

Level 1: Potential Alternatives Report
Hohokam Area Drainage Master Plan (Phase II)
Contract FCD 2009C029
July 2012



Prepared for:



**Flood Control District
of Maricopa County**

2801 West Durango Street
Phoenix, AZ 85009

and



City of Phoenix

200 W. Washington St.
Phoenix, AZ 85003

Prepared by:

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Contributions by:



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TABLE OF CONTENTS

Page

1. INTRODUCTION	1-1
1.1 PROJECT DESCRIPTION	1-1
1.2 PROJECT AUTHORIZATION	1-1
1.3 PROJECT LOCATION	1-1
1.4 PURPOSE OF REPORT	1-3
1.5 PREVIOUS HOHOKAM ADMS/ADMP REPORTS	1-3
2. PROBLEM AREAS	2-1
2.1 GENERAL	2-1
2.2 AREA 1: 7 TH ST – 16 TH ST (CIRCLE K PARK)	2-1
2.3 AREA 2: 16 TH ST – 20 TH ST (SIESTA FOOTHILLS/BOY SCOUT CAMP).....	2-3
2.4 AREA 3: 20 TH ST – 24 TH ST (PINES AT SOUTH MOUNTAIN)	2-4
2.5 AREA 4: 24 TH ST – 36 TH ST (CORTLAND POINT)	2-6
2.6 AREA 5: 36 TH ST – 48 TH ST (INDUSTRIAL AREA)	2-8
2.7 AREA 6: 16 TH ST – 20 TH ST (NORTH OF WESTERN CANAL)	2-9
2.8 AREA 7: BROADWAY RD. & 7 TH AVE-9 TH ST (LOW LAYING AREAS).....	2-10
2.9 AREA 8: PONDING ALONG WESTERN CANAL.....	2-10
3. ALTERNATIVE DEVELOPMENT PROCESS	3-1
3.1 INTRODUCTION	3-1
3.2 LEVEL 1: ALTERNATIVES FORMULATION AND PRELIMINARY ANALYSIS	3-1
3.3 LEVEL 2: ALTERNATIVES ANALYSIS	3-2
3.4 LEVEL 3: RECOMMENDED ALTERNATIVES ANALYSIS	3-2
4. POTENTIAL ALTERNATIVES & EVALUATION.....	4-1
4.1 GENERAL	4-1
4.1.1 Evaluation of Alternatives	4-2
4.2 AREA 1: 7 TH ST – 16 TH ST (CIRCLE K PARK)	4-2
4.2.1 Alternative 1.0 – No Action	4-2

4.2.2	Alternative 1.1 – Multiple Basins and Channels.....	4-3
4.2.3	Alternative 1.2 – TCCGC Retention Basin.....	4-3
4.2.4	Alternative 1.3 – TCCGC Development Stipulations.....	4-3
4.2.5	Alternative 1.4 – Local Storm Drain (16 th St) & Basins	4-4
4.2.6	Alternative 1.5 – Dobson Creek Basin Modifications	4-4
4.2.7	Alternative 1.6 – Floodwalls.....	4-4
4.2.8	Alternative 1.7 – Use Roads for Conveyance	4-5
4.2.9	Alternative 1.8 – Dam (with Outlet).....	4-5
4.2.10	Alternative 1.9 – Large Diameter Storm Drain (16 th St)	4-5
4.3	AREA 2: 16 TH ST – 20 TH ST (SIESTA FOOTHILLS/BOY SCOUT CAMP).....	4-6
4.3.1	Alternative 2.0 – No Action	4-6
4.3.2	Alternative 2.1 – Storm Drain (16 th & 20 th St.) & Basins.....	4-6
4.3.3	Alternative 2.2 – Use Roads for Conveyance	4-6
4.3.4	Alternative 2.3 – Dams (with Outlets)	4-6
4.3.5	Alternative 2.4 – Large Diameter Storm Drain (16 th St)	4-7
4.4	AREA 3: 20 TH ST – 24 TH ST (PINES AT SOUTH MOUNTAIN)	4-7
4.4.1	Alternative 3.0 – No Action	4-7
4.4.2	Alternative 3.1 – Local Storm Drain (20 th St.) & Basins	4-7
4.4.3	Alternative 3.2 – Channelize Flow to Basins (20 th PI)	4-8
4.4.4	Alternative 3.3 – Channelize Flow & Use Roads (20 th PI).....	4-8
4.4.5	Alternative 3.4 – Highline Canal Storm Drain	4-8
4.4.6	Alternative 3.5 – Multiple Basins & Channels	4-8
4.4.7	Alternative 3.6 – Use Roads for Conveyance to Basins	4-9
4.4.8	Alternative 3.7 – Dams (with Outlets)	4-9
4.4.9	Alternative 3.8 – Large Diameter Storm Drain (24 th St)	4-9
4.5	AREA 4: 24 TH ST – 36 TH ST (CORTLAND POINT)	4-10
4.5.1	Alternative 4.0 – No Action	4-10
4.5.2	Alternative 4.1 – Multiple Basins & Storm Drain (S Mtn Ave).....	4-10
4.5.3	Alternative 4.2 – Local Storm Drain & Basin (32 nd St))	4-10
4.5.4	Alternative 4.3 – Highline Storm Drain & Basin (32 nd /36 th St)	4-10
4.5.5	Alternative 4.4 – Floodwalls.....	4-11

4.5.6	Alternative 4.5 – Cortland Point Basins/Channels	4-11
4.5.7	Alternative 4.6 – Dams (with Outlets)	4-11
4.6	AREA 5: 36 TH ST – 48 TH ST (INDUSTRIAL AREA)	4-12
4.6.1	Alternative 5.0 – No Action	4-12
4.6.2	Alternative 5.1 – Highline Basin	4-12
4.6.3	Alternative 5.2 – Baseline Rd Basins	4-12
4.6.4	Alternative 5.3 – Divert Flow to 42 ND PI/Baseline Rd Basin	4-13
4.6.5	Alternative 5.4 – 44 TH St Basins	4-13
4.6.6	Alternative 5.5 – Beverly Rd Basin	4-13
4.6.7	Alternative 5.6 – Dams (with Outlets)	4-13
4.6.8	Alternative 5.7 – Large Diameter Storm Drain (40 TH St)	4-14
4.7	AREA 6: 16 TH ST – 20 TH ST (NORTH OF WESTERN CANAL)	4-14
4.7.1	Alternative 6.0 – No Action	4-14
4.7.2	Alternative 6.1 – Storm Drain (Vineyard Rd) & Basins	4-14
4.7.3	Alternative 6.2 – Floodwall & Diversion to Basins (20 TH St)	4-14
4.7.4	Alternative 6.3 – Storm Drain (18 TH & 20 TH St) & Basins	4-15
4.8	AREA 7: BROADWAY RD. & 7 TH AVE-9 TH ST (LOW LAYING AREAS)	4-15
4.8.1	Alternative 7.0 – No Action	4-15
4.8.2	Alternative 7.1 – Expand Existing Storm Drain System	4-15
4.8.3	Alternative 7.2 – Local Storm Drain System & Basins	4-16
4.9	AREA 8: PONDING ALONG WESTERN CANAL	4-16
4.9.1	Alternative 8.0 – No Action	4-16
4.9.2	Alternative 8.1 – Basins Along Western Canal	4-17
4.9.3	Alternative 8.2 – Storm Drain Relief Basins	4-17

5. EVALUATION SUMMARY/LEVEL 2 ALTERNATIVES..... 5-1

5.1	GENERAL	5-1
5.2	AREA 1: 7 TH ST – 16 TH ST (CIRCLE K PARK)	5-1
5.3	AREA 2: 16 TH ST – 20 TH ST (SIESTA FOOTHILLS/BOY SCOUT CAMP)	5-2
5.4	AREA 3: 20 TH ST – 24 TH ST (PINES AT SOUTH MOUNTAIN)	5-2
5.5	AREA 4: 24 TH ST – 36 TH ST (CORTLAND POINT)	5-3

5.6 AREA 5: 36TH ST – 48TH ST (INDUSTRIAL AREA)5-4

5.7 AREA 6: 16TH ST – 20TH ST (NORTH OF WESTERN CANAL)5-4

5.8 AREA 7: BROADWAY RD. & 7TH AVE-9TH ST (LOW LAYING AREAS).....5-5

5.9 AREA 8: PONDING ALONG WESTERN CANAL.....5-5

6. REFERENCES 6-1

FIGURES

Page

Figure 1-1: Project Location and Vicinity Map	1-2
Figure 2-1: Identified problem areas.....	2-1
Figure 2-2: Flooding along 16th St.	2-2
Figure 2-3: Bubble up and 48" outlet discharging to Euclid Ave.	2-5
Figure 2-4: Residential flooding along 21st Pl & Euclid Ave. during recent event.....	2-5
Figure 2-5: Sediment in road & the Pines at South Mountain retention basins.....	2-6
Figure 2-6: Cortland Point (left) and Shadow Mountain Villas flooding (right).	2-7
Figure 2-7: Inlet at 40th St. & Baseline (left) & wash near Beautiful Lane (right).....	2-8
Figure 2-8: Partial closure of Vineyard Rd west of 18 th St during recent storm.	2-9
Figure 4-1: Identified problem areas.....	4-1

TABLES

Page

Table 5-1: Evaluation Summary of Area 1 Alternatives	5-1
Table 5-2: Evaluation Summary of Area 2 Alternatives	5-2
Table 5-3: Evaluation Summary of Area 3 Alternatives	5-3
Table 5-4: Evaluation Summary of Area 4 Alternatives	5-3
Table 5-5: Evaluation Summary of Area 5 Alternatives	5-4
Table 5-6: Evaluation Summary of Area 6 Alternatives	5-4
Table 5-7: Evaluation Summary of Area 7 Alternatives	5-5
Table 5-8: Evaluation Summary of Area 8 Alternatives	5-5

APPENDICES

Appendix A:	Level 1 Potential Alternatives Exhibits
Appendix B:	Evaluation Matrix
Appendix C:	Level 2 Alternatives Exhibits

1. INTRODUCTION

1.1 Project Description

The Hohokam Area Drainage Master Study/Plan (ADMS/ADMP) is a two-phase regional flood control planning project to determine the nature and magnitude of existing flood hazards; develop and evaluate potential flood mitigation alternatives; provide preliminary design plans for recommended improvements; and ultimately to provide a comprehensive plan to address flooding within the study area and guide future development and flood control improvements.

The Hohokam ADMS is a comprehensive data collection and investigation effort that identified and quantified existing and potential future flood hazards and documented archeological, cultural, landscape, and recreational resources and opportunities to serve as the basis to formulate and assess flood mitigation alternatives. The effort included development of hydrologic/hydraulic models to simulate flooding conditions; data collection and site investigations; public outreach to gather essential information on existing flooding conditions and to incorporate the issues, concerns and values of the public into the decision making process; and stakeholder involvement.

Phase II, the Hohokam Area Drainage Master Plan (ADMP), will utilize the results of the ADMS to formulate flood mitigation alternatives and through three levels of alternative development, analysis and evaluation, ultimately make recommendations for study area improvements. The ADMP will expand upon the public outreach and involvement efforts and develop concept plans for recommended improvements. Recommended improvements will be prioritized and a strategy for implementation prepared. This report documents the first level of alternative formulation, development and evaluation.

1.2 Project Authorization

The Flood Control District of Maricopa County (FCDMC) authorized the performance of the Hohokam ADMS/ADMP under contract FCD 2009C029 with an effective Notice-to-Proceed date of May 12, 2010.

1.3 Project Location

The Hohokam ADMS/ADMP study area is located within the limits of the City of Phoenix and the City of Tempe. The area is approximately 28.1 sq. miles in size and bounded by I-10 to the north and east, the Salt River to the north, South Mountain Park to the south and the limits of the Laveen ADMS to the west (see Figure 1-1).

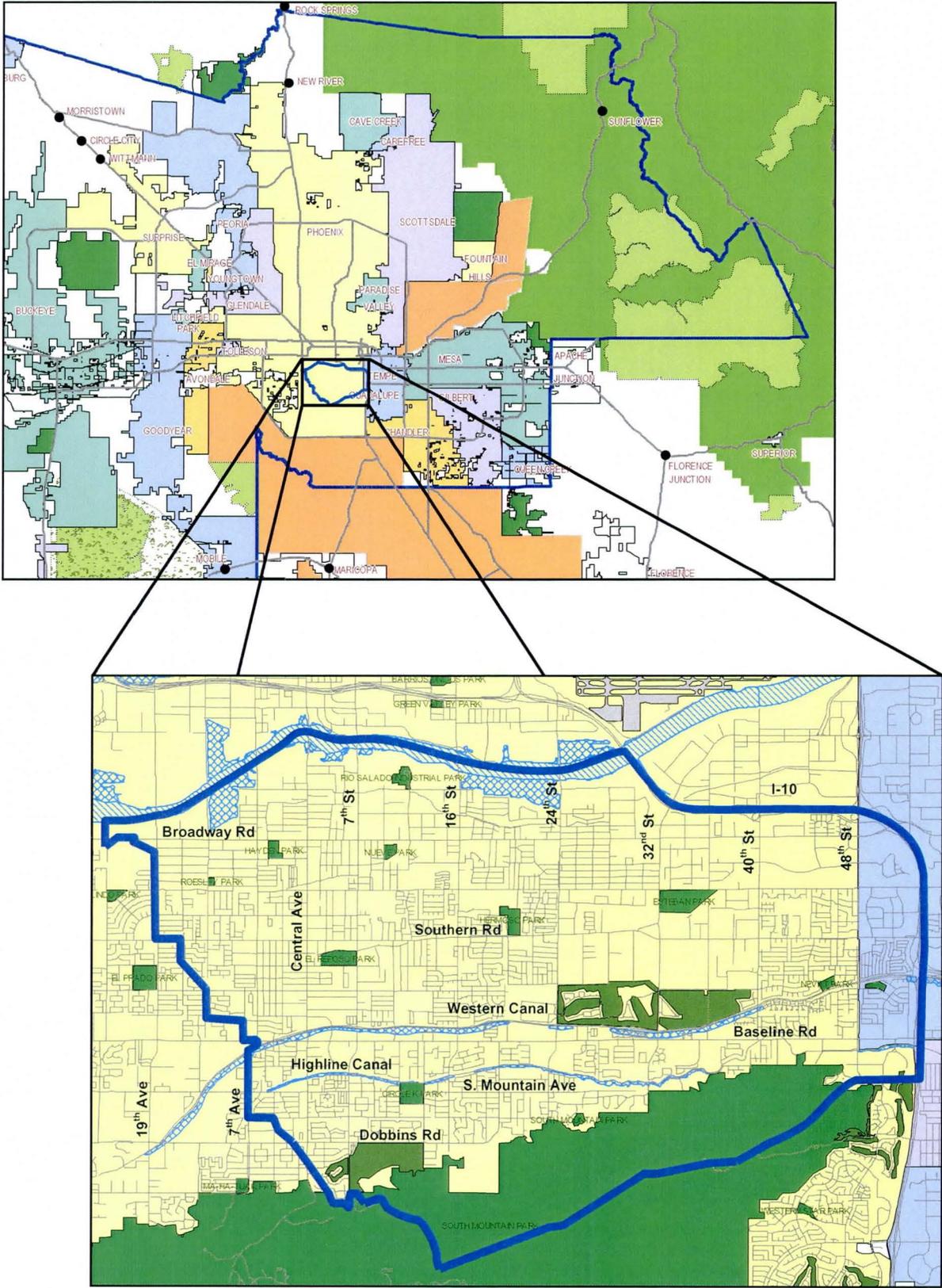


Figure 1-1: Project Location and Vicinity Map

1.4 Purpose of Report

The Level 1: Potential Alternatives Report documents the initial step of alternative formulation and evaluation for the development of the Hohokam ADMP. For Level 1, Phase I brainstorming and seed ideas were utilized to help develop potential flood mitigation alternatives for each problem area. These alternatives along with preliminary analysis information were presented to the project team and evaluated to identify the most promising alternatives for more detailed analysis and development in Level 2.

1.5 Previous Hohokam ADMS/ADMP Reports

Several reports have previously been prepared as part of the Hohokam ADMS/ADMP. These reports include:

- Class I Cultural Resources Inventory Survey
- Hohokam ADMS Data Collection Report
- Pilot Study & Sensitivity Analysis Drainage Memorandum
- Hohokam ADMS Hydrology & Hydraulics Report
- Hohokam Area Drainage Master Study (ADMS)

2. PROBLEM AREAS

2.1 General

Eight problem areas were identified in the study area (see Figure 2-1). Factors contributing to existing flooding conditions are not always constrained to a single problem area, consequently, problem area boundaries are soft and may overlap.

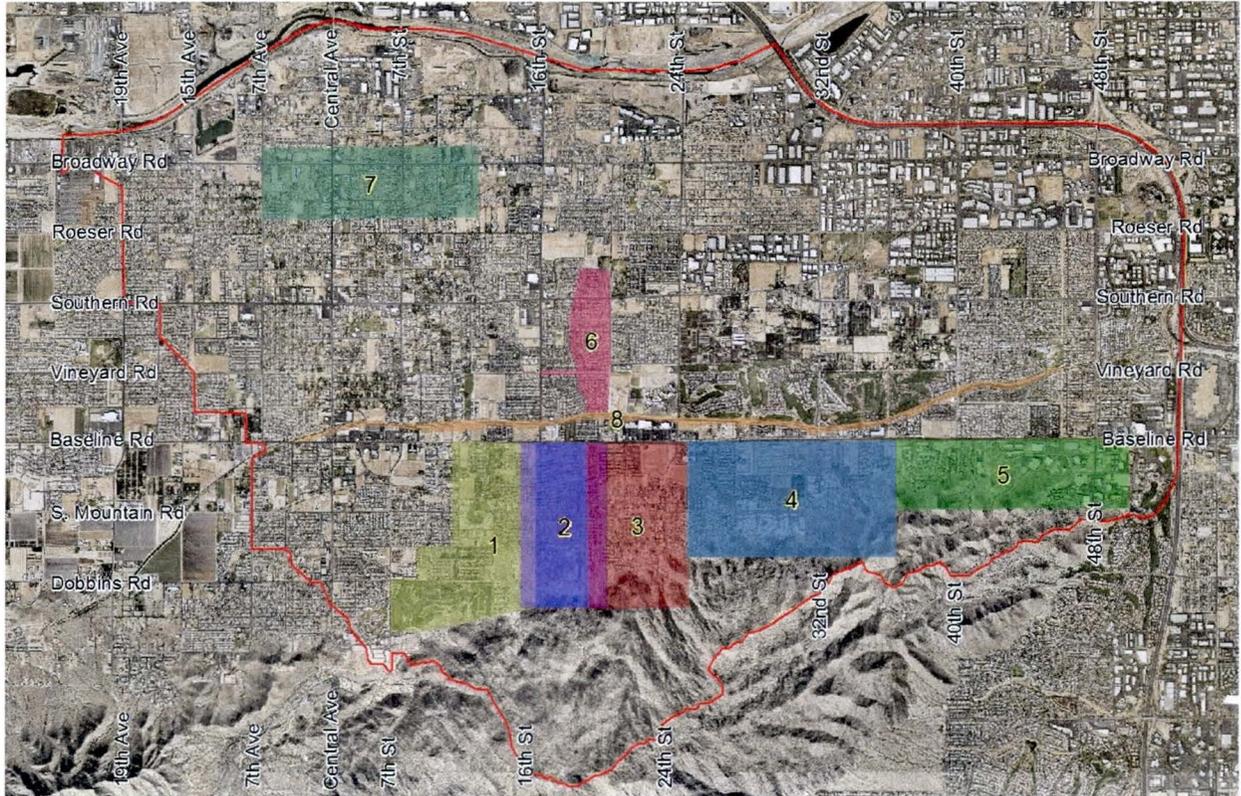


Figure 2-1: Identified problem areas.

2.2 Area 1: 7th St – 16th St (Circle K Park)

There are four general locations within this problem area that are subject to potential flooding. Flooding issues are primarily related to runoff from the South Mountains.

Montana Vista Subdivision (16th St. & Dobbins Rd.)

The Montana Vista development located at the northwest corner of 16th St and Dobbins Rd is subject to flooding from mountain runoff from two separate drainage areas. At the southeast corner of the development, a 10'x4' RCBC with a grated inlet is provided to convey flow north through the development via the culvert and a rectangular channel

downstream that extends as far as the development at which point flow continues northerly along 16th St unconfined.

The principal source of floodwater is from the relatively small, eastern most drainage area that discharges to the intersection of 16th St and Dobbins Rd. The western drainage area is much larger and drains north along 15th St to Dobbins and then either east to the 16th St intersection or into the Montana Vista development through the front entrance gates. Some flow does continue northwest overland towards 14th St and Circle K Park. The combination of these generally unconfined flows and the inadequacy of the culvert contribute to the flooding within the development. A residential property located on Dobbins Rd., upstream of the culvert and another located on 16th St, downstream of the culvert/channel and residential properties adjacent to 15th St, south of Dobbins may also be subject to potential flooding.

16th St. from Dobbins Rd. to Baseline Rd.

Flooding along 16th St has been documented and specifically a property just northeast of the Highline Canal and 16th St has been flooded twice in the past 3 years. Much of the drainage within 16th St. originates from the same two mountainous drainage areas that impact the Montana Vista Subdivision at 16th St and Dobbins Rd. However, 16th St also receives flow from side streets (e.g. from South Mountain Ave to the east) and distributes flow to sides streets (e.g. Euclid Ave to the west) as it continues north towards Baseline Road. The 16th St corridor is entwined with flooding and drainage issues at Circle K Park, Montana Vista, Highline Canal, Desert Lane, Gary Way, 15th Way, Branham Lane and possibly even 14th St and 15th St. The lack of a containing conveyance along 16th St. results in flow being distributed through the streets aggravating drainage conditions in these areas.



Figure 2-2: Flooding along 16th St.

Circle K Park (14th St. & South Mountain Ave.)

Circle K Park experiences shallow flooding indirectly from mountain runoff overland, through streets (Euclid Ave, S. Mountain Ave. and 14th St) and from flow passing through the Dobbins Creek Retention Basins. However, the concentration of flow along the east side of the park and the flow overtopping of Highline Canal at 13th and 14th St. is the area of most concern. This location has documented flooding issues related to flow overtopping the canal and undermining a block wall along the canal and flooding the property(s) downstream of the canal. Flow overtopping the canal also contributes to flooding along 13th Pl. and 14th St.

Thunderbird Country Club G.C. (7th St. & Dobbins Rd.)

