Horn and Assoc.		Feb, 2007	FCDMC	8/28/08	Electronic Copy	Entellus
47	Delineation of Spillway Flows for Signal Butte Flood Retarding Structure (F.R.S.), Revised August, 1999 (FRS)	FCD#98-17	A-N West, Inc.	FCDMC	Aug, 1999	FCDMC	8/28/08	Electronic Copy	Entellus
48	East Mesa Drains Candidate Assessment Report	FCD#93-17	HDR	FCDMC	Apr, 2004	FCDMC	8/28/08	Electronic Copy	Entellus

City of Mesa Storm Drain Master plan
Data Collection Log
Entellus No. 130.038

ID	Report Title	Data Description	Prepared by	Submitted To	Date Prepared	Requested from	Date received	Status/Location	Company
49	Ponding Along Signal Butte Floodway, Assignment No. 5 North of the Signal Butte Floodway	FCD#2000C036	Wood, Patel & Associates, Inc.	FCDMC	Jun, 2002	FCDMC	8/28/08	Electronic Copy	Entellus
50	Master Drainage Plan, Williams Gateway Airport, Master Plan Report	Williams Gateway Airport	Dibble & Associates		Aug, 1996	FCDMC	8/28/08	Electronic Copy	Entellus
51	Gila Drain Western Canal Alternatives, Conceptual Design Study-Final Report		Dibble & Associates	FCDMC	May, 1985	FCDMC	8/28/08	Electronic Copy	Entellus
52	City of Mesa SE Arterials Drainage Study		Premier Engineering Corporation	City of Mesa	Nov, 2003	FCDMC	8/28/08	Electronic Copy	Entellus
53	Dambreak Study for Apache Junction FRS and Signal Butte FRS, Buckhorn-Mesa Structures	FCD#2003C062	Kimley-Horn and Assoc.	FCDMC	Oct, 2005	FCDMC	8/28/08	Electronic Copy	Entellus
54	Final Addendum to Dambreak Study for Apache Junction FRS and Signal Butte FRS, Buckhorn-Mesa Structures	FCD#2005C016-Addendum	Kimley-Horn and Assoc.	FCDMC	May, 2006	FCDMC	8/28/08	Electronic Copy	Entellus
55	Tempe Canal Floodplain Delineation Study Technical Data Notebook Volume 1 of 2	FCD#2002-22	Hoskin-Ryan Consultants, Inc.	FCDMC	Nov, 2006	FCDMC	9/10/2008	Electronic Copy	Entellus
56	Tempe Canal Floodplain Delineation Study Technical Data Notebook Volume 2 of 2	FCD#2002-22	Hoskin-Ryan Consultants, Inc.	FCDMC	Nov, 2006	FCDMC	9/10/08	Electronic Copy	Entellus
57	Upper East Maricopa Floodway Floodplain Delineation Study-Technical Data Notebook	FCD#96-26	A-N West, Inc.	FCDMC	Nov, 2006	FCDMC	9/10/08	Electronic Copy	Entellus
58	Queen Creek Wash-Power Road to Hawes Road Pre-Design Report	Revised August 2002	Dibble & Associates	FCDMC	Nov, 2006	FCDMC	9/10/08	Electronic Copy	Entellus