The Thunderbird Country Club Golf Course (TCCGC) is located south of Dobbins Rd between 7 St. and 14th St. Located at the base of the mountain, the golf course receives a significant amount of mountain runoff. The golf course attenuates some flow. Two 2-8'x4' culverts across Dobbins Rd. discharge flow to channels through the Dobbins Creek subdivision located immediately downstream and into two retention basins. Flow overtopping the basins discharge directly to Euclid Ave and continue north along 12th St. and 14th St. and overland through residential properties and Circle K Park.

The golf course has a significant impact on area hydrology and the parcel has recently be rezoned and illustrative development plans have been submitted for the conversion of the golf course to a mixed use residential and resort development (currently known as the Vistal Development). A potential decrease in the retention/flow attenuation or increase in runoff volume provided by the golf course and even a change in the distribution flow between the two culverts crossing Dobbins Road could have significant impacts on the Dobbins Creek channels and retention basins and flows downstream of Dobbins Creek including residential properties and Circle K Park.

2.3 Area 2: 16th St – 20th St (Siesta Foothills/Boy Scout Camp)

There are three general locations within this problem area that are subject to potential flooding. Flooding issues are mainly related to runoff from the South Mountains that pass through a boy scout camp located south of Dobbins Rd. and 19th St.

19th St – Dobbins Rd to Highline Canal

Significant runoff from the mountains passes through the Boy Scout Camp and crosses Dobbins Road through a large culvert. Much of this flow is conveyed north to a 2-6'x4' RCBC through the Mountainside Estates development, however, some flow breaks out of the channel upstream of the culvert and is diverted northwest towards 17th Way. Flow passing through the culvert, outlets to a series of weirs along the west side of 19th St. This flow eventually ends up at the corner of 19th St and Euclid Ave. From north of Euclid Ave., 19th St. is an inverted crown road to convey flow. This flow contributes to

flooding along Euclid Ave, 19th St and along South Mountain Ave. Residential flooding issues have been documented at 19th St. and South Mountain Ave.

South Mountain Ave. & 17th Way

Flow breaking out of the channel and diverted west (downstream of the boy scout camp, see above) overtops the road at 18th St and the natural drainage path takes flow down west down Euclid Ave., north along 17th Way and then west down South Mountain Ave to 16th St. Significant flow in the streets presents the potential for flooding of adjacent properties and contributes to flooding issues in Area 2 along 16th St.

Vista Portica (17th Way & S. Mountain Ave.)

Vista Portica is a development located just upstream of the Highline Canal and east of 16th St. The development's sole retention basin is located at the southeast corner of 16th St and the Highline Canal. A curb opening catch basin along 16th St, just prior to the Highline Canal, captures flow and discharges it into the basin. Overtopping of the basin and the blockage and accumulation of sediment in the catch basin along 16th St are persistent drainage issues. Overtopping of the basin can be attributed to significant drainage to the retention basin not only from the development but also from offsite flows along 16th St; Highland Ranch (from the east via Francisco Dr), and South Mountain Ave (via 17th Way). Generally, documented complaints focus on the retention basin; however, it is possible that some residential properties might be subject to potential flooding due to flow from South Mountain Ave and overtopping of the basin.

2.4 Area 3: 20th St – 24th St (Pines at South Mountain)

There are four general locations within this problem area that are subject to potential flooding. Flooding issues are primarily related to runoff from the South Mountains and the lack of adequate conveyance through residential properties.

Siesta Foothills Area (20th St. & Euclid Ave.)

Runoff from the mountains and possibly some flow diverted northwest along Dobbins Rd from the Boy Scout camp contribute to flooding in the vicinity of 20th St and Dobbins Rd. On Euclid Ave, east of 20th St, two residential properties are documented as having recurring drainage and flooding issues. The properties are located in a historic flow path but recent development upstream (Siesta Foothills) has interrupted drainage patterns and flow is now discharged to Euclid Ave. at concentrated locations east of 20th St.

The source of floodwater can be attributed to surface flows from 20th St; a bubble up outlet on Euclid Ave. which is the outlet for a culvert on the east side of 20th St.; and a 48" outlet that discharges water captured in two separate mountainside drop inlets

south of Siesta Foothills. This floodwater passes north overland through the properties along small drainages and continues north overland to the Highline Canal.

Included in potential flooding areas are properties downstream impacted by these flows and in the Siesta Foothills development where flow in excess of the capacity of the mountainside drop inlets drain into the streets and to an existing retention basins at the southeast corner of 20th St and Euclid Avenue.



Figure 2-3: Bubble up and 48" outlet discharging to Euclid Ave.

21st Pl. & Euclid Ave.

Runoff from the mountains drains northwest to 21st St and then north across Euclid to a drainage tract between 21st Pl and 21st St. Along the west side of 21st Pl, several properties have documented drainage and flooding issues which is supported with FLO-2D results.



Figure 2-4: Residential flooding along 21st Pl & Euclid Ave. during recent event.

Pines at South Mountain (21st Way & Baseline Rd.)

The Pines at South Mountains is located at 21st Way and Baseline Road and immediately downstream of the Highline Canal. This location has some documented drainage issues related to flow overtopping the canal and passing through the site. Along the

boundary with the canal, the development has a detention area that drains offsite flow from the Highline Canal to two large grated inlets. The inlets convey flow north to a retention basin along Baseline Road via 2-48" pipes. Flow not captured by the inlets is conveyed overland north along 21st St. and discharged into the retention basin. Documented complaints state that there is a significant amount of flow overtopping the canal at this location that floods 21st Ave, and potentially cross streets. The source of the offsite water can be attributed to flow in 20th St, runoff from the mountains that passes through the Siesta Foothills development and north through developed and undeveloped properties, and runoff from a smaller mountain drainage area that drains north along a drainage tract between 21st St and 21st PI and then overland north to the Highline Canal.



Figure 2-5: Sediment in road & the Pines at South Mountain retention basins.

22nd St – 24th St, North of S. Mountain Ave.

West of 24th St, mountain runoff from a large subbasin is conveyed north across Euclid Ave. through a dip crossing. The flow is fairly well contained in a natural wash until the crossing of South Mountain Ave. where flow splits to the northeast along a shallow wash and northwest overland. Downstream of the flow split, residential properties are susceptible to flooding.

2.5 Area 4: 24th St – 36th St (Cortland Point)

There are three general locations within this problem area that are subject to potential flooding. Generally, the flooding issues are primarily related to runoff from the South Mountains that pass through or adjacent to the Siesta Foothills development.

25th PI – 32nd St, Ponding Along the Highline Canal

There are sizeable areas and notable depths of ponding along the Highline Canal between 25th St. and 32nd St. Developments north of the canal have structurally sound perimeter walls that are barriers to flow and no significant accommodations are made to divert flow east or west. Ponding water impacts properties south of the canal including an elementary school, a public park, a community center and some residential

properties east of 28th St. Residential properties further south are impacted by the shallow overland flow contributing to ponding along the canal.

Cortland Point (36th St & Highline Canal)

The Cortland Point subdivision is located along the north side of the Highline Canal between 34th Pl. and 36th St. This location has documented residential flooding. Along the Highline Canal, the adjacent residential properties are graded two to three feet lower than the Highline Canal. Runoff from the mountains overtops the canal and either ponds behind block walls or drain directly down the canal embankment into Melody Drive. Water ponding along the block walls seeps through the blocks and in one recorded event, collapsed the wall and flooded the property and Francisco St.



Figure 2-6: Cortland Point (left) and Shadow Mountain Villas flooding (right).

Shadow Mountain Villas (36th St & Baseline Rd)

Shadow Mountain Villas Condominiums is located at 36th St and Baseline. The condo property is downstream of Cortland Point and the Highline Canal. This location has documented flooding in a parking lot located along the Highline Canal and may receive runoff from the mountains through Cortland Point via 34th Pl and/or Melody Drive and 36th St. However, the grading and drainage design of the condo development itself contributes, if not causes, the majority of the drainage and flood issues. The onsite drainage is handled by interior roads some of which have inverted crowns to increase conveyance capacity. These roads all drain to the north parking lot which also serves as the development's retention basin. Unfortunately, parked cars are susceptible to flooding several feet deep. During small rainfall events, the parking lot likely still floods to some degree. During large events, offsite drainage from flow overtopping the canal may enter the site and aggravate the situation and increase the ponding depth of the parking lot.

2.6 Area 5: 36th St – 48th St (Industrial Area)

There are three general locations within this problem area that are subject to potential flooding. Flooding issues are primarily related to runoff from the South Mountains in at least four separate locations.

38th St. & Baseline Rd (Blossom Hills).

The Blossom Hills development is located at 38th St., south of Baseline Rd and along the north side of the Highline Canal. Along the Highline Canal, the adjacent residential properties at times are graded two to three feet lower than the Highline Canal. Similar to the Cortland Point subdivision, runoff from the mountains has the potential to overtop the canal and pond behind block walls. Unlike Cortland Point, however, there is a culvert that can convey some flow under the canal and the area between the residential walls and the canal is wider and has generally been graded to drain to a channel through the development. In addition, the walls are much more substantial and are not likely to seep and fail with 2-3 ft of static water pressure. However, blockage of the culvert has created potential flooding conditions upstream of the Highline Canal in the past according to Salt River Project (SRP) personnel.

42nd St. & Baseline Rd.

A wash runs roughly parallel to 42nd St and terminates at a combined culvert/storm drain hydraulic inlet south of Baseline Road. Upstream of the wash, flow is well contained and does not appear to significantly impact adjacent residential properties during the 100-year events. However, the 100-yr peak discharges greatly exceed the capacity of the storm drain inlet which outfalls to a 30" storm drain pipe and a 30" culvert. The consequences of the flow overwhelming the inlet is that Baseline Rd. in the vicinity would be flooded (2-3 ft deep) and floodwater could potentially impact properties along the northwest corner of 40th St. and Baseline Rd.



Figure 2-7: Inlet at 40th St. & Baseline (left) & wash near Beautiful Lane (right).

46th St. & Beautiful Lane

In the proximity of 46th St and Beautiful Lane, two separate washes/drainages contribute to flooding of industrial buildings south of Beautiful Lane and potentially industrial properties north of Beautiful Land along Baseline Road. The western-most drainage is primarily responsible for documented flooding of an industrial building. The building site was placed in the historic flow path and mountain runoff floods the parking lot and ponds behind an elevated Highline Canal which parallels Beautiful Lane. The eastern most wash has a larger drainage area and is more incised. Near Beautiful Land, flow from the wash passes through several drop inlet and detention basins ultimately being drainage by a storm drain that crosses the Highline Canal and discharges to a retention basin along Baseline Road. The magnitude of the runoff, the limited capacity of the storm drain pipes/drop inlet and blockage from debris likely contribute to the accumulation of water and potential flooding behind Highline Canal.

2.7 Area 6: 16th St – 20th St (North of Western Canal)

Generally, the flooding issues in this problem area are related to the lack, or inadequacy, of drainage infrastructure. Drainage issues along Vineyard, west of 16th St, 18th St and 20th St have been observed in the field during field reconnaissance. The observed issue was significant street flooding and ponding along Vineyard Rd between 16th St and 18th St. Concentrated street flow and flooding along 18th St., 20th St. and Southern Ave. was also observed. However, no residential flooding was observed or reported. Residential properties at the terminus of cul-de-sacs at 16th Pl. and 19th Pl. appear to be susceptible to potential flooding.



Figure 2-8: Partial closure of Vineyard Rd west of 18th St during recent storm.

The source of the floodwater is likely primarily interior street runoff concentrating in these collector streets. However, for the 100-year events, flow overtopping the Western Canal also contributes to flows and aggravates drainage and flooding conditions. Overtopping flow is captured by hardened channels between the residential block walls

and the canal embankment and discharge into the streets at cul-de-sacs terminating at the canal at 17th St., 18th St., 19th St and 19th Pl.

2.8 Area 7: Broadway Rd. & 7th Ave-9th St (Low Laying Areas)

Several areas south of Broadway Rd between 7th Ave and 9th St are located in low laying areas and experience widespread shallow flooding due to elevations and lack of sufficient drainage infrastructure. The source of floodwater is local runoff and drainage. During a site visit a resident confirmed the area had drainage and flooding issues in the past. While there are other similar locations located throughout the study area, they tend to be smaller in size and more isolated.

2.9 Area 8: Ponding Along Western Canal

Along the length of the Western Canal there are areas of ponding behind the canal due to the elevation of the canal embankments. Much of this is due to local drainage runoff but during large flood events flow from Baseline Road and south of Baseline may contribute to flooding problems. In addition, there are some areas downstream of the canal that could be adversely impacted from flow overtopping the canal. Areas such as between 14th St and 16th were the situation is similar to Cortland Point where water could be impounded between residential block wall and the canal embankment and no accommodations have been made for drainage. Failure of these walls in such circumstances would likely result in the flooding of downstream properties.

3. ALTERNATIVE DEVELOPMENT PROCESS

3.1 Introduction

Phase II, the Hohokam Area Drainage Master Plan (ADMP), will utilize the results of the Phase I Hohokam Area Drainage Master Study (ADMS) to formulate flood mitigation alternatives and through three levels of alternative, development, analysis and evaluation, make recommendations for study area improvements. The ADMP will expand upon the public outreach and involvement efforts and develop concept plans for recommended improvements. Recommended improvements will be prioritized and a strategy for implementation prepared.

This report documents the Level 1: Alternative Formulation and Evaluation. Subsequent levels of alternative development (Levels 2 and 3) will be documented upon completion.

3.2 Level 1: Alternatives Formulation and Preliminary Analysis

In Level 1, the brainstorming alternatives and seed ideas generated in Phase I aided in the formulation of potential alternatives to mitigate flooding issues in the problem areas. These potential alternatives were presented along with preliminary analysis information to the project team for evaluation at the Level 1 Potential Alternative Meeting.

The preliminary analysis and evaluation of alternatives were based upon information available from the Phase I hydrologic & hydraulic analyses and data collection efforts. No additional analyses or detailed cost estimates were to be performed. To assist in the evaluation of alternatives, a Level 1 evaluation matrix was developed to rate alternatives based upon:

- Flood Mitigation Effectiveness
- Community Acceptance
- Land and Resource Compatibility
- Relative Cost

At this level of alternative formulation and analysis, the rating of each criterion was limited to being either a positive, negative or neutral.

In the Level 1 Potential Alternative Meeting, the project team discussed the merits of each alternative. In some instances, alternatives were combined or refined as part of the discussion. Then, as a group, the project team evaluated each alternative using the matrix and to come to a consensus on which alternatives were most promising and should be further developed and investigated in Level 2.

3.3 Level 2: Alternatives Analysis

For subsequent Level 2, alternatives will be further developed to determine their engineering feasibility, effectiveness and approximate costs. The alternatives will be developed to an extent to identify potential utility impacts, ROW/land acquisition requirements, potential multi-use opportunities, and environmental/cultural resource issues. Integral to the development and assessment of the alternatives will be the District's CSFHM approach that will consider flooding context, land and resource context and community text. A more detailed analysis and evaluation will be used to assess project alternatives. Feedback from public involvement will also be obtained and considered as part of the community context to identify recommended alternatives for further development in Level 3.

3.4 Level 3: Recommended Alternatives Analysis

The final level of alternative development, Level 3, will develop recommended alternatives to a level at which 15% plans can be completed. Hydrologic and hydraulic models will be developed to reflect the recommended alternatives. Landscape and multiple-use guidelines along with an implementation plan will be developed to guide future development and provide a strategy for implementation. Public meetings will be held to present the recommended alternatives and receive public input.

4. POTENTIAL ALTERNATIVES & EVALUATION

4.1 General

This section discusses the preliminary alternatives presented to the project team at the Level 1 Alternatives Formulation Meeting and the conclusions reached for each alternative upon evaluation. Given that there were often multiple sources contributing to flooding conditions in each problem area, typically the initial alternatives were not comprehensive solutions for the entire problem area but addressed issues related to a specific flooding source. In addition, some alternatives presented were general concepts (e.g. floodwalls or inverted roads for conveyance) that could have been considered an approach or a component of multiple alternatives; however, they were presented separately to get the project team's feedback specifically on their application.

Exhibits for each alternative are provided in Appendix A. The "No Action" Alternative exhibits are provided for each problem and display the Phase I 100-yr, 6-hr future conditions FLO-2D maximum flow depth results.

The Evaluation Matrix tables for the potential alternatives are provided in Appendix B and show the consensus evaluation of the potential alternatives.

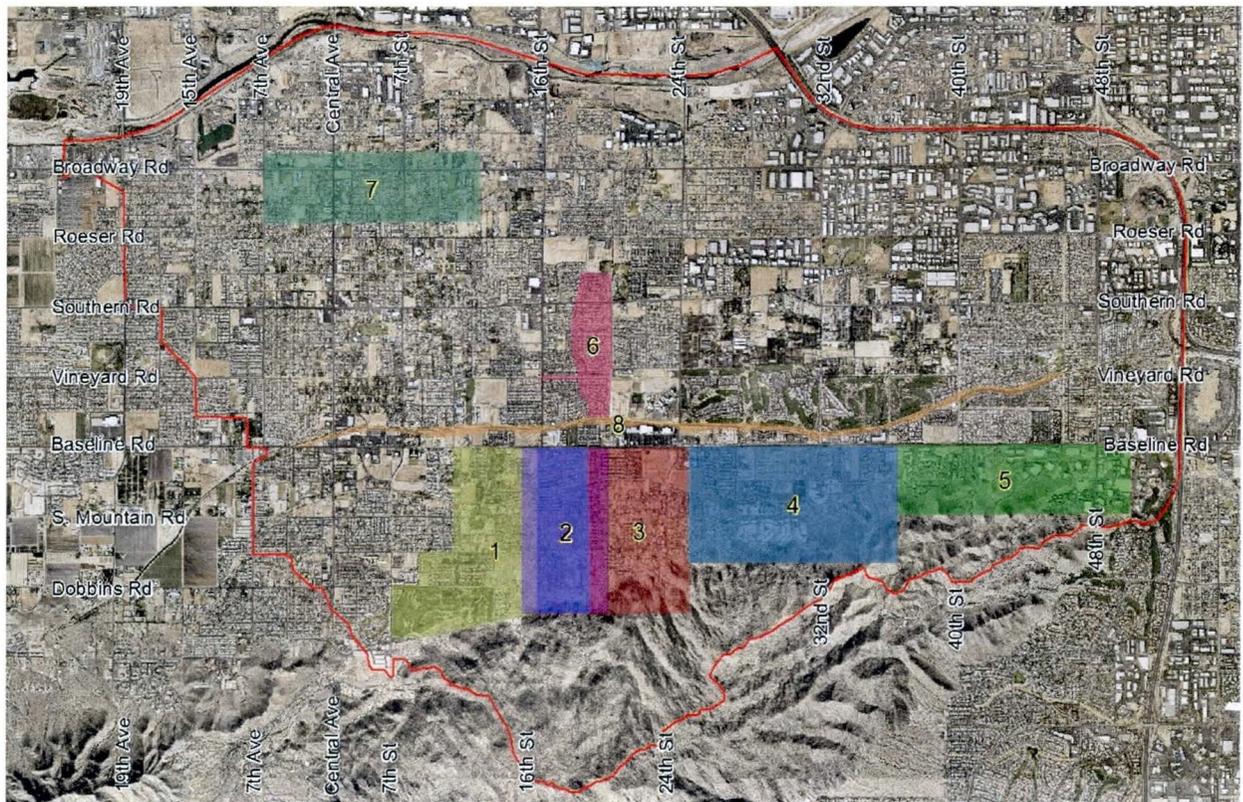


Figure 4-1: Identified problem areas.

4.1.1 Evaluation of Alternatives

Alternatives were evaluated at the Level 1 Potential Alternative Meeting that included members from the District, City of Phoenix, J.E. Fuller Hydrology and Geomorphology, Logan Simpson Design, and Stanley Consultants. The alternatives were presented to the project team along with information developed as part of the Phase I hydrology and hydraulic analyses, the Context Sensitive Flood Hazard Mitigation (CSFHM) Inventory and Analysis, the Class I Cultural Resource Survey and gathered as part of the data collection effort. With this information at their disposal, the merits of each alternative were discussed, in some instances alternatives were combined or refined. Then, as a group, the project team evaluated alternatives and came to a consensus on those alternatives that could be given further consideration in Level 2.

Using the evaluation matrix, the project team, assessed each alternative based upon four criteria:

- Flood Mitigation Effectiveness;
- Community Acceptance;
- Land & Resource Compatibility; and,
- Relative Cost.

At the meeting, the three aspects of the flood hazard mitigation solutions (structure types, structural methods, and landscape themes) were discussed and it was determined that consideration of structural methods and landscape themes would be premature at this early stage of alternative development; however, consideration should be given to the structural types. A review and discussion of the CSFHM Inventory and Analysis indicated that the urban- and suburbanized nature of the existing community, future and existing land use, and natural and cultural resources, results in all structural types being generally acceptable throughout the study area with the exception of dams, and in some areas, channel levees. Since no alternatives proposed channel levees at this stage of the study, and the team agreed that dams would not be acceptable due to where they would have to be located (within South Mountain Park), all other structural types identified would be acceptable to the community and compatible with the existing land uses and resources. The alternatives evaluation discussion then focused primarily on the Flood Mitigation Effectiveness and Relative Cost criteria.

4.2 Area 1: 7th St – 16th St (Circle K Park)

4.2.1 Alternative 1.0 – No Action

This alternative would not implement any improvements to address the existing flood conditions.

Conclusion: Generally a “No Action” alternative will be a consideration for all problems areas in Level 2.

4.2.2 Alternative 1.1 – Multiple Basins and Channels

This alternative consists of a series of retention basins, channels and storm drain to capture, contain and convey mountain runoff. South of Dobbins Road, runoff from the mountains will be captured in a basin and/or channel and conveyed across Dobbins Rd in a culvert. To the west, the culvert will discharge to a channel and basin located in the vacant parcel north of Dobbins Rd and west of 16th St. To the east, a culvert will discharge to the existing culvert/channel through the Montana Vista development and to the same retention basin. The basin could potentially have an outlet down 16th St to the existing storm drain on Baseline or flows could be directed northwest to Circle K Park where a channel/basin would direct flow to a storm drain line down 14th St or to a basin located north of Highline Canal along 11th St. The Circle K park area itself could provide additional retention storage.

Conclusion: This alternative is recommended for Level 2. This alternative is the most comprehensive alternative for Problem Area 1. This alternative could share components (e.g. 16th St storm drain) with alternatives for the adjacent problem area (Problem Area 2). The COP indicated that 14th St has been identified as an alignment for a potential storm drain extension to help alleviate flooding conditions in the Circle K park area and along 14th St.

4.2.3 Alternative 1.2 – TCCGC Retention Basin

This alternative consists of constructing a channel to divert runoff from the mountains to a retention basin to be located within the existing Thunderbird Country Club Golf Course (TCCGC). In addition, the analysis and design of the basin would incorporate the Dobbins Creek retention basins to assure the proper distribution of flow to each basin and that the basins are not overtopped for the 100-year event.

Conclusion: This alternative is recommended for Level 2. Despite the challenges of proposing a regional retention basin on a site that is in the initial stages of redevelopment, the effectiveness of the alternative merits further consideration in Level 2.

4.2.4 Alternative 1.3 – TCCGC Development Stipulations

This alternative consists of working with the City of Phoenix development services and the developer of the TCCGC site to assure the site development considers its impact on the downstream Dobbins Creek retention basins and to assure the basins are not overtopped during the 100-yr event. This might require additional retention (above what

is currently provided by the golf course) and/or analyses to determine the appropriate distribution of flows through the site to each channel and basin.

Conclusion: This alternative is not directly recommended for Level 2. Instead, it is to be a recommendation to the COP that would help mitigate some flooding issues related to overtopping of the Dobbins Creek retention basins.

4.2.5 Alternative 1.4 – Local Storm Drain (16th St) & Basins

This alternative consists of a storm drain system down 16th St with laterals on Dobbins Rd., Euclid Ave, and South Mountain Ave to capture flows contributing to flooding along 16th St and in the region of Circle K Park. The system would outlet to the existing storm drain system on 16th St. An option would be to outlet to a retention basin (e.g. northwest of 16th St and Baseline Rd.) which would then drain to the existing storm drain system.

Conclusion: This alternative is recommended for Level 2. This alternative would require supplemental detention basins or additional storm drain capacity from Baseline to the Salt River since the existing storm drain system does not have the capacity to receive additional inflows. This alternative and Alternative 1.9 are similar in nature, consequently, portions of Alternative 1.9 may be considered as components of this alternative. The City of Phoenix has identified 14th St as a preferable alignment for storm drain alternatives since the COP is considering extending the storm drain in Baseline south down 14th St in a separate project.

4.2.6 Alternative 1.5 – Dobson Creek Basin Modifications

This alternative consists of regrading the existing Dobbins Creek retention basins to provide sufficient storage to retain the 100-year event without overtopping.

Conclusion: This alternative is not recommended for Level 2. Flow overtopping the basins contributes to downstream flooding conditions for the 100-year event; however, the impact is small in comparison to other contributing sources. In addition, the operation of the existing basins is dependent upon upstream conditions in the TCCGC which will be developed in the near future. The change will likely impact the amount and distribution of flow to the east and west channels and thereby the operation and effectiveness of the Dobbins Creek retention basins.

4.2.7 Alternative 1.6 – Floodwalls

This alternative consists of replacing walls along the canal with more substantial walls not susceptible to failure or overtopping to help prevent the potential of downstream flooding. In addition, the alternative would include grading swales along the walls to direct flows to a specific outfall location.

Conclusion: This alternative is not directly recommended for Level 2. Instead, it is to be considered as a potential component of other potential alternatives.

4.2.8 Alternative 1.7 – Use Roads for Conveyance

This alternative consists of reconstructing specific roads to improve their capacity to convey flow within the existing or expanded right of way limits. Means of improved conveyance could include: placement of curb and gutter; reconstruction of the roadway cross section to be an inverted crown with a concrete valley gutter; and/or expansion of the right of way to incorporate a median for drainage and/or roadside drainage facilities/ditches.

Conclusion: This alternative is not recommended for Level 2. The COP will not consider the use of roads as a primary means of conveyance. However, exceptions may be made in specific instances and in limited areas.

4.2.9 Alternative 1.8 – Dam (with Outlet)

This alternative consists of a dam south of Dobbins Rd to retain runoff from the mountains prior to Dobbins Rd. A basin outlet down 16th St would drain the basin to the existing storm drain system in Baseline Rd. The dam and flood pool would be located within South Mountain Park.

Conclusion: This alternative is not recommended for Level 2. The issues related to land acquisition/ROW, maintenance, liability, certification, cost, impact to South Mountain Park and other issues appear to override the potential benefits of a dam alternative.

4.2.10 Alternative 1.9 – Large Diameter Storm Drain (16th St)

This alternative consists of a large diameter storm drain along 16th St. from the Salt River to Dobbins to capture runoff from the mountains at the intersection of 16th St and Dobbins Rd. Additional laterals would be added to problem locations as necessary.

Conclusion: This alternative is not directly recommended for Level 2. Instead, it is to be considered as a potential component of Alternative 1.4.

4.3 Area 2: 16th St – 20th St (Siesta Foothills/Boy Scout Camp)

4.3.1 Alternative 2.0 – No Action

This alternative would not implement any improvements to address the existing flood conditions.

Conclusion: Generally a “No Action” alternative will be a consideration for all problems areas in Level 2.

4.3.2 Alternative 2.1 – Storm Drain (16th & 20th St.) & Basins

This alternative consists of storm drain lines along 16th St, South Mountain Ave and 20th St to convey flow to basins located along 20th St (at Desert Lane or north of Highline Canal) or to the existing storm drain system in 16th St. Channel improvements would be made to prevent flow from breaking out of the channel downstream of Dobbins Rd. In addition, a retention basin could be considered in the Boy Scout Camp.

Conclusion: This alternative is recommended for Level 2. In addition, this alternative will consider elements from Alternatives 2.4, 3.1, 3.3 and 3.4 to mitigate flooding conditions not only in Problem Area 2 but also Problem Area 3.

4.3.3 Alternative 2.2 – Use Roads for Conveyance

This alternative consists of reconstructing South Mountain Ave, 17th Way, 19th St, and 20th St to better serve as conveyance of floodwater within the existing or expanded right of way limits. Means of improved conveyance could include: placement of curb and gutter; reconstruction of the roadway cross section to be an inverted crown with a concrete valley gutter; and/or expansion of the right of way to incorporate a median for drainage and/or roadside drainage facilities/ditches.

Conclusion: This alternative is not recommended for Level 2. The COP will not consider the use of use of roads as a primary means of conveyance. However, exceptions may be made in specific instances and in limited areas.

4.3.4 Alternative 2.3 – Dams (with Outlets)

This alternative consists of a dam within the Boy Scout Camp and South Mountain Park. The dam would drain to an outlet that extended down 20th St to the existing storm drain system on Baseline Rd.

Conclusion: This alternative is not recommended for Level 2. The issues related to land acquisition/ROW, maintenance, liability, certification, cost, impact to the Boy Scout camp facility, and other issues appear to override the potential benefits of a dam alternative.

4.3.5 Alternative 2.4 – Large Diameter Storm Drain (16th St)

This alternative consists of a storm drain line down 16th St and 20th St with laterals to capture flow in problem areas on Euclid Ave, Dobbins Rd. South Mountain Ave, and 17th Way. The 16th St main line would be connected to the existing storm drain in 16th St which would likely require upsizing to accommodate the addition flow. The 20th St storm drain would outlet to a basin northeast of 20th St and the Highline Canal. Potentially, the 16th St storm drain could also be connected to a proposed retention basin along 16th St. prior to discharging into the existing storm drain system.

Conclusion: This alternative is not directly recommended for Level 2. Instead, it is to be considered as a potential component of Alternative 2.1.

4.4 Area 3: 20th St – 24th St (Pines at South Mountain)

4.4.1 Alternative 3.0 – No Action

This alternative would not implement any improvements to address the existing flood conditions.

Conclusion: Generally a “No Action” alternative will be a consideration for all problems areas in Level 2.

4.4.2 Alternative 3.1 – Local Storm Drain (20th St.) & Basins

This alternative consists of constructing a storm drain system down 20th St with laterals down Euclid Ave and 21st Pl. The bubble up outlet and storm drain outlet from the Siesta Foothills development would be connected directly to the storm drain. The storm drain would outlet to a basin at 20th St and Desert Lane. An option would be to also have a basin north of Highline Canal along 20th St instead or to provide additional retention.

Conclusion: This alternative is not directly recommended for Level 2. Instead, it is to be considered as a potential component of Alternative 2.1.

4.4.3 Alternative 3.2 – Channelize Flow to Basins (20th PI)

This alternative consists of channelizing flow through existing residential properties to a basin at 20th St and Desert Lane.

Conclusion: This alternative is not recommended for Level 2. It was not expected that an adequate channel could be constructed through the properties without taking multiple properties which essentially were the homes to which protection would have been provided.

4.4.4 Alternative 3.3 – Channelize Flow & Use Roads (20th PI)

This alternative consists of a system of roadways improvements (to convey flow), channelization to convey flow to retention basins along 24th St. Means of improved conveyance could include: placement of curb and gutter; reconstruction of the roadway cross section to be an inverted crown with a concrete valley gutter; and/or expansion of the right of way to incorporate a median for drainage and/or roadside drainage facilities/ditches. An existing drainage easement parallel to 21st St could potentially be used for conveyance.

Conclusion: This alternative is not directly recommended for Level 2. Instead, it was proposed that part of it be considered as a potential element of Alternative 2.1. In this instance, the COP might be amenable to constructing an inverted road along Euclid Ave. and/or 21st Pl. to help convey flow away from problem areas.

4.4.5 Alternative 3.4 – Highline Canal Storm Drain

This alternative consists of a storm drain line along the Highline Canal to capture flow south of the canal and convey it to a retention basin either on 24th St or on 20th St.

Conclusion: This alternative is not directly recommended for Level 2. Instead, it was proposed that it be considered a potential element of Alternative 2.1. It was suggested that a storm drain line north of the canal and outside of SRP ROW would be preferable to avoid issues with SRP ROW and/or issues with property owners south of the canal. It was recommended that any storm drain line be located north of canal within the Pines at South Mountain development, a development that has had documented flooding problems and would be more amenable to improvements to address the issue.

4.4.6 Alternative 3.5 – Multiple Basins & Channels

This alternative consists of multiple basins and channels along the existing wash to help attenuate and contain flow through the developed areas and outlet to proposed retention basins along the north side of the Highline Canal on 24th St. An option would be to

provide storm drain lines instead or to supplement the conveyance capacity of the channels.

Conclusion: This alternative is recommended for Level 2. Basins initially proposed along the south side of Highline Canal are not to be considered since partial takes of properties are not to be considered.

4.4.7 Alternative 3.6 – Use Roads for Conveyance to Basins

This alternative consists of reconstructing 24th St, Desert Lane and South Mountain Ave to better serve as conveyance of floodwater within the existing or expanded right of way limits. Means of improved conveyance could include: placement of curb and gutter; reconstruction of the roadway cross section to be an inverted crown with a concrete valley gutter; and/or expansion of the right of way to incorporate a median for drainage and/or roadside drainage facilities/ditches.

Conclusion: This alternative is not recommended for Level 2. The COP will not consider the use of use of roads as a primary means of conveyance. However, exceptions may be made in specific instances and in limited areas.

4.4.8 Alternative 3.7 – Dams (with Outlets)

This alternative consists of dams at potentially three locations (roughly at 22nd St., 24th St, and along Valley View Dr.) to detain floodwater and drain to outlets to the existing storm drain system in Baseline Rd. A storm drain main line would extend south from Baseline Rd to Euclid to serve as the outfall for all the potential dam outlets. At least two of the dams would be located within the South Mountain Park. All the floodpools of the dams would extend into the park. In addition, at least one dam would isolate one or two residential properties behind the dam.

Conclusion: This alternative is not recommended for Level 2. The issues related to land acquisition/ROW, maintenance, liability, certification, cost, and other issues appear to override the potential benefits of a dam alternative.

4.4.9 Alternative 3.8 – Large Diameter Storm Drain (24th St)

This alternative includes the extension of storm drain south down 24th St from Baseline Rd with laterals down South Mountain Ave. and Euclid Ave to capture flow in the wash west of 24th St.

Conclusion: This alternative is recommended for Level 2.

4.5 Area 4: 24th St – 36th St (Cortland Point)

4.5.1 Alternative 4.0 – No Action

This alternative would not implement any improvements to address the existing flood conditions.

Conclusion: Generally a “No Action” alternative will be a consideration for all problems areas in Level 2.

4.5.2 Alternative 4.1 – Multiple Basins & Storm Drain (S Mtn Ave)

This alternative consists of a basin/channel/storm drain system that would capture flows along South Mountain Ave., Winston Drive and 27th St and convey flow to an expansion of the existing retention basin in Francisco Highlands Park. A storm drain along the Highline Canal would drain the basin to the existing storm drain system on Baseline Rd and 24th St. An option would be to construct a basin at the southeast corner of Baseline and 24th St to detain flow prior to discharging to the existing storm drain.

Conclusion: This alternative is recommended for Level 2. It is recommended that the retention basin along the Highline Canal be limited to the park and not include are within the adjacent elementary school. In addition, it is proposed that consideration be given to regrading the existing Desert Rose subdivision retention basin along the south side of S. Mountain Ave (west of 28th St) to drain flows to the east and to the basin in the park.

4.5.3 Alternative 4.2 – Local Storm Drain & Basin (32nd St)

This alternative consists of a storm drain line along South Mountain Ave. to capture drainage along the road and convey it to a retention basin north of Highline Canal on 32nd St. The basin outlet be extended to drain to the existing storm drain in 32nd St., north of Baseline.

Conclusion: This alternative is not recommended for Level 2. The costs associated with the construction of storm drain lines and basins were considered to outweigh the realized benefits. The improvements would benefit only a few properties.

4.5.4 Alternative 4.3 – Highline Storm Drain & Basin (32nd/36th St)

This alternative consists of a storm drain line along the Highline Canal to capture mountain runoff prior to entering the canal. The storm drain line could be constructed to drain to the east to a basin/outlet at 36th St or extended west to a basin at 32nd St.

Conclusion: This alternative is not recommended for Level 2. The costs associated with the construction of storm drain lines and basins were considered to outweigh the realized benefits. The improvements would primarily only benefit properties in the Cortland Point subdivision.

4.5.5 Alternative 4.4 – Floodwalls

This alternative consists of replacing the existing walls along the canal within the Cortland Point subdivision with more structurally sound walls that would not readily fail or leak from water ponding between the walls and the canal. An option would be to build the walls as retaining walls, backfill the area between the canal and the walls and construct a drainage swale to convey any flow overtopping the canal to an outlet to the east (flow would be discharged to Melody Lane).

Conclusion: This alternative is not recommended for Level 2. Concerns related to building flood resistant walls on private property including potential liability, long term maintenance, and wall ownership made this alternative unattractive.

4.5.6 Alternative 4.5 – Cortland Point Basins/Channels

This alternative consists of multiple interconnected retention basins and/or channels along the Highline Canal to intercept and detain runoff from the mountain upstream of the canal. The basin site located north of the canal at 36th St would outlet to the existing storm drain in Baseline Road and 32nd St.

Conclusion: This alternative is recommended for Level 2. It is preferable not to have basins south of the canal and simply drain floodwater to the east to the basin on 36th St. More detailed analysis in Level 2 would determine if basins south of the canal would be necessary.

4.5.7 Alternative 4.6 – Dams (with Outlets)

This alternative consists of at least three dams (roughly 27th St, 32nd St, and 36th St alignments) to detain floodwater and drain to outlets connected to the storm drain in Baseline Rd. At least one dam would be located within South Mountain Park. The flood pool of others would potentially also extend into the park.

Conclusion: This alternative is not recommended for Level 2. The issues related to land acquisition/ROW, maintenance, liability, certification, cost, and other issues appear to override the potential benefits of a dam alternative. One potential site location also could potentially isolate an existing developed residential property behind the dam.

4.6 Area 5: 36th St – 48th St (Industrial Area)

4.6.1 Alternative 5.0 – No Action

This alternative would not implement any improvements to address the existing flood conditions.

Conclusion: Generally a “No Action” alternative will be a consideration for all problems areas in Level 2.

4.6.2 Alternative 5.1 – Highline Basin

This alternative consists of a retention basin south of the Highline Canal to attenuate runoff from the mountains prior to the canal. The basin could utilize the existing culvert under the canal as an outlet or a new outlet could be constructed in line with the downstream drainage corridor through the Blossom Hill development.

Conclusion: This alternative is not recommended for Level 2. The flooding conditions upstream of the canal do not appear to be very problematic or impact any structures. Some issues have arisen due to the blockage of the culvert across the canal. Downstream of the canal, the development has made accommodations for offsite flow including a drainage corridor to control flow around and through the development. The perimeter/property walls are also solid retaining walls that are not readily susceptible to failure. Proposed improvements would improve the existing conditions, however, based on field review, the existing conditions do not appear to be as significant as initial FLO-2D results might suggest. These FLO-2D results arise from limitations of FLO-2D input (grid sizes, levee/wall orientations, grid located where there is a dramatic change in elevations).

4.6.3 Alternative 5.2 – Baseline Rd Basins

This alternative consists of multiple interconnected retention basins south of Baseline Road to attenuate flow prior to discharging to the existing storm drain. This alternative could potentially help mitigate flooding issues for three different problem locations. Potentially a basin located northwest of 40th St and Baseline Rd could also be proposed if necessary.

Conclusion: This alternative is not recommended for Level 2. The improvements would address some flooding issues in Baseline Rd and downstream, however, the benefit to cost ratio was not considered sufficient to merit further consideration in Level 2.

4.6.4 Alternative 5.3 – Divert Flow to 42nd PI/Baseline Rd Basin

This alternative consists of a channel to divert flow to a basin further west along the Highline Canal. The basin outlet would then be connected to the existing storm drain on Baseline Rd. This alternative would address flooding issues related to flooding of the industrial building south of the Highline Canal; however, it would not necessarily address other issues in the problem area. An option would be to use pipes to divert some flow from the wash further to the west to the basin in order to help alleviate that problem location.

Conclusion: This alternative is not recommended for Level 2. The improvements would primarily benefit a single commercial/industrial building. There is limited potential to help address other problem locations. The benefit to cost ratio was not considered sufficient to merit further consideration in Level 2.

4.6.5 Alternative 5.4 – 44th St Basins

This alternative consists of an inline basin upstream of the industrial building susceptible to periodic flooding (44th St & Beautiful Lane) that would outlet to another basin north of the Highline Canal adjacent to a different industrial building. The basin outlet would then be connected to the existing storm drain on Baseline Rd. This alternative would address flooding issues related to flooding of the industrial building south of the Highline Canal; however, it would not address other issues in the problem area.

Conclusion: This alternative is not recommended for Level 2. The improvements would primarily benefit a single commercial/industrial building. The benefit to cost ratio was not considered sufficient to merit further consideration in Level 2.

4.6.6 Alternative 5.5 – Beverly Rd Basin

This alternative consists of an inline basin in a vacant parcel south of Beverly Rd. and upstream of a large culvert/bridge across the eastern most wash. This alternative would address flooding issues related to Beautiful Lane attributed to this wash; however, it would not address other issues in the problem area.

Conclusion: This alternative is not recommended for Level 2. The improvements would benefit only a few select commercial/industrial locations. The benefit to cost ratio was not considered sufficient to merit further consideration in Level 2.

4.6.7 Alternative 5.6 – Dams (with Outlets)

This alternative consists of dams at potentially three locations (roughly 42nd St, 46th St, and Desert Lane alignments) to detain floodwater and control its release downstream or drain to an outlet to the existing storm drain system in Baseline Rd. At least one dam

would be located within South Mountain Park. The flood pool of others would potentially also extend into the park.

Conclusion: This alternative is not recommended for Level 2. The issues related to land acquisition/ROW, maintenance, liability, certification, cost, and other issues appear to override the potential benefits of a dam alternative. One potential site location also had an issue related to the proximity of a future water distribution facility.

4.6.8 Alternative 5.7 – Large Diameter Storm Drain (40th St)

This alternative consists of new storm drain to increase the 40th St storm drain system capacity and extend the system into problems areas along Baseline Rd, 44th St and Beautiful Lane.

Conclusion: This alternative is recommended for Level 2. Consideration may be given to incorporating a small basin into the system (perhaps at 40th St and Baseline Rd) to help accommodate additional flow into the storm drain system.

4.7 Area 6: 16th St – 20th St (North of Western Canal)

4.7.1 Alternative 6.0 – No Action

This alternative would not implement any improvements to address the existing flood conditions.

Conclusion: Generally a “No Action” alternative will be a consideration for all problems areas in Level 2.

4.7.2 Alternative 6.1 – Storm Drain (Vineyard Rd) & Basins

This alternative would extend a storm drain line down Vineyard Rd with a lateral south up 18th St towards the Western Canal. The storm drain could be connected to the existing storm drain system on 16th St. or it could be extended further to the west to outlet to couple of potential retention basin sites.

Conclusion: This alternative is recommended for Level 2.

4.7.3 Alternative 6.2 – Floodwall & Diversion to Basins (20th St)

This alternative would prevent flow overtopping the Western Canal from entering into the subdivision through the cul-de-sacs adjacent to the canal. Floodwalls would be

constructed across the openings and the channel system used to divert flow to the east towards proposed basins to be located within South Mountain Community College.

Conclusion: This alternative is not recommended for Level 2. The alternative will not address the inherent drainage and flooding issues within the development. Flooding issues in the area arise prior to the arrival of the flood wave that overtops the canal.

4.7.4 Alternative 6.3 – Storm Drain (18th & 20th St) & Basins

This alternative would extend storm drain lines down both 18th St and 20th St. These storm drain lines could be connected directly to the existing storm drain in Southern Ave or they could be extended further north and outlet to potential retention basin(s) located on Bowker St.

Conclusion: This alternative is recommended for Level 2. The COP owns property north of Bowker St (Hermosa Park) that could potentially be used for retention.

4.8 Area 7: Broadway Rd. & 7th Ave-9th St (Low Laying Areas)

4.8.1 Alternative 7.0 – No Action

This alternative would not implement any improvements to address the existing flood conditions. Shallow street flooding and potentially residential flooding could occur in low laying locations.

Conclusion: Generally a “No Action” alternative will be a consideration for all problems areas in Level 2. Supplemental survey of finish floor elevations in the potential flood hazard areas would help identify the need for improvements.

4.8.2 Alternative 7.1 – Expand Existing Storm Drain System

This alternative would extend laterals down residential streets from the existing storm drain systems to improve drainage conditions and reduce potential flood hazards. The capacity of new laterals and the ability to improve flooding and drainage conditions would be limited by the capacity of the existing storm drain systems.

Conclusion: This alternative is recommended for Level 2. A more detailed review/investigation into the existing local storm drain system will better define the extent and capacity of the existing system, its effectiveness and determine what additional improvements would be beneficial.

4.8.3 Alternative 7.2 – Local Storm Drain System & Basins

This alternative consists of local storm drain systems that would outlet to local retention basins which would then drain into the existing storm drain system. These systems would not necessarily be limited by the existing storm drain capacities and consequently could have a greater potential to improve drainage conditions and reduce flood hazards than just an extension of the existing storm drain system itself (Alternative 7.1).