59	Design Report for Queen Creek Channel-Power Road to Sossaman Road-Queen Creek, Arizona	Revised December 2002	Coe & Van Loo Consultants, Inc.	FCDMC	Nov, 2006	FCDMC	9/10/08	Electronic Copy	Entellus
60	Master Drainage Plan for Red Mountain Ranch	Revised November 1984	Standage & Truitt Engineering, LTD	City of Mesa	Nov, 1984	City of Mesa	9/22/08	Electronic Copy	Entellus
61	Hydrology Report for Dove Industrial Park Unit Two		Coen Engineering Corporation	City of Mesa	Nov, 1983	City of Mesa	9/22/08	Electronic Copy	Entellus
62	Drainage Report for The Commons Industrial Park at Falcon View Unit 1		Ace Engineering, Inc.	City of Mesa	Jun, 1997	City of Mesa	9/23/08	Electronic Copy	Entellus
63	GIS Data from FCDMC	Including some hydrology parametrs, structures and other shapefiles.	FCDMC			FCDMC	9/29/08	Electronic Copy	GIS Data from FCDMC 9-29-2008
64	HEC-1 Model for East Mesa ADMP	HEC-1 Model for East Mesa ADMP	Multiple			City of Mesa	10/16/08	Electronic Copy	Original HEC-1 Models
65	Final Technical Data Note book Consolidated Canal FDS Updated 2003	FCD#99-09 Updated Mar, 2003	Tetra Tech, Inc.	FCDMC	Dec, 2001 Updated Mar, 2003	FCDMC	11/6/08	Electronic Copy	Entellus
66	Hydrologic Analysis for Incorporation into Eastern Canal Floodplain Delineation Study	Hydrology for Eastern Canal	Primatech LLC	FCDMC	May, 1997	FCDMC	11/6/08	Electronic Copy	Entellus
67	Eastern Canal Floodplain Delineation Study-Technical Data Notebook-Revised December 1997	FCD#96-10, Revised Dec, 1997	A-N West, Inc.	FCDMC	Jun, 1997 Revised Dec, 1997	FCDMC	11/6/08	Electronic Copy	Entellus
68	Eastern Canal-Floodplain Delineation Study-Technical Data Notebook Book 1of 2	Hydrology from DC#66	Primatech LLC	FCDMC	May, 1997	FCDMC	11/7/08	Electronic Copy	Entellus
69	Eastern Canal-Floodplain Delineation Study-Technical Data Notebook Book 2of 2					FCDMC	11/8/08	Electronic Copy	Entellus
70	Eastern Canal North FDS-Technical Data Notebook Submittal-Vol 1 of 3	Volume 1 of 3	Primatech LLC	FCDMC	Oct, 2001	FCDMC	11/13/08	Electronic Copy	Entellus
71	Eastern Canal North FDS-Technical Data Notebook Submittal-Vol 2 of 3	Volume 2 of 3	Primatech LLC	FCDMC	Oct, 2001	FCDMC	11/13/08	Electronic Copy	Entellus
72	Eastern Canal North FDS-Technical Data Notebook Submittal-Vol 3 of 3	Volume 3 of 3	Primatech LLC	FCDMC	Oct, 2001	FCDMC	11/13/08	Electronic Copy	Entellus