Conclusion: This alternative is recommended for Level 2. The location of potential retention basin sites will need to be reviewed for effectiveness and feasibility. Consideration should be given to a potential basin located in a COP park/property located in the vicinity of Broadway Rd. and 8th Ave.

4.9 Area 8: Ponding Along Western Canal

Along the length of the Western Canal there are areas of ponding behind the canal due to the elevation of the canal embankments. Much of this is due to local drainage runoff but during large flood events flow from Baseline Road and south of Baseline may contribute to flooding problems. In addition, there are some areas downstream of the canal that could be adversely impacted from flow overtopping the canal such as the area between 14th St and 16th where water could be impounded between residential block walls and the canal embankment and no accommodations have been made for drainage. Failure of these walls in such circumstances would likely result in the flooding of downstream properties

4.9.1 Alternative 8.0 – No Action

While a few existing developed properties may be impacted by the floodplain and ponding along the canal, residential structures are generally not impacted. Undeveloped properties would need to address the existing conditions as part of their development.

Conclusion: The “No Action” alternative is the only alternative recommended for Level 2. For this problem area, it was decided that impact of ponding along the canal was primarily limited to properties along the canal. Many of these properties are undeveloped and consequently should address the issue upon development as newer developments along the canal have by utilizing the area for retention. With some exceptions, most structures of older developed properties are generally located outside of the ponding limits or elevated. This could be verified by conducting supplemental surveys to determine finish floor elevations and better determine the flood hazards along the canal.

4.9.2 Alternative 8.1 – Basins Along Western Canal

This alternative would consist of acquiring properties along the canal to remove from the floodplain and/or construct retention basins to which floodwater from adjacent properties could be diverted.

Conclusion: This alternative is not recommended for Level 2. As stated in the No Action Alternative, ponding along the Western Canal was considered an issue that should be addressed upon development of the property or individually by each property as necessary.

4.9.3 Alternative 8.2 – Storm Drain Relief Basins

This alternative consists of identifying strategically placed locations throughout the study area (not just limited to problem area 8) to construct detention basins to provide relieve to the study area storm drain systems either for existing conditions or to offset new flows being contributed to the storm drain system by other project alternatives.

Conclusion: This alternative is not recommended for Level 2. However, this concept may be considered as a potential element of other alternatives (in other problem areas) if considered necessary based upon Level 2 analyses.

5. EVALUATION SUMMARY/LEVEL 2 ALTERNATIVES

5.1 General

In the Level 1 Potential Alternative Meeting, the project team discussed the merits of each alternative. In some instances, the alternatives were combined or refined as part of the discussion. Then, as a group, the project team evaluated each alternative to come to a consensus on which alternatives should be further investigated in Level 2.

The Evaluation Matrix tables for alternatives are provided in Appendix B. Exhibits for alternatives are provided in Appendix C.

5.2 Area 1: 7th St – 16th St (Circle K Park)

Four alternatives will be considered in Level 2:

- Alternative 1.0 – No Action
- Alternative 1.1 – Multiple Basins and Channels
- Alternative 1.3 – TCC Golf Course Retention Basin
- Alternative 1.4 – Local Storm Drain (16th St) & Basins

Alternatives 1.3, 1.6, and 1.9 may in part be incorporated into other accepted alternatives, however, by themselves will not be considered an alternative for Level 2.

Table 5-1: Evaluation Summary of Area 1 Alternatives

Level 1 Alternative		Consider in Level 2?	Comments
ID	Description		
1.0	No Action	Yes	
1.1	Multiple Basins & Channels	Yes	
1.2	TCCGC Retention Basin	Yes	
1.3	TCCGC Development Stipulations	No	However, consider as a potential component of other Level 2 alternatives
1.4	Local Storm Drain (16 th St) & Basins	Yes	To include components of Alternative 1.9
1.5	Dobson Creek Basin Modifications	No	
1.6	Floodwalls	No	However, consider as a potential component of other Level 2 alternatives
1.7	Use Roads for Conveyance	No	
1.8	Dam (with Outlet)	No	
1.9	Large Diameter Storm Drain (16 th St)	No	To combine with Alternative 1.4.

5.3 Area 2: 16th St – 20th St (Siesta Foothills/Boy Scout Camp)

Two alternatives will be considered in Level 2:

- Alternative 2.0 – No Action
- Alternative 2.1 – Multiple Basins and Channels

Alternatives 2.1 may include components of other alternatives including Alternatives 2.1, 2.4, 3.1, 3.2 and 3.3.

Table 5-2: Evaluation Summary of Area 2 Alternatives

Level 1 Alternative		Consider in Level 2?	Comments
ID	Description		
2.0	No Action	Yes	
2.1	Storm Drain (16 th & 20 th St.) & Basins	Yes	Include components from multiple other alternatives (2.1, 2.4, 3.1, 3.2 and 3.3).
2.2	Use Roads for Conveyance	No	Roads are generally not to be used as a primary conveyance of floodwater.
2.3	Dams (with Outlets)	No	
2.4	Large Diameter Storm Drain (16 th St)	No	To combine with Alternative 2.1.

5.4 Area 3: 20th St – 24th St (Pines at South Mountain)

Three alternatives will be considered in Level 2:

- Alternative 3.0 – No Action
- Alternative 3.5 – Multiple Basins and Channels
- Alternative 3.8 – Large Diameter Storm Drain (24th St)

Alternatives 3.1, 3.3, and 3.4 may in part be incorporated into other accepted alternatives, however, by themselves will not be considered an alternative for Level 2.

Table 5-3: Evaluation Summary of Area 3 Alternatives

Level 1 Alternative		Consider in Level 2?	Comments
ID	Description		
3.0	No Action	Yes	
3.1	Local Storm Drain (20 th St.) & Basins	No	To combine with Alternative 2.1.
3.2	Channelize Flow to Basins (20 th Pl)	No	
3.3	Channelize Flow & Use Roads (20 th Pl)	No	To combine with Alternative 2.1.
3.4	Highline Canal Storm Drain	No	To combine with Alternative 2.1.
3.5	Multiple Basins & Channels	Yes	
3.6	Use Roads for Conveyance	No	
3.7	Dams (with Outlets)	No	
3.8	Large Diameter Storm Drain (24 th St)	Yes	

5.5 Area 4: 24th St – 36th St (Cortland Point)

Three alternatives will be considered in Level 2:

- Alternative 4.0 – No Action
- Alternative 4.1 – Multiple Basins and Channels (S. Mtn. Ave)
- Alternative 4.5 – Cortland Point Basins/Channels

Table 5-4: Evaluation Summary of Area 4 Alternatives

Level 1 Alternative		Consider in Level 2?	Comments
ID	Description		
4.0	No Action	Yes	
4.1	Multiple Basins & Storm Drain (S Mtn Ave)	Yes	No basins to be proposed in elementary school area. Utilize basin along S Mtn Ave. to convey flow east.
4.2	Local Storm Drain & Basin (32 nd St)	No	
4.3	Highline Storm Drain & Basin (32 nd /36 th St)	No	
4.4	Floodwalls	No	
4.5	Cortland Point Basins/Channels	Yes	Revised to favor channels along south side of canal as opposed to basins.
4.6	Dams(with Outlets)	No	

5.6 Area 5: 36th St – 48th St (Industrial Area)

Two alternatives will be considered in Level 2:

- Alternative 5.0 – No Action
- Alternative 5.7 – Large Diameter Storm Drain (40th St)

Table 5-5: Evaluation Summary of Area 5 Alternatives

Level 1 Alternative		Consider in Level 2?	Comments
ID	Description		
5.0	No Action	Yes	
5.1	Highline Basin	No	
5.2	Baseline Rd Basins	No	
5.3	Divert Flow to 42 nd Pl/Baseline Rd Basin	No	
5.4	44 th St Basins	No	
5.5	Beverly Rd Basin	No	
5.6	Dams (with Outlets)	No	
5.7	Large Diameter Storm Drain (40 th St)	Yes	Potentially could consider a small basin to attenuate flows to storm drain.

5.7 Area 6: 16th St – 20th St (North of Western Canal)

Three alternatives will be considered in Level 2:

- Alternative 6.0 – No Action
- Alternative 6.1 – Storm Drain (Vineyard Rd) & Basins
- Alternative 6.3 – Storm Drain (18th & 20th St) & Basins

Table 5-6: Evaluation Summary of Area 6 Alternatives

Level 1 Alternative		Consider in Level 2?	Comments
ID	Description		
6.0	No Action	Yes	
6.1	Storm Drain (Vineyard Rd) & Basins	Yes	Survey of home finish floor elevations in flood hazard areas would better define extent and magnitude of flood hazards.
6.2	Floodwall & Diversion to Basins (20 th St)	No	
6.3	Storm Drain (18 th & 20 th St) & Basins	Yes	Survey of home finish floor elevations in flood hazard areas would better define extent and magnitude of flood hazards.

5.8 Area 7: Broadway Rd. & 7th Ave-9th St (Low Laying Areas)

Three alternatives will be considered in Level 2:

- Alternative 7.0 – No Action
- Alternative 7.1 – Expand Existing Storm Drain System
- Alternative 7.2 – Local Storm Drain System & Basins

Table 5-7: Evaluation Summary of Area 7 Alternatives

Level 1 Alternative		Consider in Level 2?	Comments
ID	Description		
7.0	No Action	Yes	
7.1	Expand Existing Storm Drain System	Yes	
7.2	Local Storm Drain System & Basins	Yes	

5.9 Area 8: Ponding Along Western Canal

No flood mitigation alternatives will be considered for Level 2 in Area 8. It was decided that flooding along the Western Canal. Many of these properties are undeveloped and consequently should address flooding issues upon development as newer developments along the canal have by utilizing the area for retention. With some exceptions, most structures of older developed properties are generally located outside of the ponding limits or elevated.

Table 5-8: Evaluation Summary of Area 8 Alternatives

Level 1 Alternative		Consider in Level 2?	Comments
ID	Description		
8.0	No Action	Yes	
8.1	Basins Along Western Canal	No	Issues should be addressed with future development of properties
8.2	Storm Drain Relief Basins	No	Could be a component of other problem area alternatives in Level 2.

6. REFERENCES

Stanley Consultants, *Hohokam Area Drainage Master Study (Phase I) Data Collection Report*, December 2011.

Stanley Consultants, *Hohokam Area Drainage Master Study (Phase I) Hydrology & Hydraulics Report*, February 2012.

Stanley Consultants, *Hohokam Area Drainage Master Study (Phase I) (Draft)*, December 2010.



APPENDIX A

**Level 1 Potential Alternatives
Exhibits**

Legend

 Problem Area 1

Ex. Storm Drain (in)

 18 - 24

 25 - 36

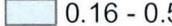
 37 - 48

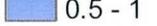
 49 - 60

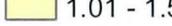
 61 - 72

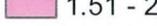
 73 - 96

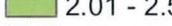
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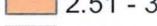
 0.16 - 0.5

 0.5 - 1

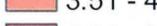
 1.01 - 1.5

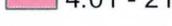
 1.51 - 2

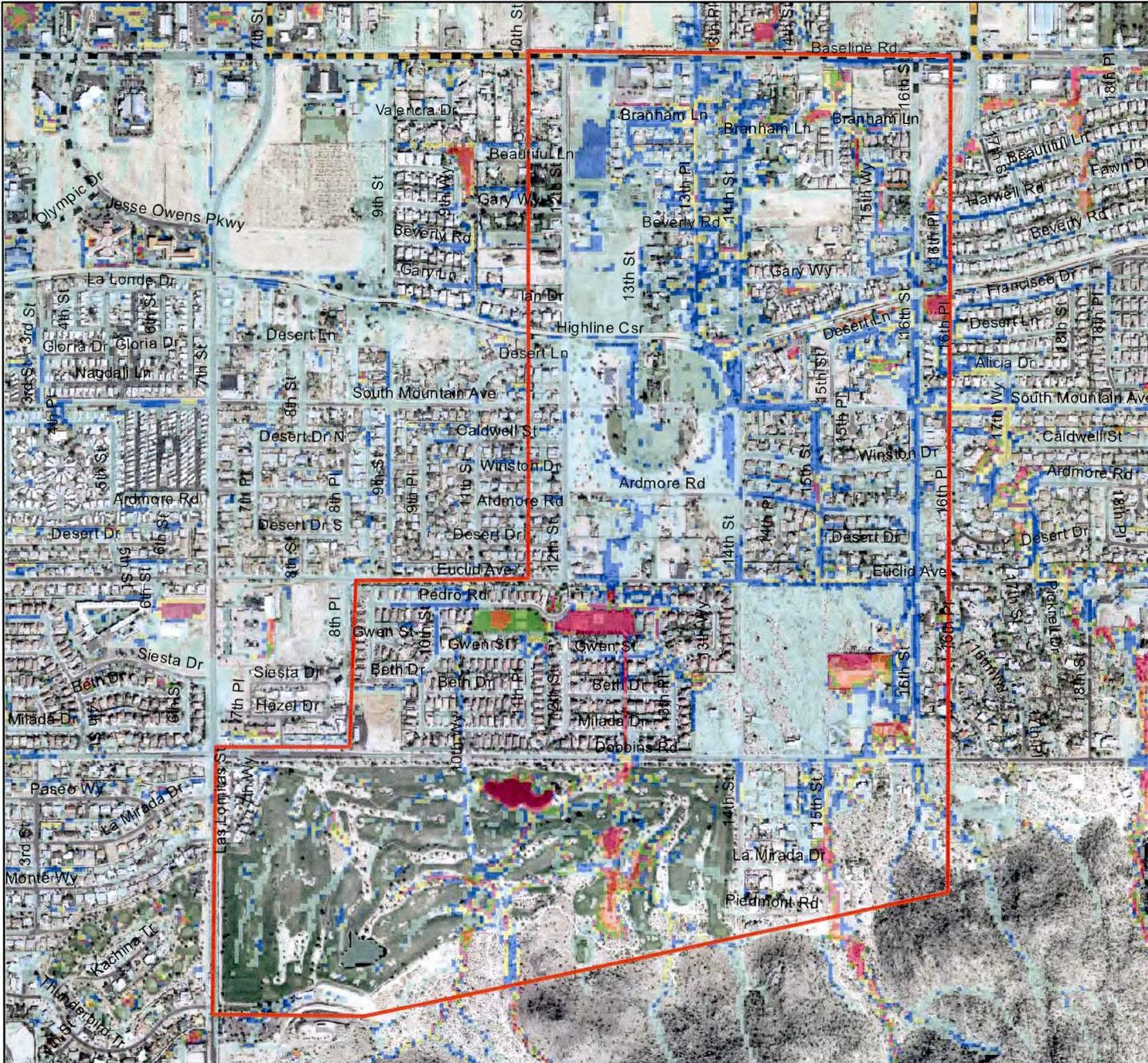
 2.01 - 2.5

 2.51 - 3

 3.01 - 3.5

 3.51 - 4

 4.01 - 21



**Level 1 Alternative
Formulation Meeting
Alt 1.0 (No Action)
F100Y6H Results**

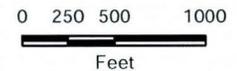
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

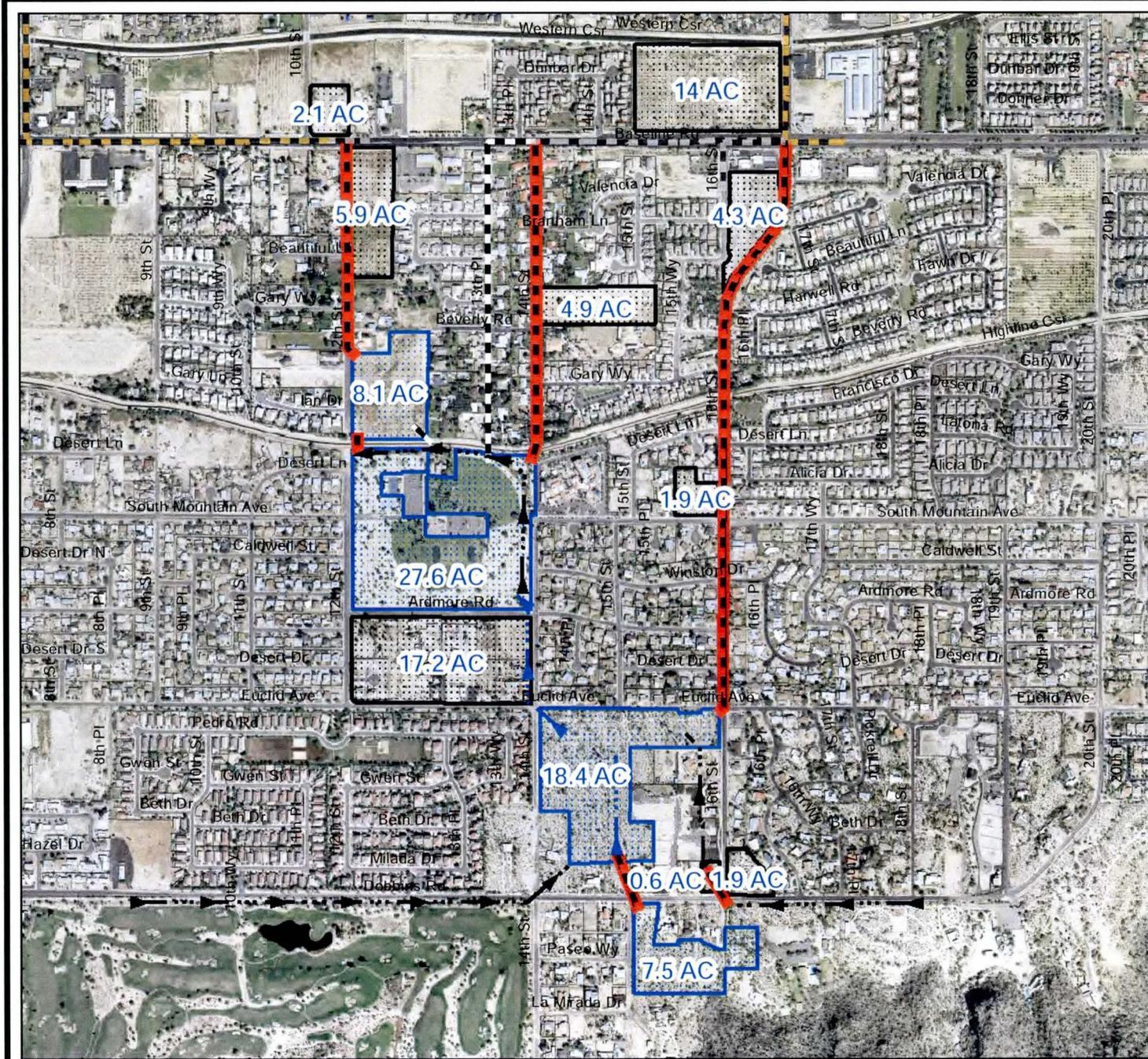
Alternative 1.1

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 1.1



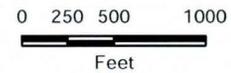
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

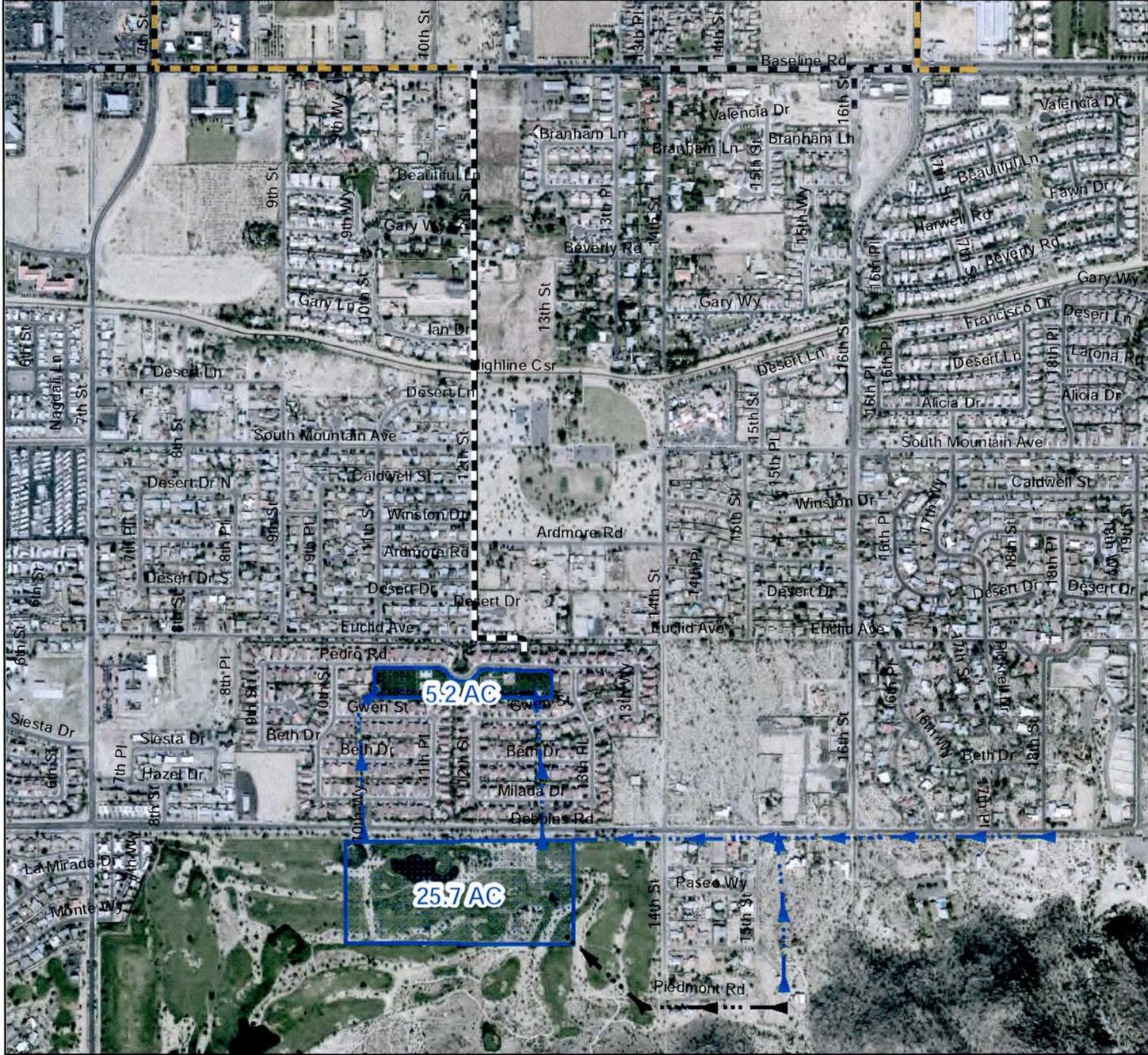
Alternative 1.2

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 1.2



Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 1.3

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative Formulation Meeting

Alternative 1.3



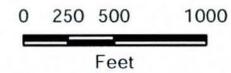
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

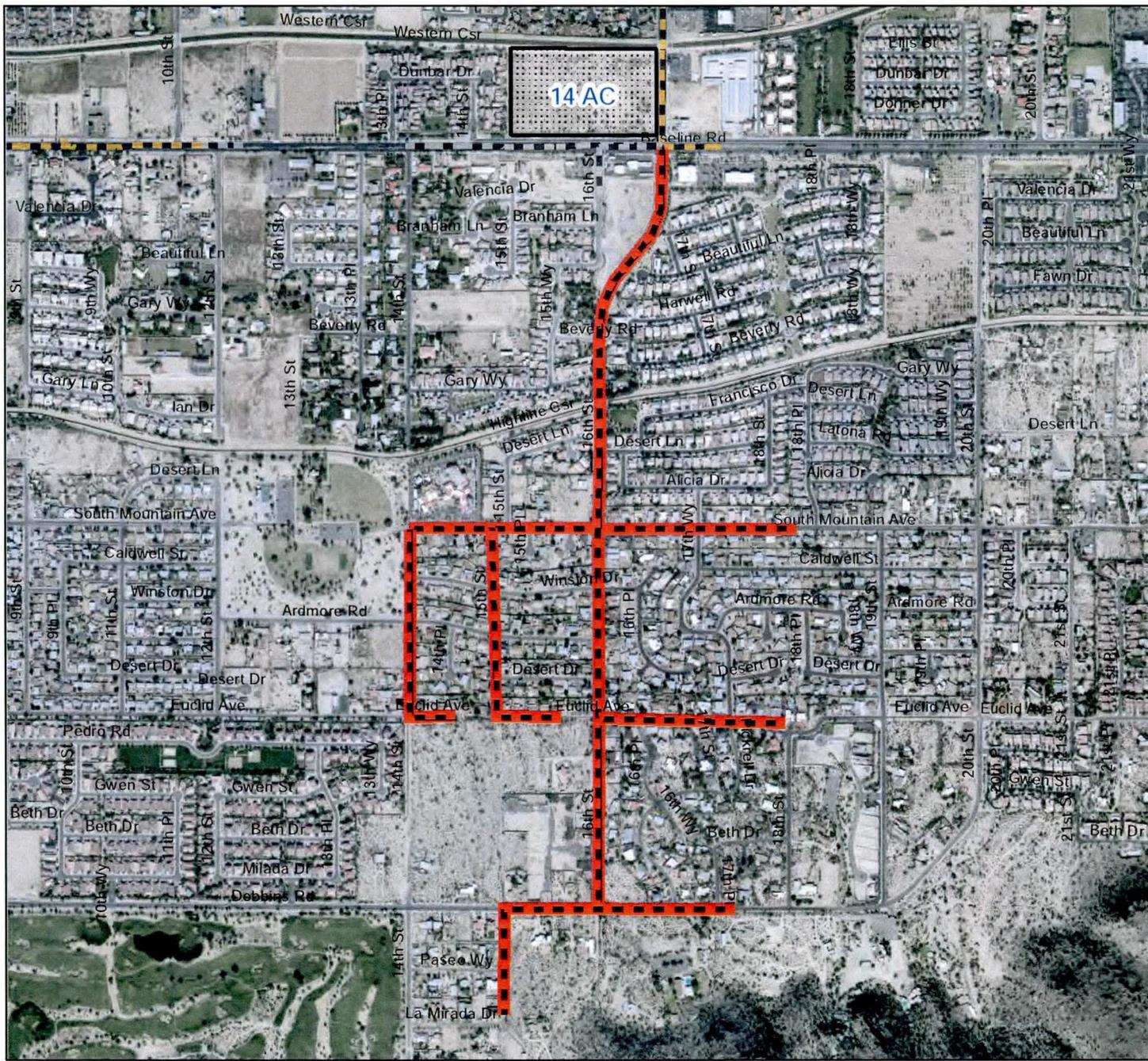
Alternative 1.4

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 1.4



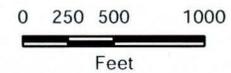
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 1.5

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



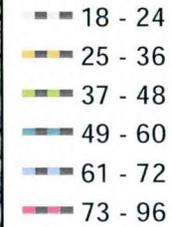
Level 1 Alternative Formulation Meeting

Alternative 1.5

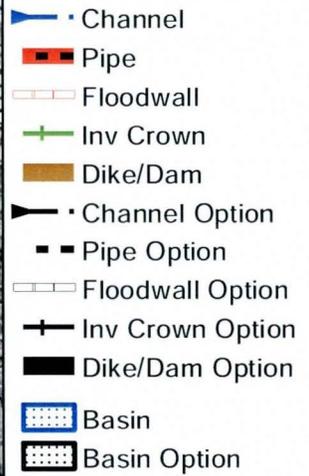


Legend

Ex. Storm Drain (in)

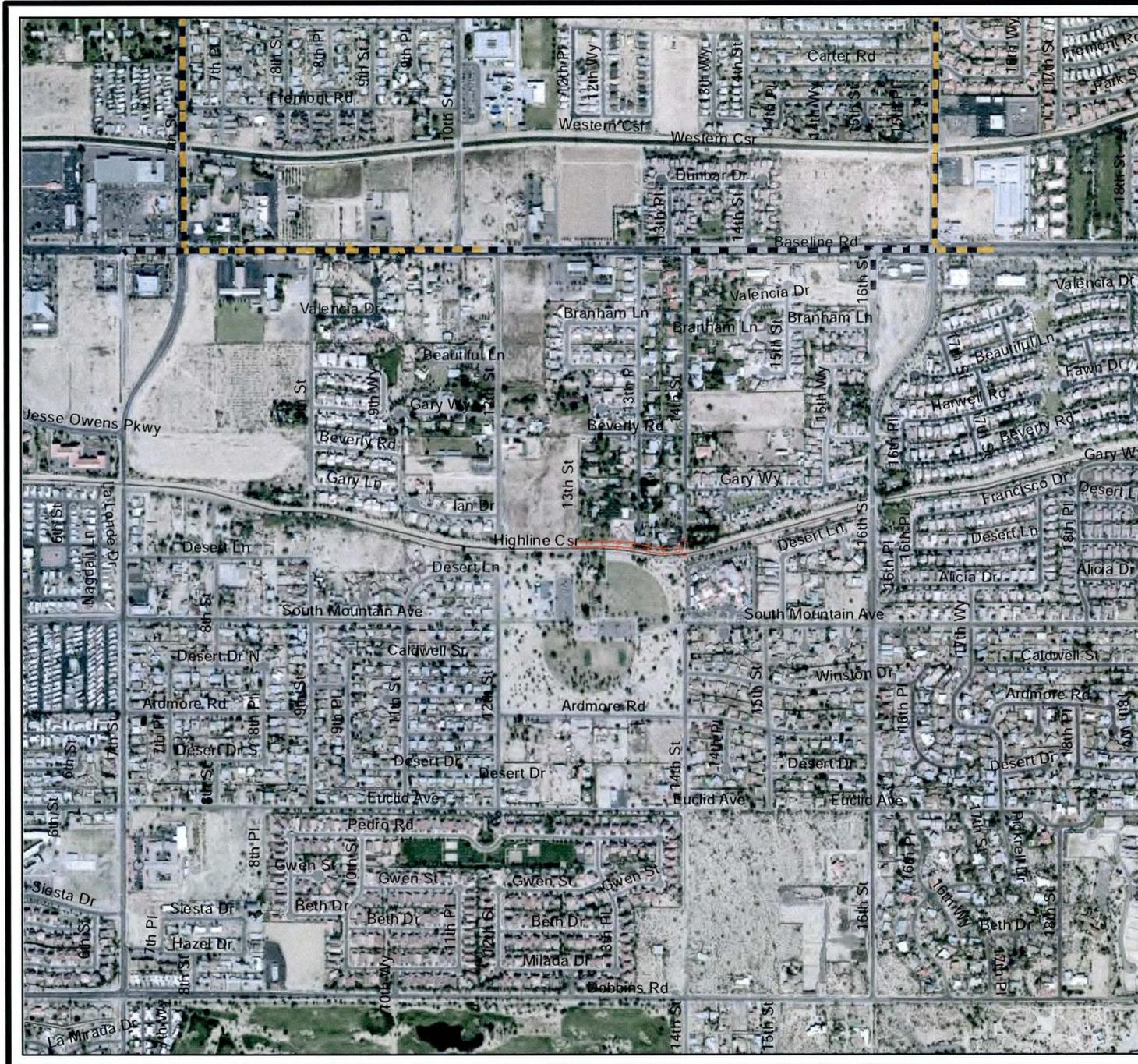


Alternative 1.6



Level 1 Alternative
Formulation Meeting

Alternative 1.6



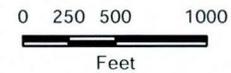
Legend

Ex. Storm Drain (in)

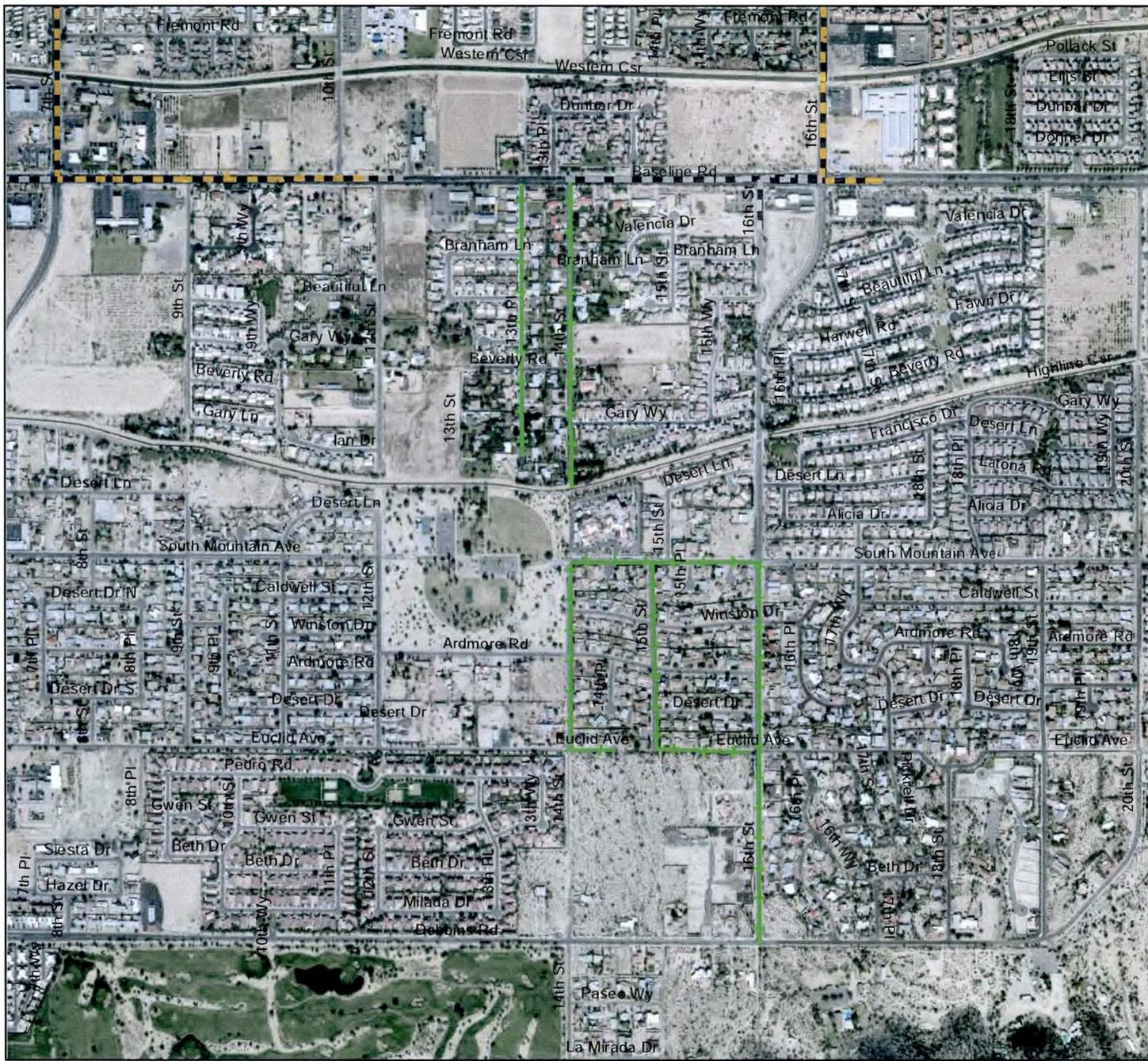
- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 1.7

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative Formulation Meeting
Alternative 1.7



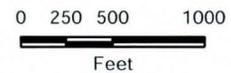
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

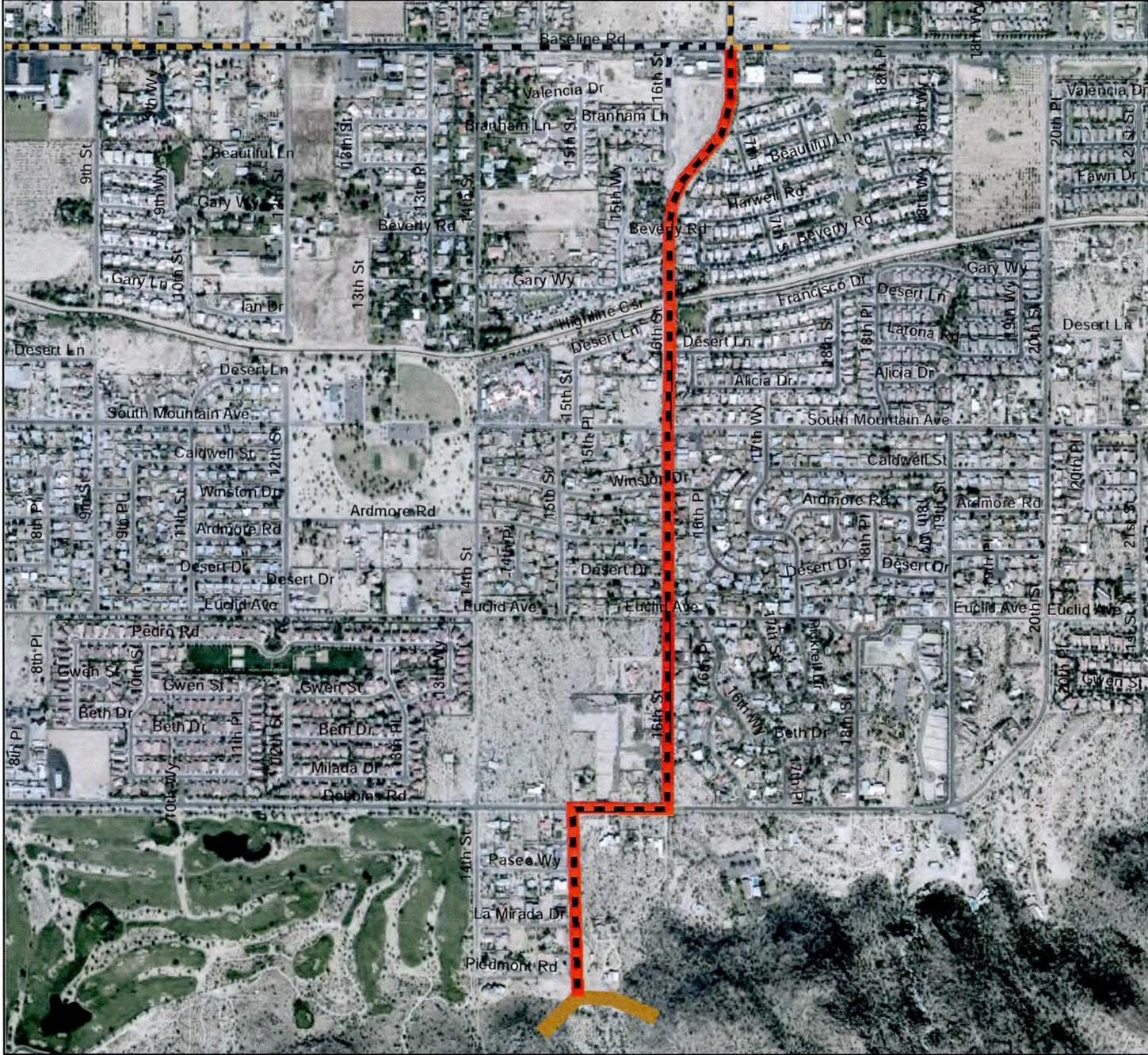
Alternative 1.8

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative Formulation Meeting

Alternative 1.8



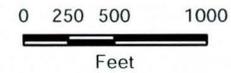
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 1.9

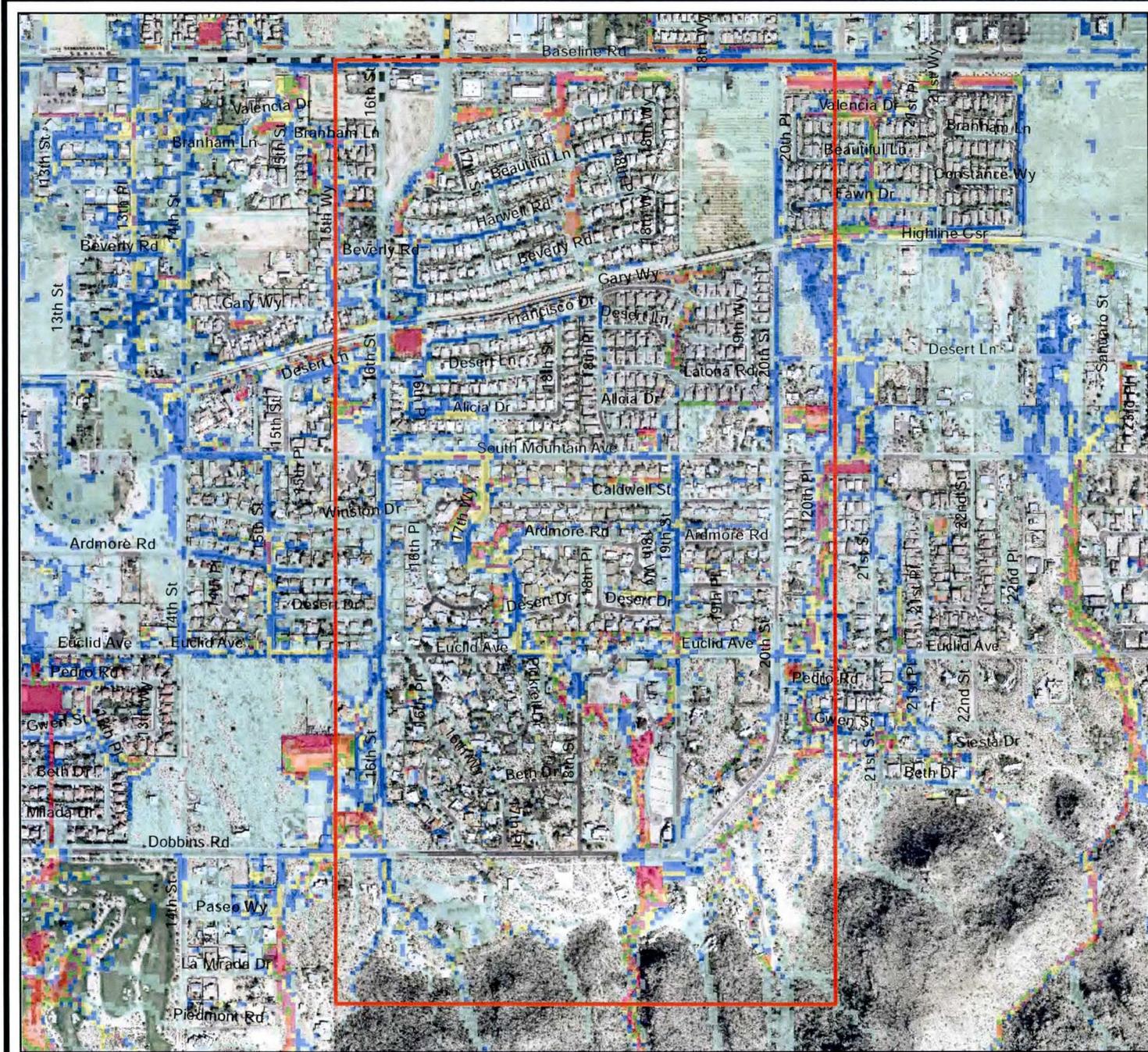
- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 1.9





Legend

Problem Area 2

Ex. Storm Drain (in)

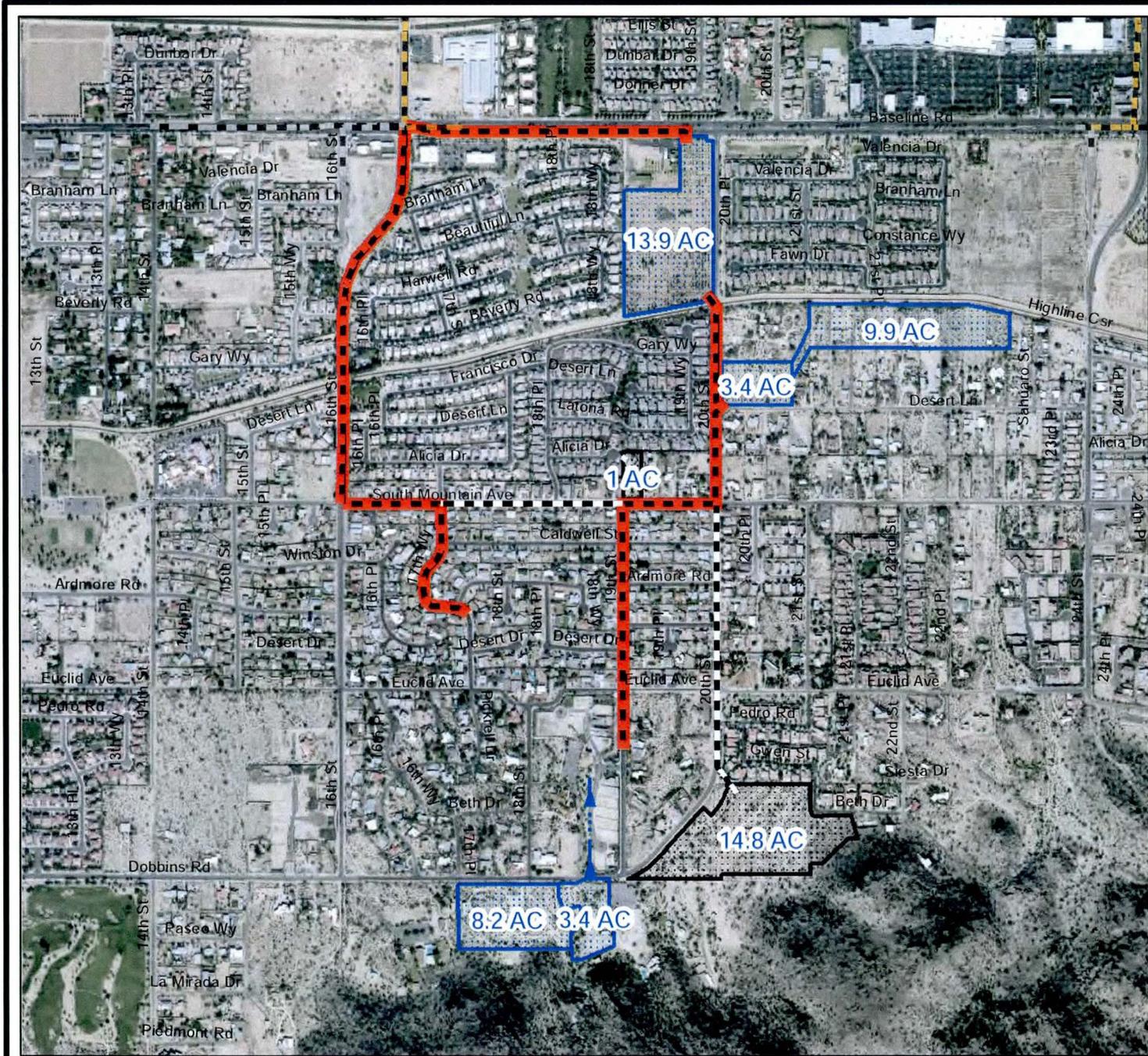
- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Depth Max (ft)