City of Mesa Storm Drain Master plan
Data Collection Log
Entellus No. 130.038

ID	Report Title	Data Description	Prepared by	Submitted To	Date Prepared	Requested from	Date received	Status/Location	Company
73	Queen Creek Sanokai Wash Hydraulic Master Plan-Administrative Report-Correspondence	FCD#98-26	Huitt-Zollars	FCDMC	Nov, 2000	FCDMC	11/13/08	Electronic Copy	Entellus
74	Queen Creek Sanokai Wash Hydraulic Master Plan-Administrative Report-Meeting Minutes	FCD#98-26	Huitt-Zollars	FCDMC	Nov, 2000	FCDMC	11/14/08	Electronic Copy	Entellus
75	Queen Creek Sanokai Wash Hydraulic Master Plan-Technical Report	FCD#98-26	Huitt-Zollars	FCDMC	Nov, 2000	FCDMC	11/15/08	Electronic Copy	Entellus
76	Queen Creek Sanokai Wash Hydraulic Master Plan-Study Report	FCD#98-26	Huitt-Zollars	FCDMC	Nov, 2000	FCDMC	11/16/08	Electronic Copy	Entellus
77	Queen Creek Sanokai Wash Hydraulic Master Plan-Study Report-Executive Summary	FCD#98-26	Huitt-Zollars	FCDMC	Nov, 2000	FCDMC	11/17/08	Electronic Copy	Entellus
78	Queen Creek Sanokai Wash Hydraulic Master Plan and East Maricopa Floodway Capacity Mitigation Study-Survey	FCD#98-26	Huitt-Zollars	FCDMC	Nov, 2000	FCDMC	11/18/08	Electronic Copy	Entellus
79	Data Collection Report Final for Queen Creek-Sanokai Wash Hydraulic Master Planand-EMF Capacity Mitigation Study	FCD#98-26	Huitt-Zollars	FCDMC	Nov, 2000	FCDMC	11/19/08	Electronic Copy	Entellus
80	CD: Queen Creek-Sanoqui Executive Summary H&H	FCD#98-26	Huitt-Zollars	FCDMC	Nov, 2000	FCDMC	11/20/08	Electronic Copy	Entellus
81	CD: Queen Creek-Sonokai Wash Hydraulic Master Plan Technical Data CD	FCD#98-26	Huitt-Zollars	FCDMC	Nov, 2000	FCDMC	11/21/08	Electronic Copy	Entellus
82	CD: Queen Creek-Sonoqui Wash Main Report	FCD#98-26	Huitt-Zollars	FCDMC	Nov, 2001	FCDMC	11/22/08	Electronic Copy	Entellus
83	HEC-1 Models for Spook Hill ADMP		Wood, Patel & Associates, Inc.		Sep, 2002	FCDMC	12/16/08	Electronic Copy	Entellus
84	Pre Design Concept Study Report for Siphon Draw Drainage Improvements-Assignment No_4	FCD#2003C019	Wood, Patel & Associates, Inc.	FCDMC	Aug, 2004	FCDMC	1/14/09	Electronic Copy	Entellus
85	Siphon Draw Drainage Improvements-Concept Letter Report-Assignment_2	FCD#2005C021	Wood, Patel & Associates, Inc.	FCDMC	May, 2006	FCDMC	1/15/09	Electronic Copy	Entellus
86	Siphon Draw Drainage Improvements Pre-Design Study Report_AssignmentNo_1.pdf	FCD#2003C019	Wood, Patel & Associates, Inc.	FCDMC	Aug, 2004	FCDMC	1/16/09	Electronic Copy	Entellus
87	Elliot Outfall Channel-Design Report	FCD#442-04-31	FCDMC	FCDMC	Jul, 2004	FCDMC	3/26/09	Electronic Copy	Entellus
88	Elliot Outfall Channel Crimson Road Channel FCD 2004C038	As-builts	FCDMC	FCDMC	Oct, 2004	FCDMC	3/26/09	Electronic Copy	Entellus
89	Elliot Road Detention Basin Phase 1	As-builts	FCDMC	FCDMC	May, 2000	FCDMC	3/26/09	Electronic Copy	Entellus
90	South Area Drainage Evaluation: Phoenix Mesa Gateway Airpport	PhxMesa Gateway Airport	Dibble & Associates		Feb, 2008	City of Mesa	3/27/09	Electronic Copy	Entellus
91	New York City-High Performance Infrastructure Guidelines		New York City Department of Design & Construction	New York City	Oct, 2005		8/28/08	Electronic Copy	Entellus
92	City of Mesa-Storm Drain Master Plan (1999)	Digital files including exhibit	Tetra Tech, Inc.	City of Mesa	Sep, 1999	City of Mesa	5/18/09	Electronic Copy	Entellus
93	Design Calculations-Analysis Notebook Rittenhouse-Chandler Heights Detention Basins	FCD#2000C040 A121.622	Kirkham Michael Consulting Engineers	FCDMC	Mar, 2004	FCDMC	5/22/09	Electronic Copy	Entellus
94	Hydrology-Hydraulic Report-Rittenhouse and Chandler Heights Detention Basins	FCD#2000C040 A121.709	Kirkham Michael Consulting Engineers	FCDMC	Oct, 2003	FCDMC	5/22/09	Electronic Copy	Entellus
95	4/5 Basins Along CAP Canal-Drainage Report	FCD#98-31 A442.301	Dibble & Associates	FCDMC	Mar, 2000	FCDMC	5/22/09	Electronic Copy	Entellus
96	4/5 Basins Along CAP Canal-Drainage HEC-1, HEC-RAS	FCD#98-31	Dibble & Associates	FCDMC	Mar, 2000	FCDMC	5/22/09	Electronic Copy	Entellus
97	East Mesa ADMP-Update (hydrology Basins)	Hydrology Basins for the East Mesa Area Drainage Master Plan Update.	FCDMC	FCDMC		FCDMC	6/15/09	Electronic Copy	Entellus
98	Gilbert Chandler ADMS Watershed Management Related Maps	Hydrology Exhibits		FCDMC		FCDMC	6/21/09	Electronic Copy	Entellus