- 0.16 - 0.5
- 0.5 - 1
- 1.01 - 1.5
- 1.51 - 2
- 2.01 - 2.5
- 2.51 - 3
- 3.01 - 3.5
- 3.51 - 4
- 4.01 - 21



Level 1 Alternative
 Formulation Meeting
 Alt 2.0 (No Action)
 F100Y6H Results



Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 2.1

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 2.1



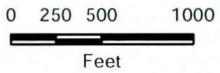
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 2.2

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 2.2

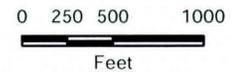
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

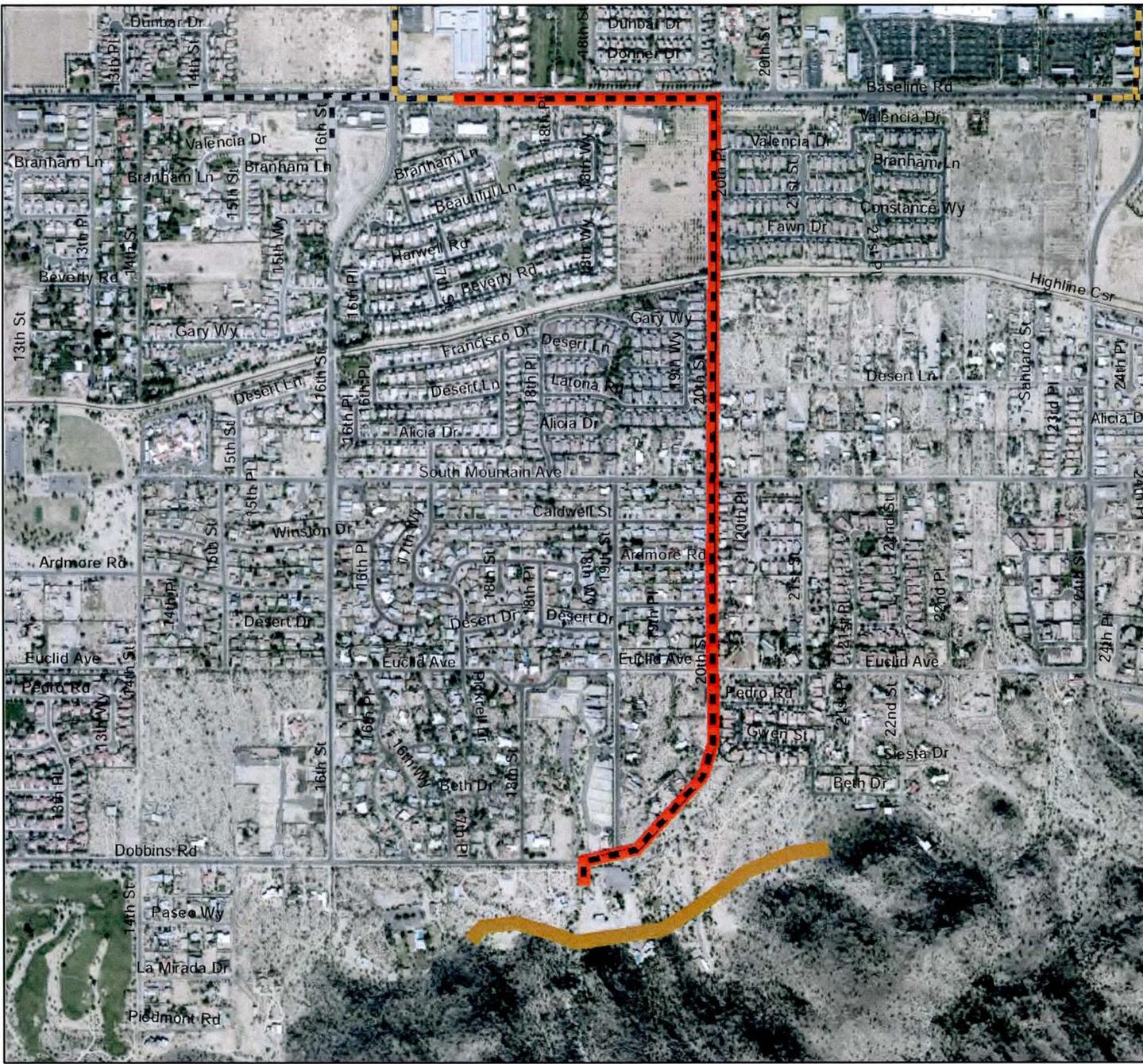
Alternative 2.3

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 2.3



Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

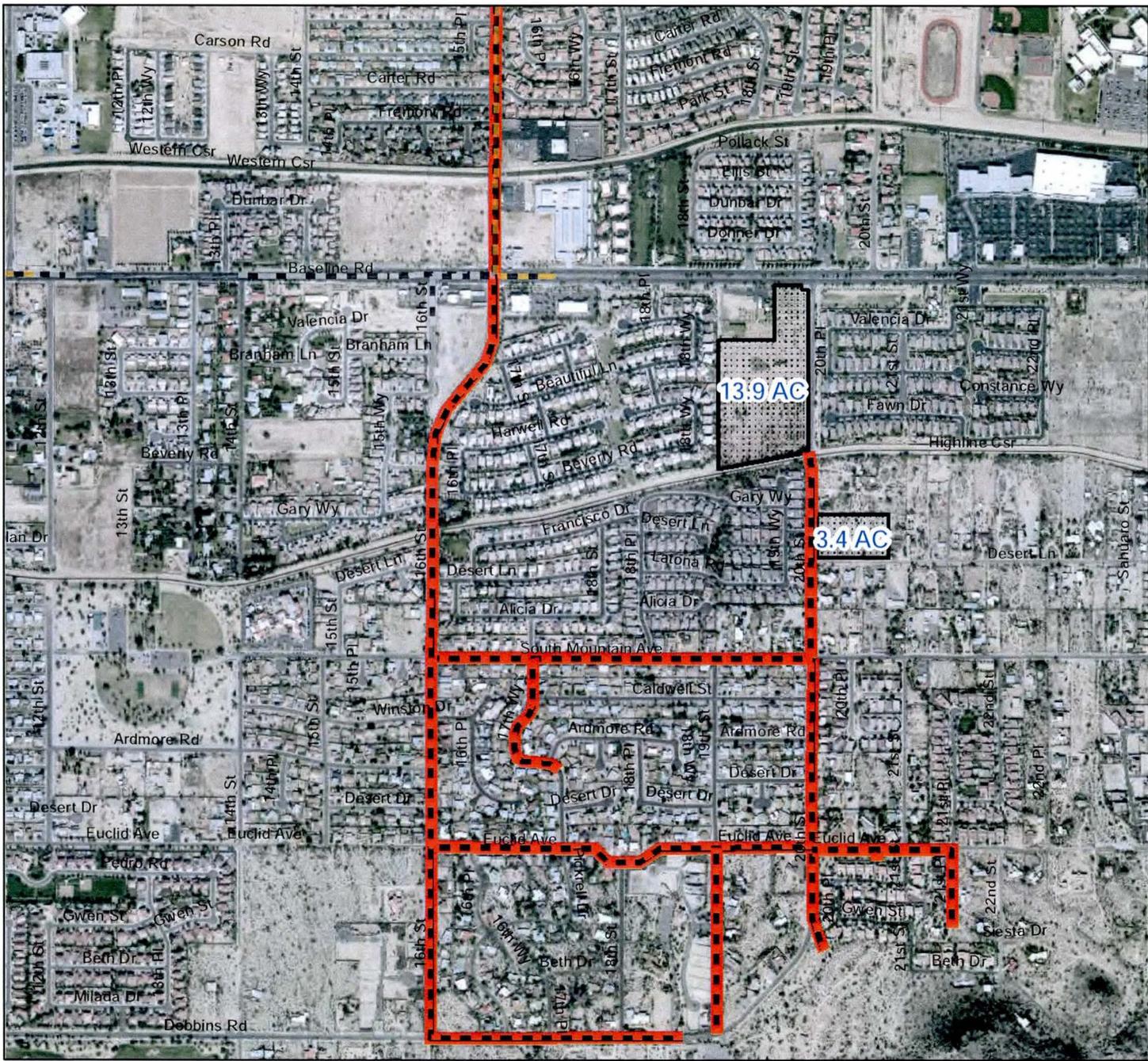
Alternative 2.4

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 2.4



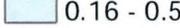
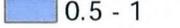
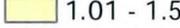
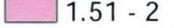
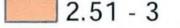
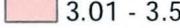
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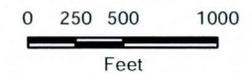
 Problem Area 3

Ex. Storm Drain (in)

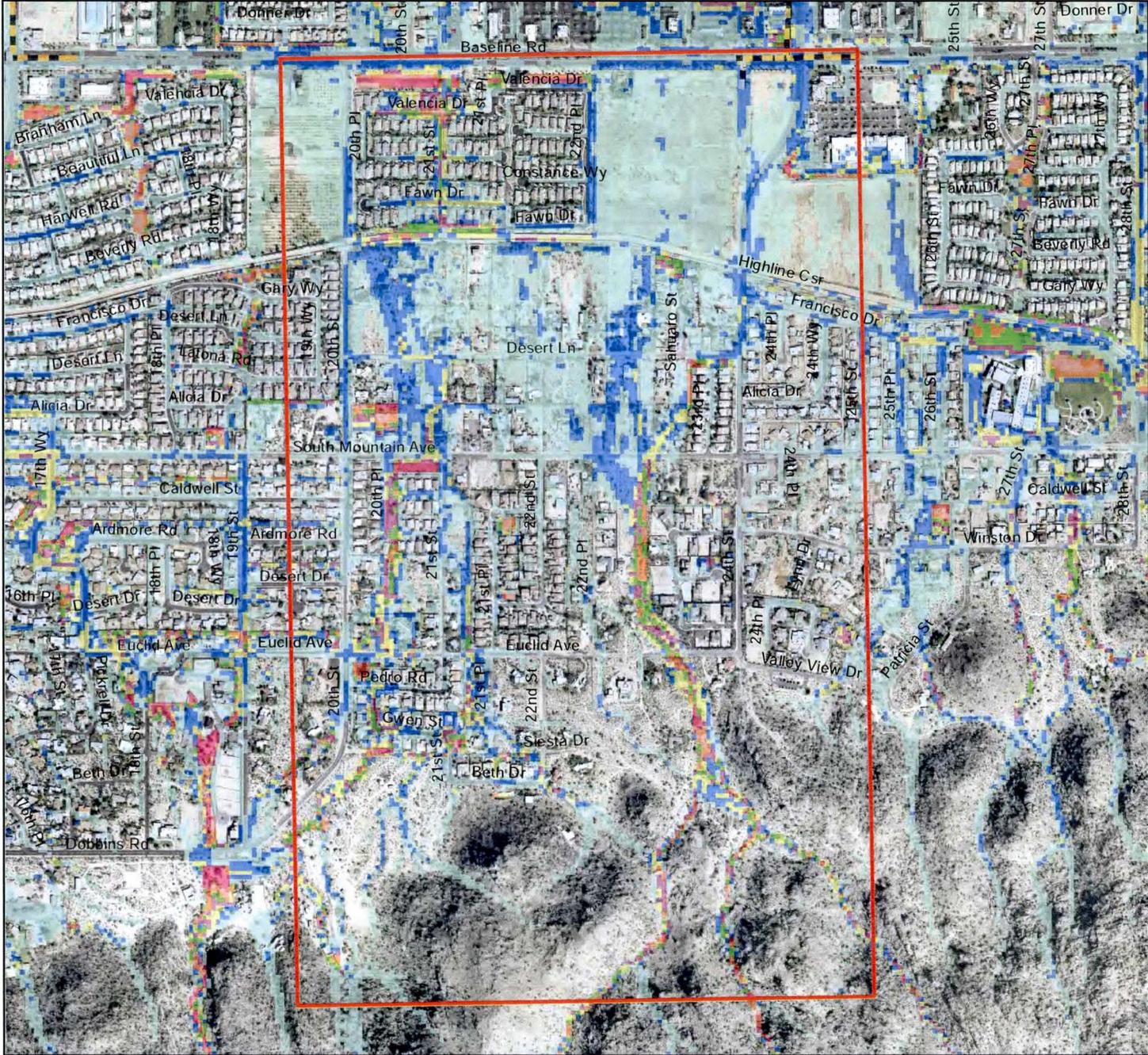
-  18 - 24
-  25 - 36
-  37 - 48
-  49 - 60
-  61 - 72
-  73 - 96

Depth Max (ft)

-  0.16 - 0.5
-  0.5 - 1
-  1.01 - 1.5
-  1.51 - 2
-  2.01 - 2.5
-  2.51 - 3
-  3.01 - 3.5
-  3.51 - 4
-  4.01 - 21



Level 1 Alternative
Formulation Meeting
Alt 3.0 (No Action)
F100Y6H Results



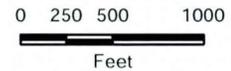
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

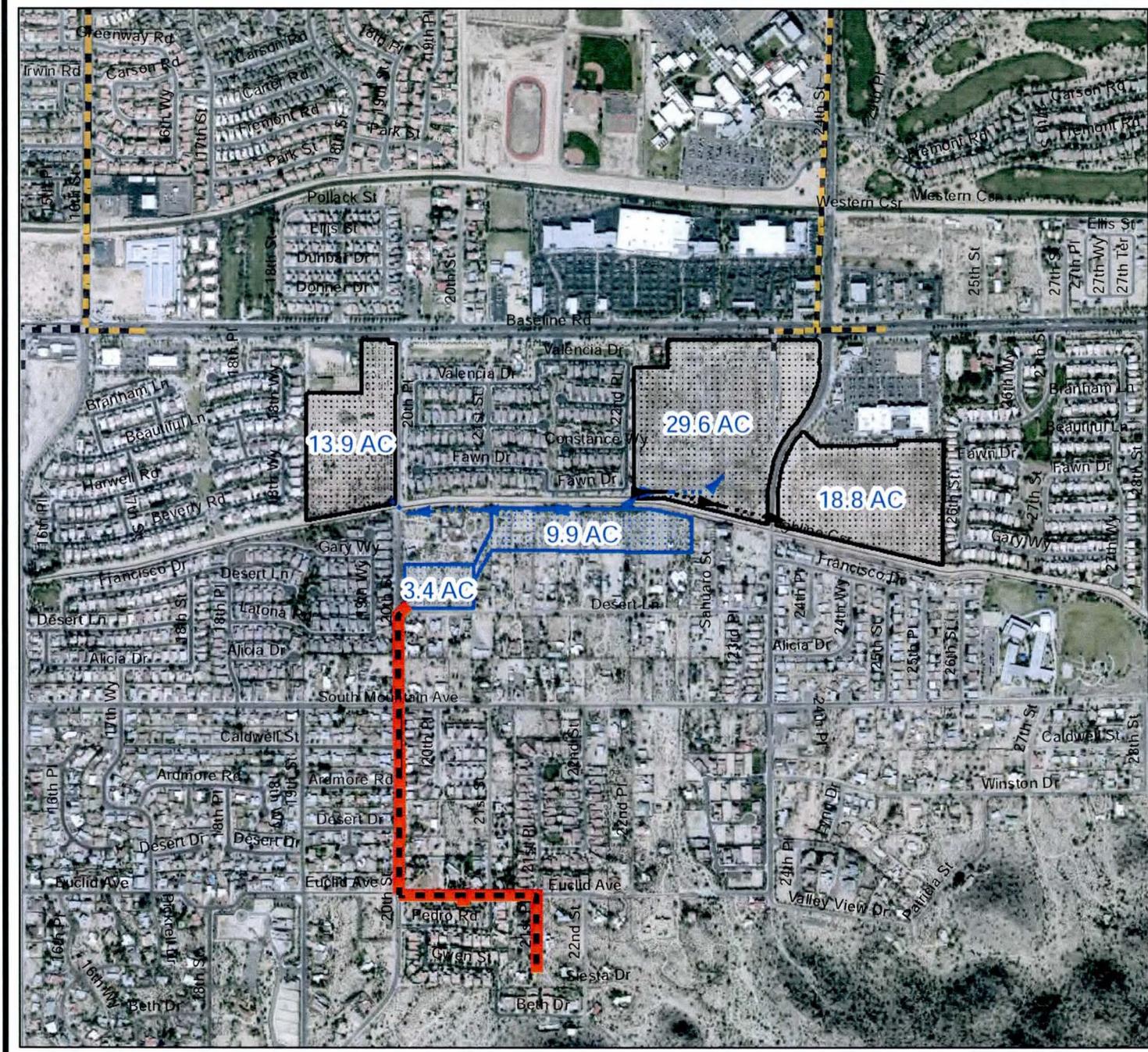
Alternative 3.1

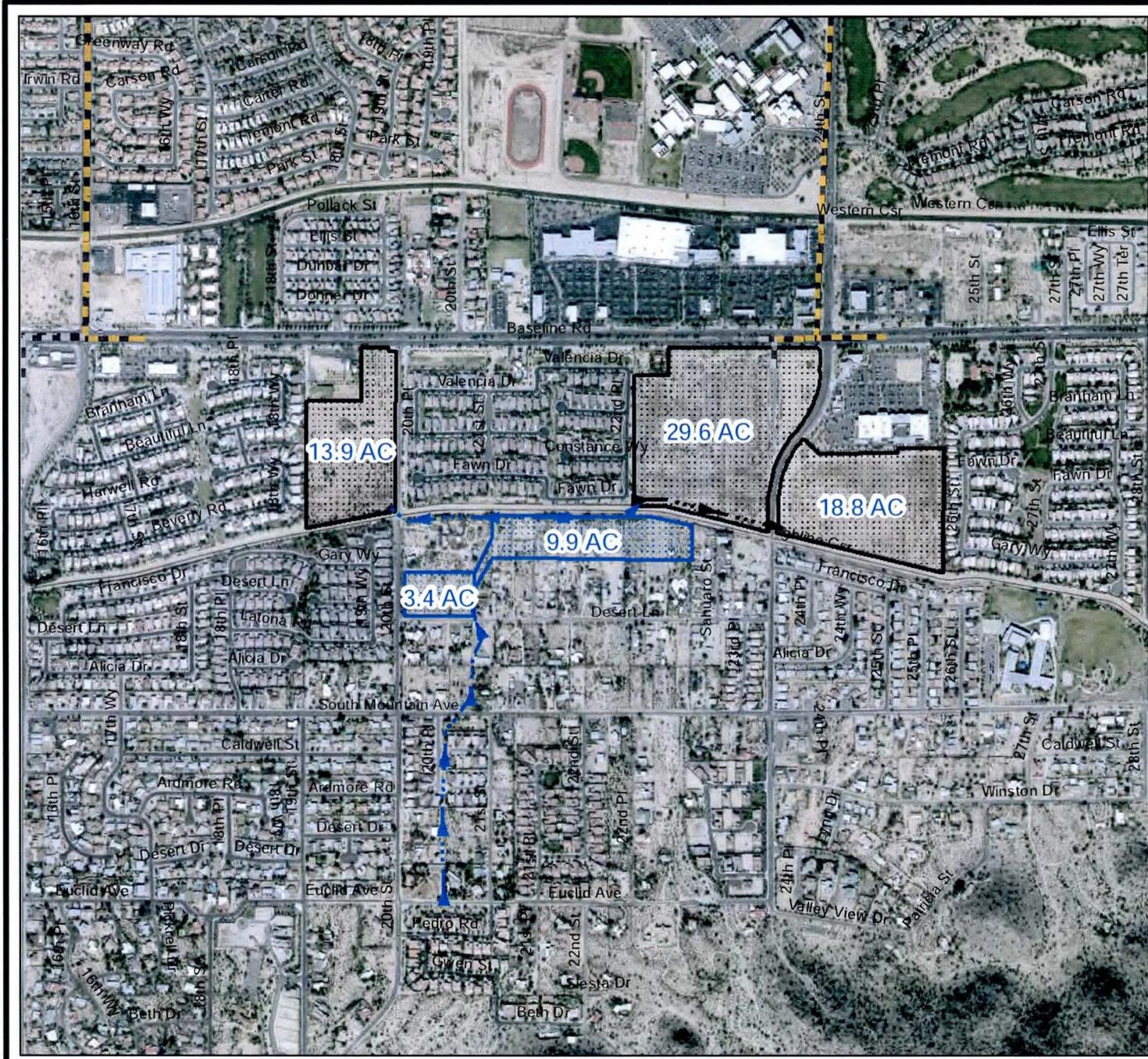
- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative Formulation Meeting

Alternative 3.1





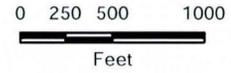
Legend

Ex. Storm Drain (in)