City of Mesa Storm Drain Master plan
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ID	Report Title	Data Description	Prepared by	Submitted To	Date Prepared	Requested from	Date received	Status/Location	Company
99	Gilbert FDS HEC-1 Models	HEC-1 Models	David Evans and Associates	FCDMC	Nov, 2004	FCDMC	7/28/09	Electronic Copy	Entellus
100	Drainage technical Memorandum - Street Improvements - Signal Buttes and Elliot	Street Improvements - Signal Buttes and Elliot	Kimley - Horn	City of Mesa	Jul, 2009	City of Mesa	8/12/09	Electronic Copy	Entellus
101	Oak Street Basin Conceptual Design Summary Report Spook Hill ADMP	Oak Street Basin	Wood, Patel & Associates, Inc.	FCDMC	Feb, 2004	FCDMC	8/27/09	Electronic Copy	Entellus
102	SD 15 - Thunder Mountain Drainage Study 03-1984	Thunder Mointain Drainage study	Trico International, Inc	FCDMC	Mar, 1984	FCDMC	8/27/09	Electronic Copy	Entellus
103	Siphon Draw Wash - Drainage Improvements project - Volume 1 of 2	FCD#2007C012	Stanley & AMEC	FCDMC	Sep, 2008	FCDMC	8/27/09	Electronic Copy	Entellus
104	Siphon Draw Wash - Drainage Improvements project - Volume 2 of 2	FCD#2007C012	Stanley & AMEC	FCDMC	Sep, 2008	FCDMC	8/27/09	Electronic Copy	Entellus
105	Revised Drainage Report for Madrid Mesa - Arizona	Drainage Report for Madrid Mesa	JMI & Associates	City of Mesa	Jun, 2004	FCDMC		Electronic Copy	Entellus
106	Hermosa Vista - Hawes Road Storm Drainand Basin Project Design Data Report	Hermosa Vista - Hawes Road Storm Drainand Basin Projec	Wood, Patel & Associates, Inc.	FCDMC	Feb, 2008	FCDMC		Electronic Copy	Entellus
107	Hermosa Vista - Hawes Road Storm Drain and Basin Design Concept Report	Concept Report	Wood, Patel & Associates, Inc.	FCDMC	Oct, 2005	FCDMC		Electronic Copy	Entellus
108	Plans for the Construction of McDowell Road Basin and Storm Drain Project Maintenance Plan	McDowell Road Basin	Kimley - Horn	FCDMC	Oct, 2006	FCDMC		Electronic Copy	Entellus
109	Geotechnical Evaluation Hermosa Vista Drive Hawes Road Storm Drain and Basin Mesa Arizona	Geotechnical Evaluation	Ninyo & Moorre	City of Mesa	Jul, 2007	FCDMC		Electronic Copy	Entellus
110	Elliot Rd Detention Basin and out fall channel phase II crismon rd channel					FCDMC		Electronic Copy	Entellus
111	Elliot Road Dentention Basin and outfall Channel phase 1					FCDMC		Electronic Copy	Entellus
112	Hermosa Vista Hawes Rd Storm Drain and Basin 2007C030							Electronic Copy	Entellus
113	McDowelll Rd Storm Drain And Basin 2006C010							Electronic Copy	Entellus

City of Mesa Storm Drain Master plan
Data Collection Log
Entellus No. 130.038

ID	Report Title	Data Description	Prepared by	Submitted To	Date Prepared	Requested from	Date received	Status/Location	Company
A-1	001 Broadway Road between Loop 101 and Dobson Road	A112090, A2760, A3040, A34055, A54779, A56249, X13144, X8963	Multiple	Multiple	Multiple	City of Mesa	5/11/09	Electronic Copy	Entellus
A-2	002 Westwood Road between Southern Ave. and Holmes Ave	A36891, A38462, A53775, A60753, A8054	Multiple	Multiple	Multiple	City of Mesa	5/11/09	Electronic Copy	Entellus
A-3	003 Intersection of Baseline Road and Alma School Road	A24718, A52117, A6779, A8325	Multiple	Multiple	Multiple	City of Mesa	5/11/09	Electronic Copy	Entellus
A-4	004 Mesa Dr from Wedgewood Dr to 8th St	A60217, A62606	Multiple	Multiple	Multiple	City of Mesa	5/11/09	Electronic Copy	Entellus
A-5	005 Ellsworth Rd from Sleepy Hollow Rd to Balsama Ave	A50634, A82640, A92157, X1191	Multiple	Multiple	Multiple	City of Mesa	5/11/09	Electronic Copy	Entellus
A-6	006 Intersection of University Dr & Higley Rd	A38172, A42411	Multiple	Multiple	Multiple	City of Mesa	5/11/09	Electronic Copy	Entellus
A-7	007 Eastern Canal from Broadway Rd to Pueblo Ave	A11752, A14770, A40396	Multiple	Multiple	Multiple	City of Mesa	5/11/09	Electronic Copy	Entellus
A-8	008 Ellsworth Rd. from Ray Rd. to Germann Rd	A111324	Multiple	Multiple	Multiple	City of Mesa	5/11/09	Electronic Copy	Entellus
A-9	009 Windsor Rd from Allred Ave & Broadway Rd	A13233, A29203, A32965, A33871, A45450	Multiple	Multiple	Multiple	City of Mesa	5/11/09	Electronic Copy	Entellus
A-10	010 Broadway Rd from 59th St to 70th St	A17721, A28014, A33455, A37142, A37583, A40874, A50984, A60489, A86440	Multiple	Multiple	Multiple	City of Mesa	5/11/09	Electronic Copy	Entellus
A-11	011 Ellsworth Rd from Pueblo Ave to Southern Ave	A118061, A118567, A47593, A50634, A85362, A89284	Multiple	Multiple	Multiple	City of Mesa	5/11/09	Electronic Copy	Entellus
A-12	012 Retention Area at N.E. Corner of Guadalupe Rd & Cherry	A51842, A58257	Multiple	Multiple	Multiple	City of Mesa	5/11/09	Electronic Copy	Entellus
A-13	013 Retention Area at N.E. Corner of Guadalupe Rd & Alma School	A13351, A19819	Multiple	Multiple	Multiple	City of Mesa	5/11/09	Electronic Copy	Entellus

APPENDIX B. GENERAL DOCUMENTATION AND CORRESPONDENCE

B.1: Drainage Regulation Memorandum
B.2: Green Features Memorandum
B.3: Drywell Memorandum
B.4: General Correspondence

APPENDIX C. HYDROLOGY

C.1 Retention Summary
C.2 Subbasin Data
C.3 HEC-1: Existing Conditions – Tempe Canal 10 year
HEC-1: Existing Conditions – Tempe Canal 100 year
HEC-1: Proposed Conditions – Tempe Canal 10 year
HEC-1: Proposed Conditions – Tempe Canal 100 year
C.4 HEC-1: Existing Conditions – Eastern Canal 10 year
HEC-1: Existing Conditions – Eastern Canal 100 year
HEC-1: Proposed Conditions – Eastern Canal 10 year
HEC-1: Proposed Conditions – Eastern Canal 100 year
C.5 HEC-1: Existing Conditions – Consolidated Canal 10 year
HEC-1: Existing Conditions – Consolidated Canal 100 year
HEC-1: Proposed Conditions – Consolidated Canal 10 year
HEC-1: Proposed Conditions – Consolidated Canal 100 year
C.6 HEC-1: Existing Conditions – Northeast East Mesa 10 year
HEC-1: Existing Conditions – Northeast East Mesa 100 year
HEC-1: Proposed Conditions – Northeast East Mesa 10 year
HEC-1: Proposed Conditions – Northeast East Mesa 100 year
C.7 HEC-1: Existing Conditions – Northwest East Mesa 10 year
HEC-1: Existing Conditions – Northwest East Mesa 100 year
HEC-1: Proposed Conditions – Northwest East Mesa 10 year
HEC-1: Proposed Conditions – Northwest East Mesa 100 year
C.8 HEC-1: Existing Conditions – South East Mesa 10 year
HEC-1: Existing Conditions – South East Mesa 100 year
HEC-1: Proposed Conditions – South East Mesa 10 year
HEC-1: Proposed Conditions – South East Mesa 100 year

APPENDIX D. HYDRAULICS

D.1 Equivalent Pipe Size
D.2 Irrigation Connections
D.3 Elevation Checks
D.4 City of Mesa Standard Details - Roadway Geometry
D.5 Existing Number of Lanes
D.6 Roadway Capacity Rating Curves

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APPENDIX E. HYDRAULICS FOR ALTERNATIVES