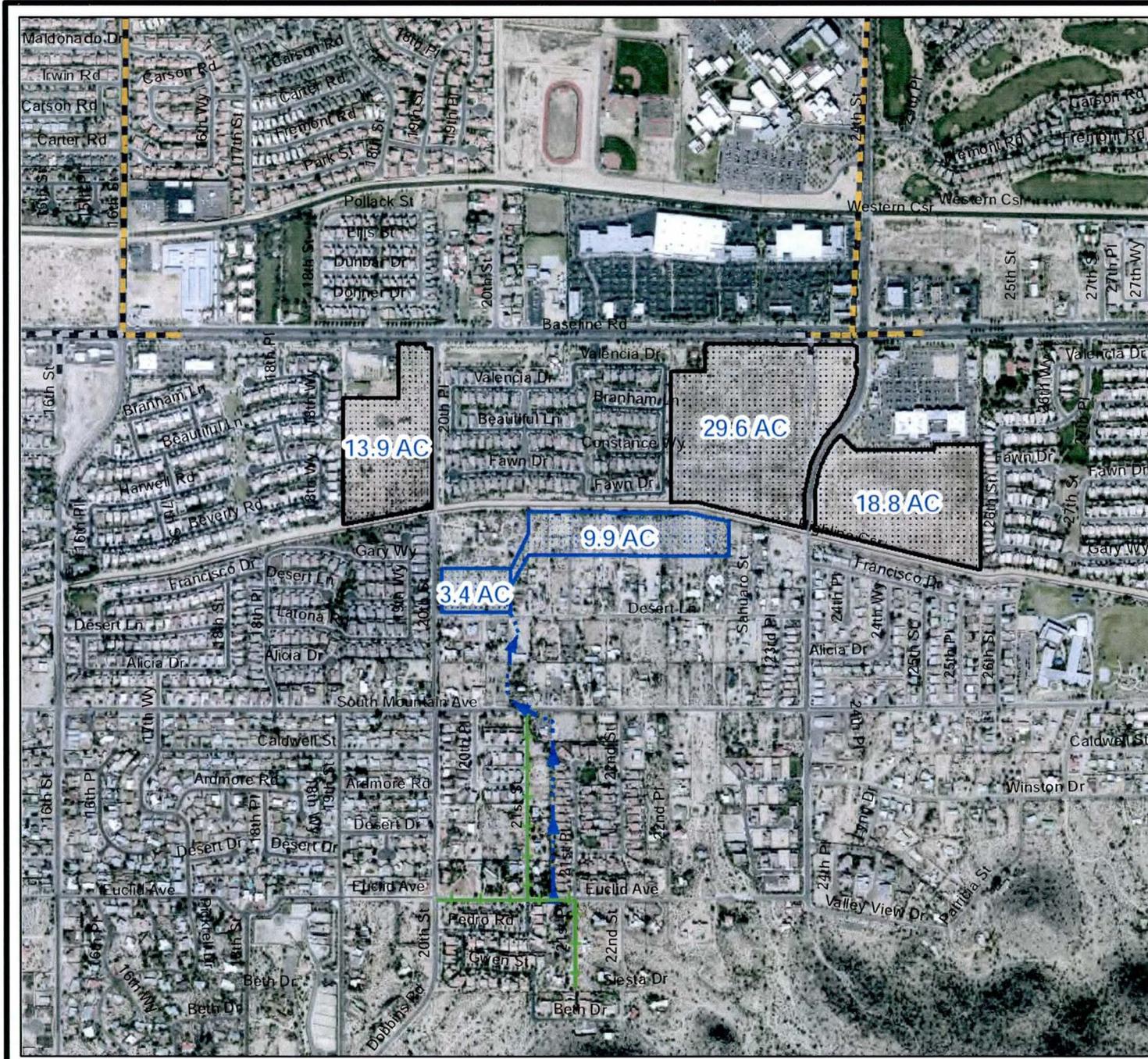
- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 3.2

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative Formulation Meeting
Alternative 3.2



Legend

- Ex. Storm Drain (in)
- 18 - 24
 - 25 - 36
 - 37 - 48
 - 49 - 60
 - 61 - 72
 - 73 - 96

- Alternative 3.3
- Channel
 - Pipe
 - Floodwall
 - Inv Crown
 - Dike/Dam
 - Channel Option
 - Pipe Option
 - Floodwall Option
 - Inv Crown Option
 - Dike/Dam Option
 - Basin
 - Basin Option



Level 1 Alternative Formulation Meeting
Alternative 3.3



Legend

- Ex. Storm Drain (in)
- 18 - 24
 - 25 - 36
 - 37 - 48
 - 49 - 60
 - 61 - 72
 - 73 - 96

- Alternative 3.4
- Channel
 - Pipe
 - Floodwall
 - Inv Crown
 - Dike/Dam
 - Channel Option
 - Pipe Option
 - Floodwall Option
 - Inv Crown Option
 - Dike/Dam Option
 - Basin
 - Basin Option



Level 1 Alternative Formulation Meeting
Alternative 3.4

Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

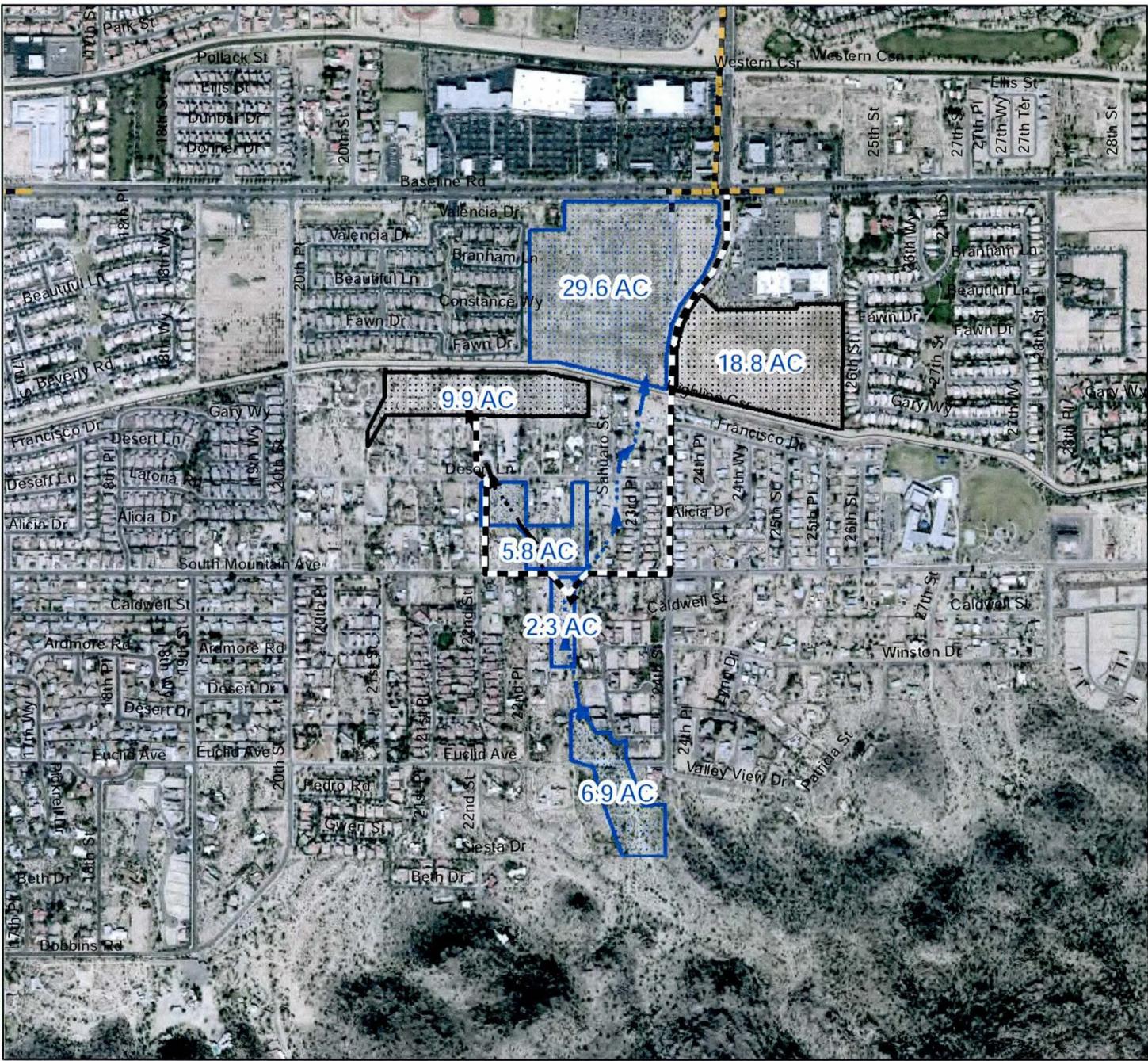
Alternative 3.5

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative Formulation Meeting

Alternative 3.5



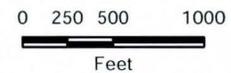
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

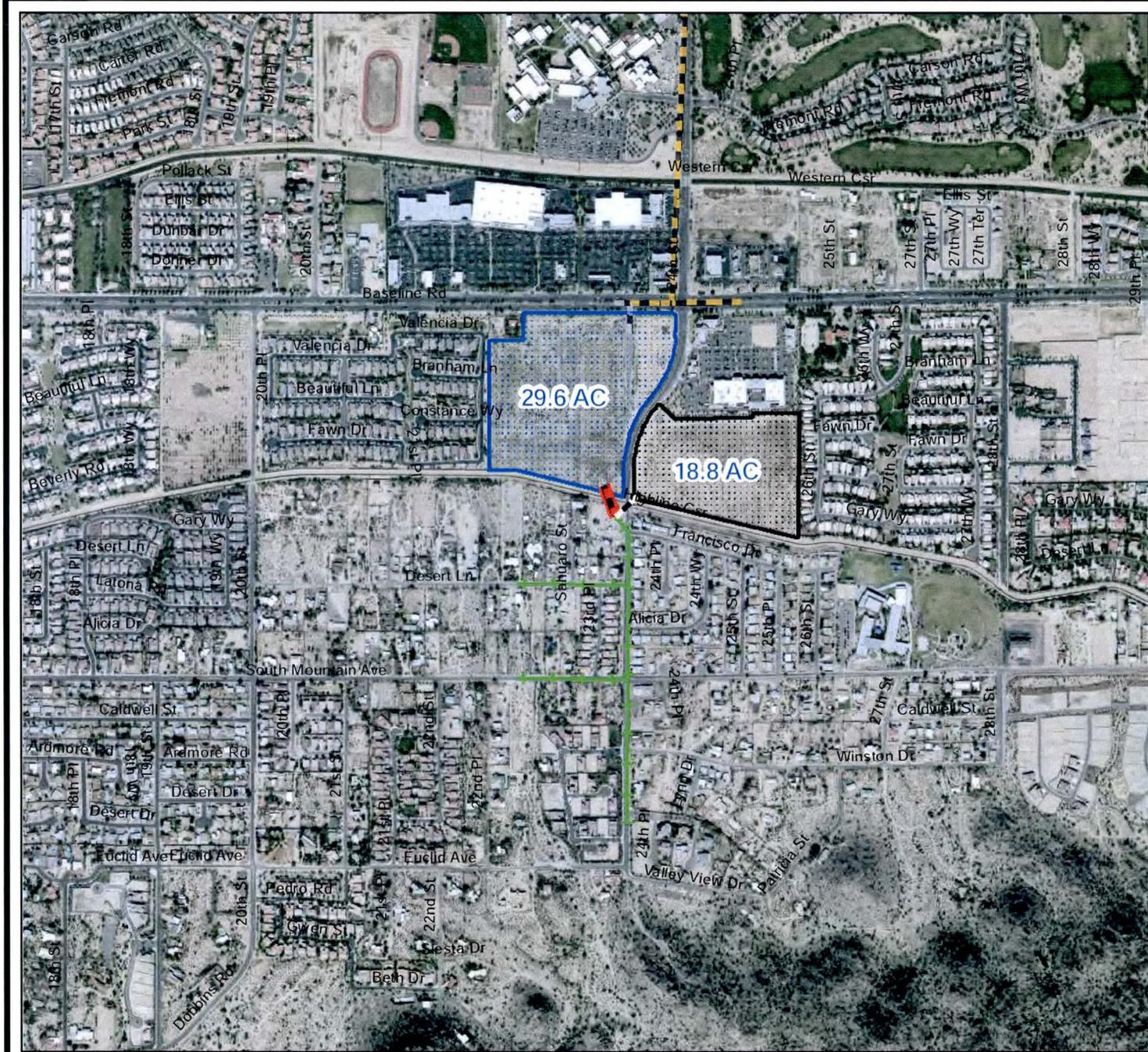
Alternative 3.6

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 3.6



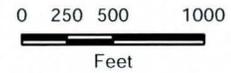
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 3.7

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 3.7



Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 3.8

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 3.8



Legend

 Problem Area 4

Ex. Storm Drain (in)

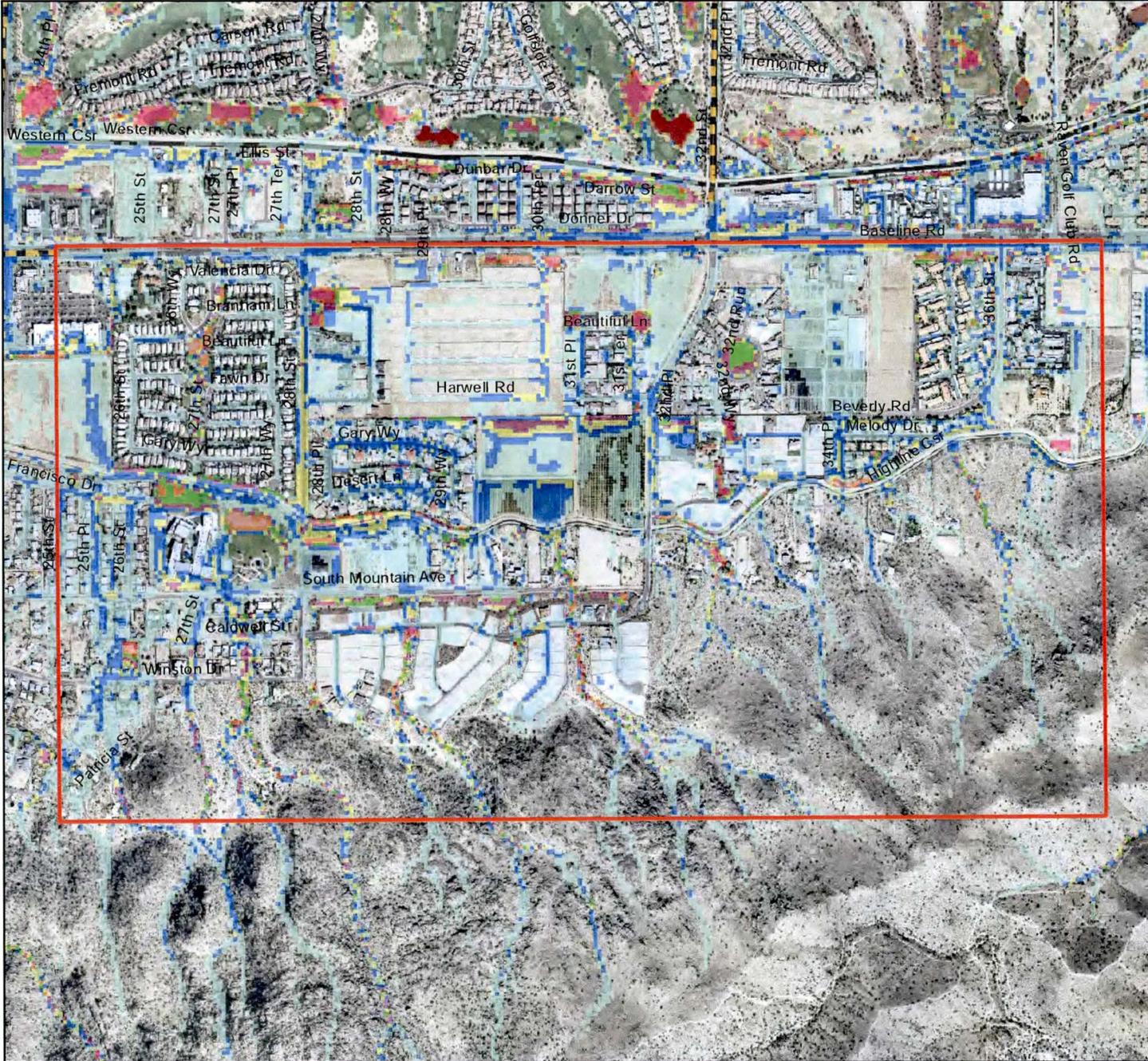
-  18 - 24
-  25 - 36
-  37 - 48
-  49 - 60
-  61 - 72
-  73 - 96

Depth Max (ft)

-  0.16 - 0.5
-  0.5 - 1
-  1.01 - 1.5
-  1.51 - 2
-  2.01 - 2.5
-  2.51 - 3
-  3.01 - 3.5
-  3.51 - 4
-  4.01 - 21



Level 1 Alternative
Formulation Meeting
Alt 4.0 (No Action)
F100Y6H Results



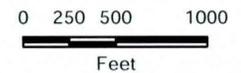
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

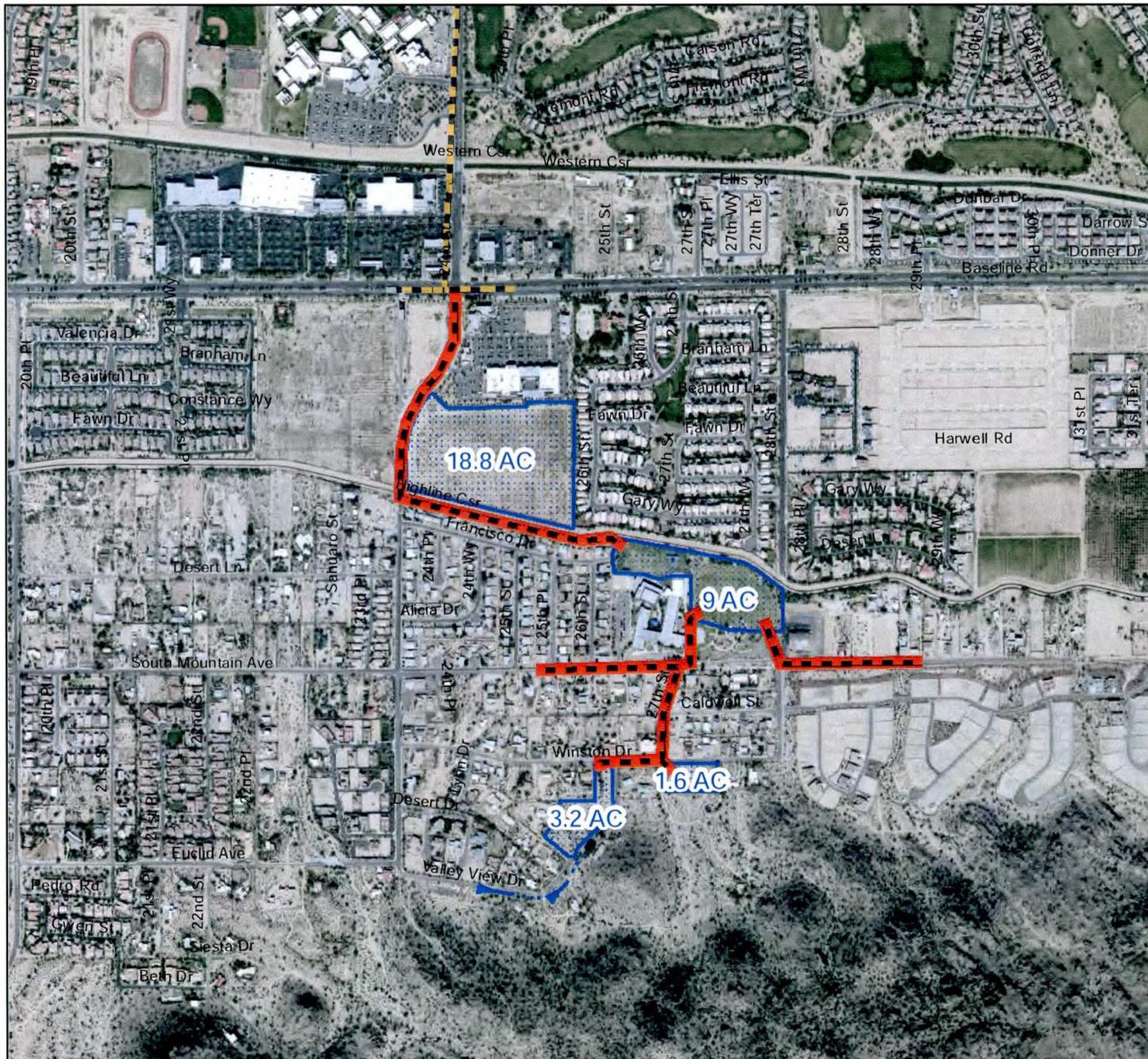
Alternative 4.1

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 4.1



Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Channel

Pipe

Floodwall

Inv Crown

Dike/Dam

Channel Option

Pipe Option

Floodwall Option

Inv Crown Option

Dike/Dam Option

Alternative 4.2-Basins

Basin

Basin Option



0 250 500 1000

Feet

Level 1 Alternative
Formulation Meeting

Alternative 4.2



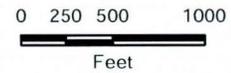
Legend

Ex. Storm Drain (in)