E.1 Network 4C - Dobson Road
E.2 Network 5B - Broadway Road
E.3 Network 7C - Southern Avenue and Dobson Road
E.4 Network 8C - Baseline Road and Alma School Road
E.5 Network 11B - Main Street
E.6 Network 11C - McClellan Road
E.7 Network 15C - Alma School Road
E.8 Network 18D - Country Club Drive
E.9 Network 23A - Country Club Drive
E.10 Network 23A-2 - Westwood Road
E.11 Network 31C - Mesa Drive
E.12 Network 31D – Baseline Road
E.13 Network 39C - Stapley Drive
E.14 Network 47C - Gilbert Road
E.15 Network 54B - 24th Street
E.16 Network 55A - Lindsay Road
E.17 Network 58B - Lindsay Road
E.18 Network 59B - Lindsay Road/Eastern Canal
E.19 Network 62A & 62A-2 - Consolidated Canal
E.20 Network 63A - Val Vista Drive
E.21 Network 70C - Eastern Canal South
E.22 Network 71C - Greenfield Road
E.23 Network 73D - Higley Road
E.24 Network 75B - McKellips Road
E.25 Network 76A - Ellsworth Road
E.26 Network 77C - University Drive
E.27 Network 81B - McDowell Road
E.28 Network 85B - Higley Road
E.29 Network 85B-2 - Main Street
E.30 Network 86A - Power Road
E.31 Network 87C - Southern Ave
E.32 Network 91D - Power Road
E.33 Network 95B - Power Road
E.34 Network 96C - Baseline Road
E.35 Network 97D - McDowell Road
E.36 Network 98D - Hermosa Vista Drive
E.37 Network 111B - Baseline Road
E.38 Network 113A - Oak Street Channel and Storm Drain
E.39 Network 117D-2 - 97th Way
E.40 Network 117D - Ellsworth Road
E.41 Network 122B - Spook Hill Proposed Channel and Storm Drain
E.42 Network 123B - 94th Street Proposed Channel
E.43 Network 125C - Crismon Road
E.44 Network 127A - Crismon Road
E.45 Network 127-2 - Ellsworth Road
E.46 Network 133A - Signal Butte Road
E.47 Network 133B - University Drive
E.48 Network 143A - Signal Butte Road

APPENDIX F. COST ANALYSIS

F.1 Unit Cost Summary
F.2 Cost Estimate

APPENDIX G. PROPOSED DRAINAGE INFRASTRUCTURE

Network 4C - Dobson Road
Network 11B - Main Street
Network 31C - Mesa Drive
Network 31D – Baseline Road
Network 39C - Stapley Drive
Network 47C - Gilbert Road
Network 59B - Lindsay Road/Eastern Canal
Network 63A - Val Vista Drive
Network 70C - Eastern Canal South
Network 71C - Greenfield Road
Network 75B - McKellips Road
Network 76A - Ellsworth Road
Network 77C - University Drive
Network 86A - Power Road
Network 95B - Power Road
Network 113A - Oak Street Channel and Storm Drain
Network 117D - Ellsworth Road
Network 122B - Spook Hill Proposed Channel and Storm Drain
Network 123B - 94th Street Proposed Channel
Network 125C - Crismon Road
Network 133A - Signal Butte Road
Network 133B - University Drive
Network 312A - Guadalupe Road
Network 320B - 80th Street Proposed Channel
Network 336A - Loop 802 Proposed Channel
Network 336A-2 – Pacos Road Detention Basins:
Network 353B - Hawes Road Channel

APPENDIX H. ADEQUATE STORM DRAIN SYSTEM HYDRAULICS

Network 5B - Broadway Road
Network 7C - Southern Avenue and Dobson Road
Network 8C - Baseline Road and Alma School Road
Network 11C - McClellan Road
Network 15C - Alma School Road
Network 18D - Country Club Drive
Network 23A - Country Club Drive
Network 23A-2 - Westwood Road
Network 54B - 24th Street
Network 55A - Lindsay Road
Network 58B - Lindsay Road
Network 62A & 62A-2 - Consolidated Canal
Network 73D - Higley Road
Network 81B - McDowell Road
Network 85B - Higley Road
Network 85B-2 - Main Street
Network 87C - Southern Ave
Network 91D - Power Road
Network 96C - Baseline Road
Network 97D - McDowell Road
Network 98D - Hermosa Vista Drive
Network 111B - Baseline Road
Network 117D-2 - 97th Way
Network 127A - Crismon Road
Network 127-2 - Ellsworth Road
Network 143A - Signal Butte Road