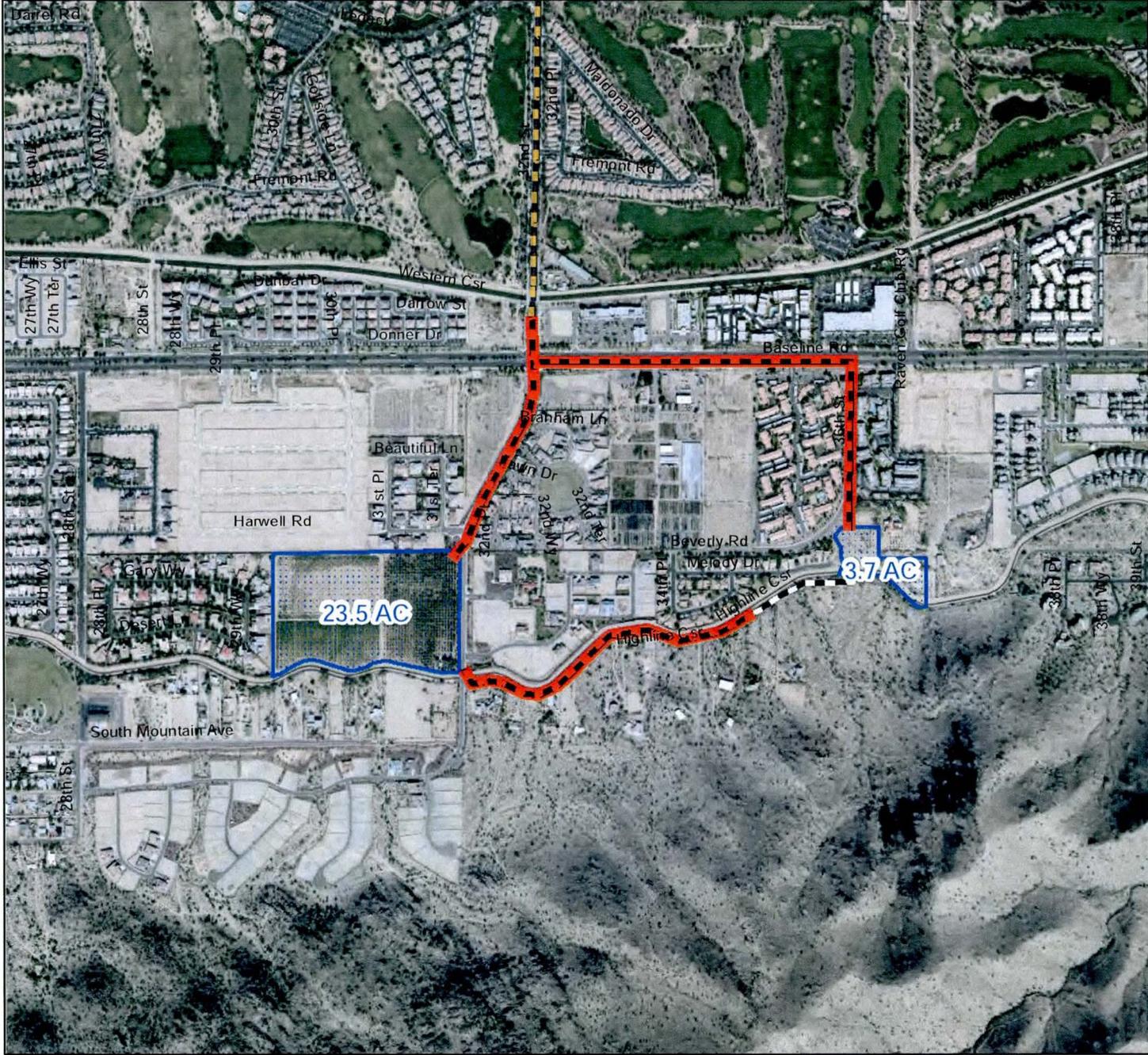
- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 4.3

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative Formulation Meeting
Alternative 4.3





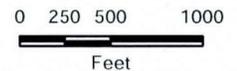
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 4.4

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative Formulation Meeting

Alternative 4.4

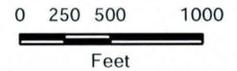
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

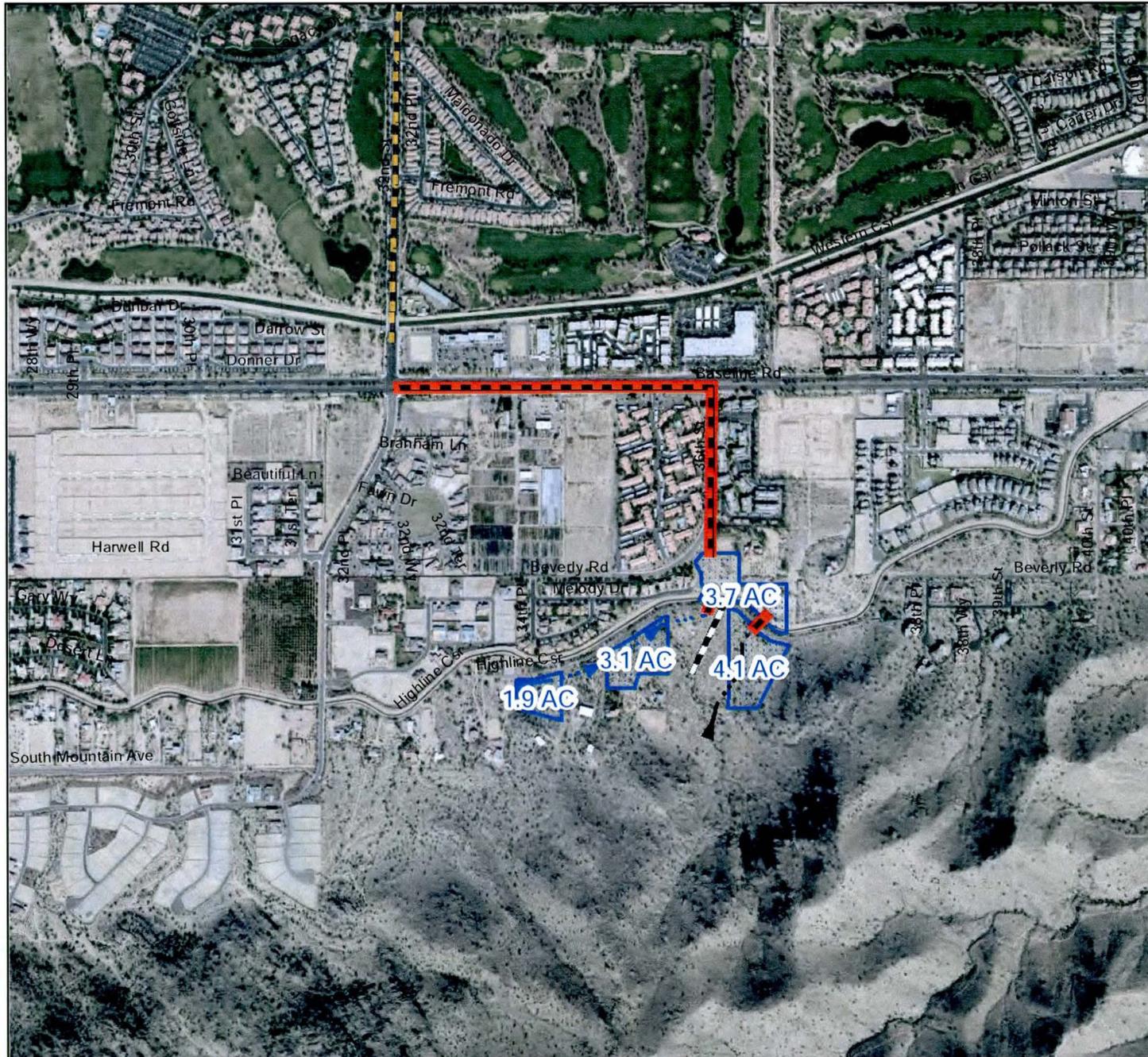
Alternative 4.5

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 4.5



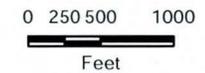
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

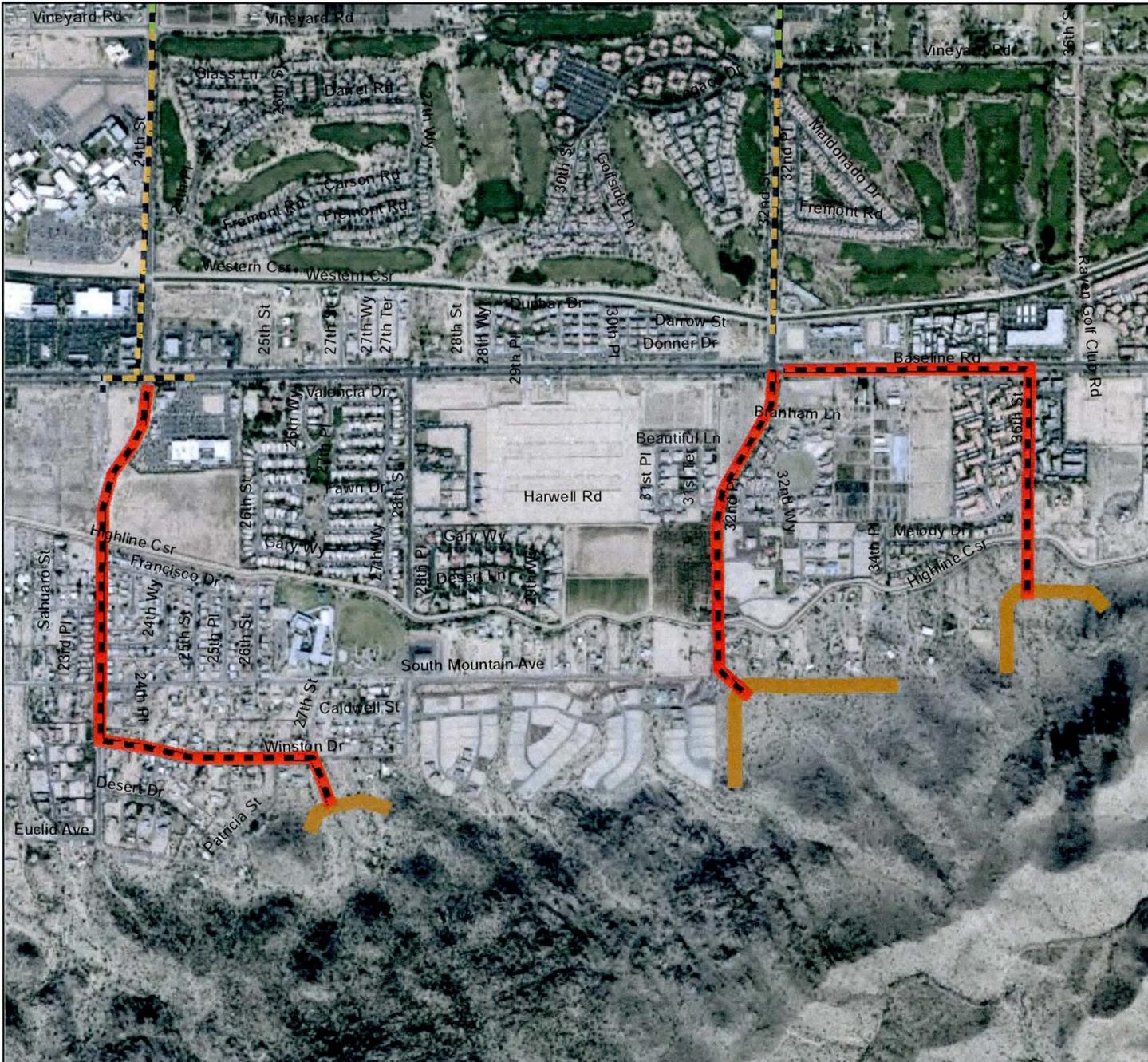
Alternative 4.6

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative Formulation Meeting

Alternative 4.6



Legend

Problem Area 5

Ex. Storm Drain (in)

— 18 - 24

— 25 - 36

— 37 - 48

— 49 - 60

— 61 - 72

— 73 - 96

Depth Max (ft)

0.16 - 0.5

0.5 - 1

1.01 - 1.5

1.51 - 2

2.01 - 2.5

2.51 - 3

3.01 - 3.5

3.51 - 4

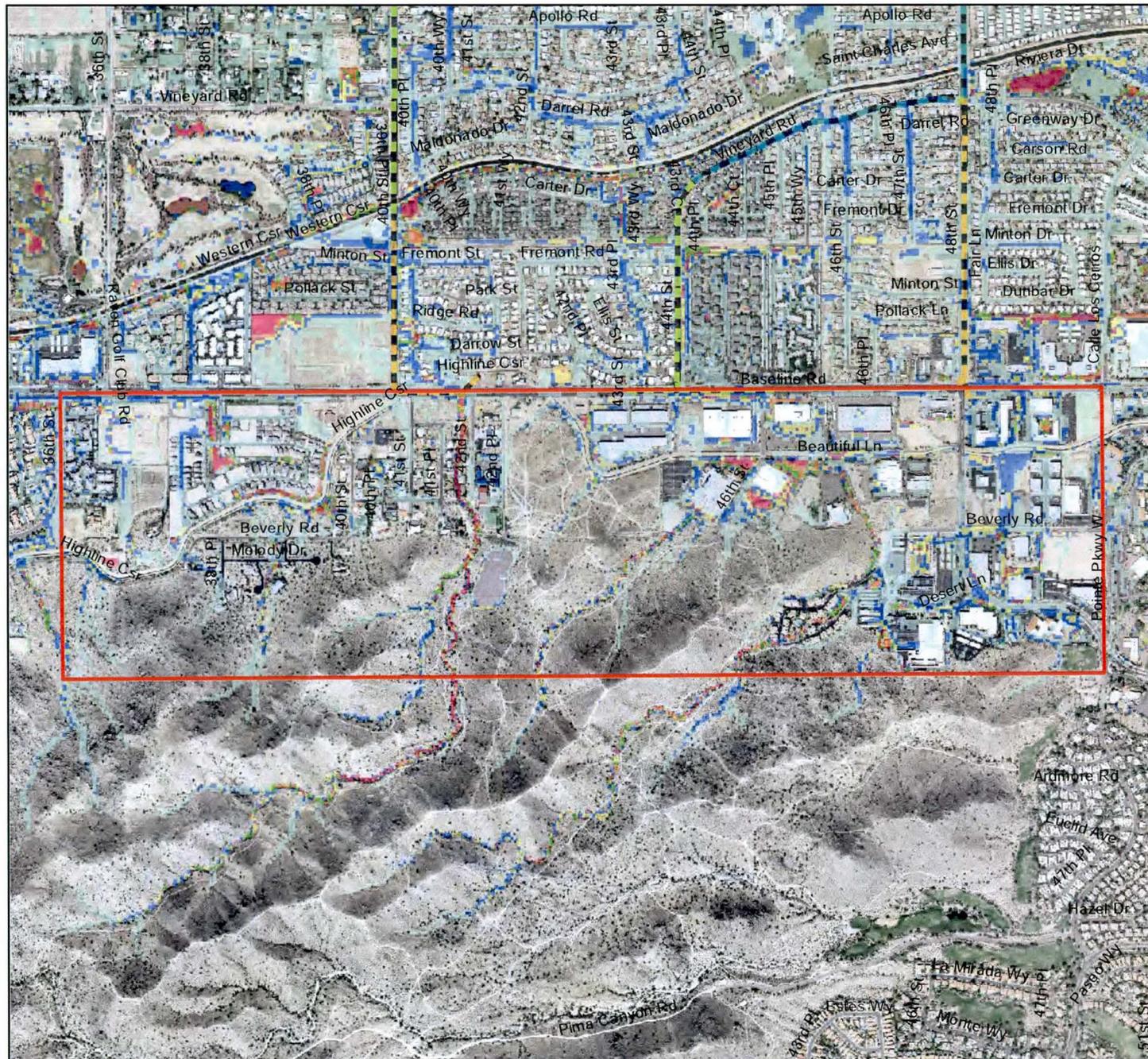
4.01 - 21



0 250 500 1000

Feet

Level 1 Alternative
Formulation Meeting
Alt 5.0 (No Action)
F100Y6H Results





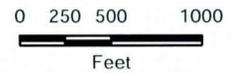
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 5.1

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 5.1



Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 5.2

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative Formulation Meeting

Alternative 5.2

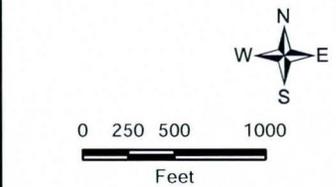
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 5.3

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting
Alternative 5.3



Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

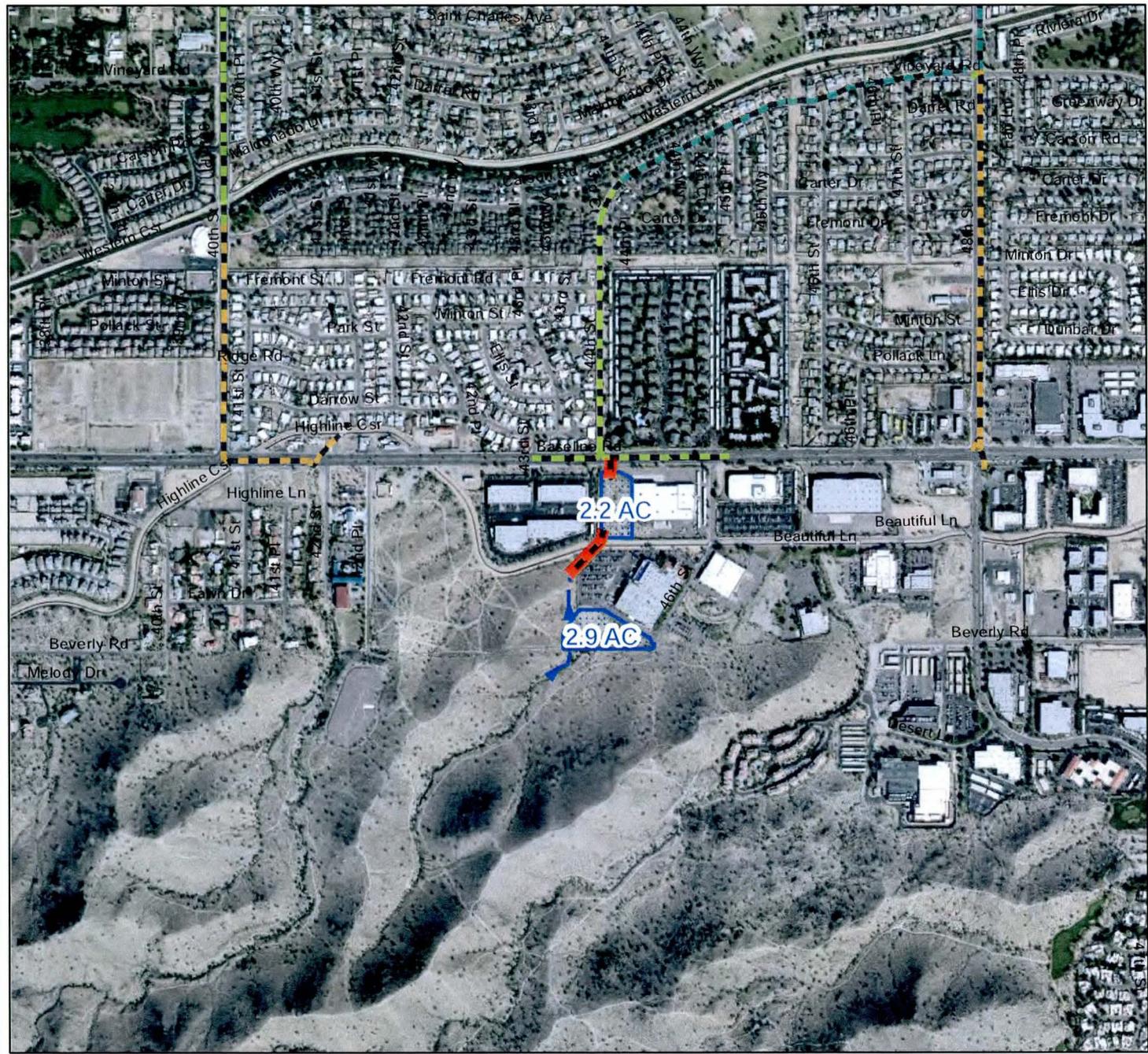
Alternative 5.4

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 5.4



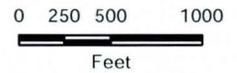
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 5.5

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 5.5



Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 5.6

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative Formulation Meeting

Alternative 5.6

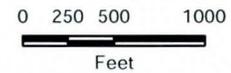
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

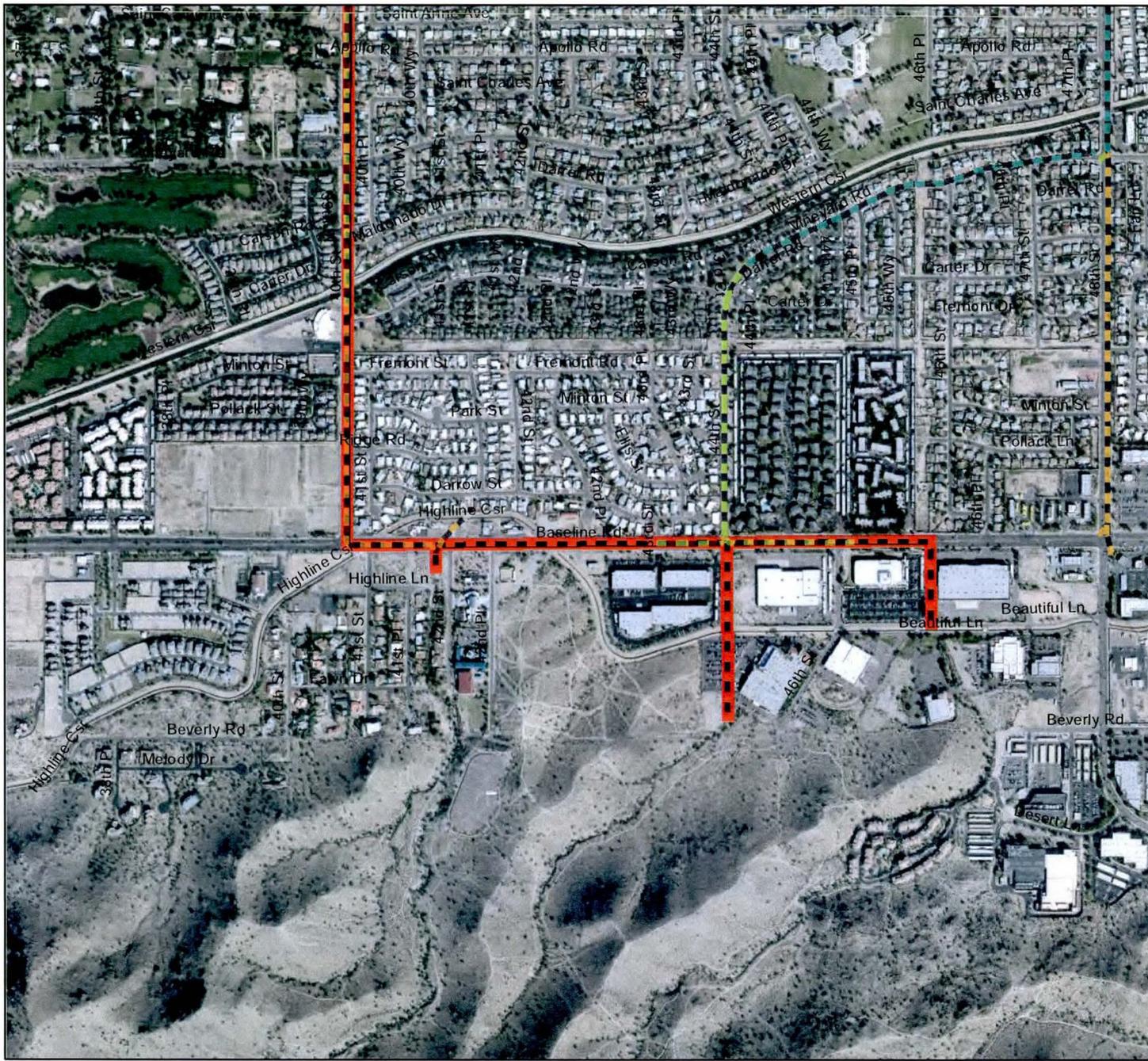
Alternative 5.7

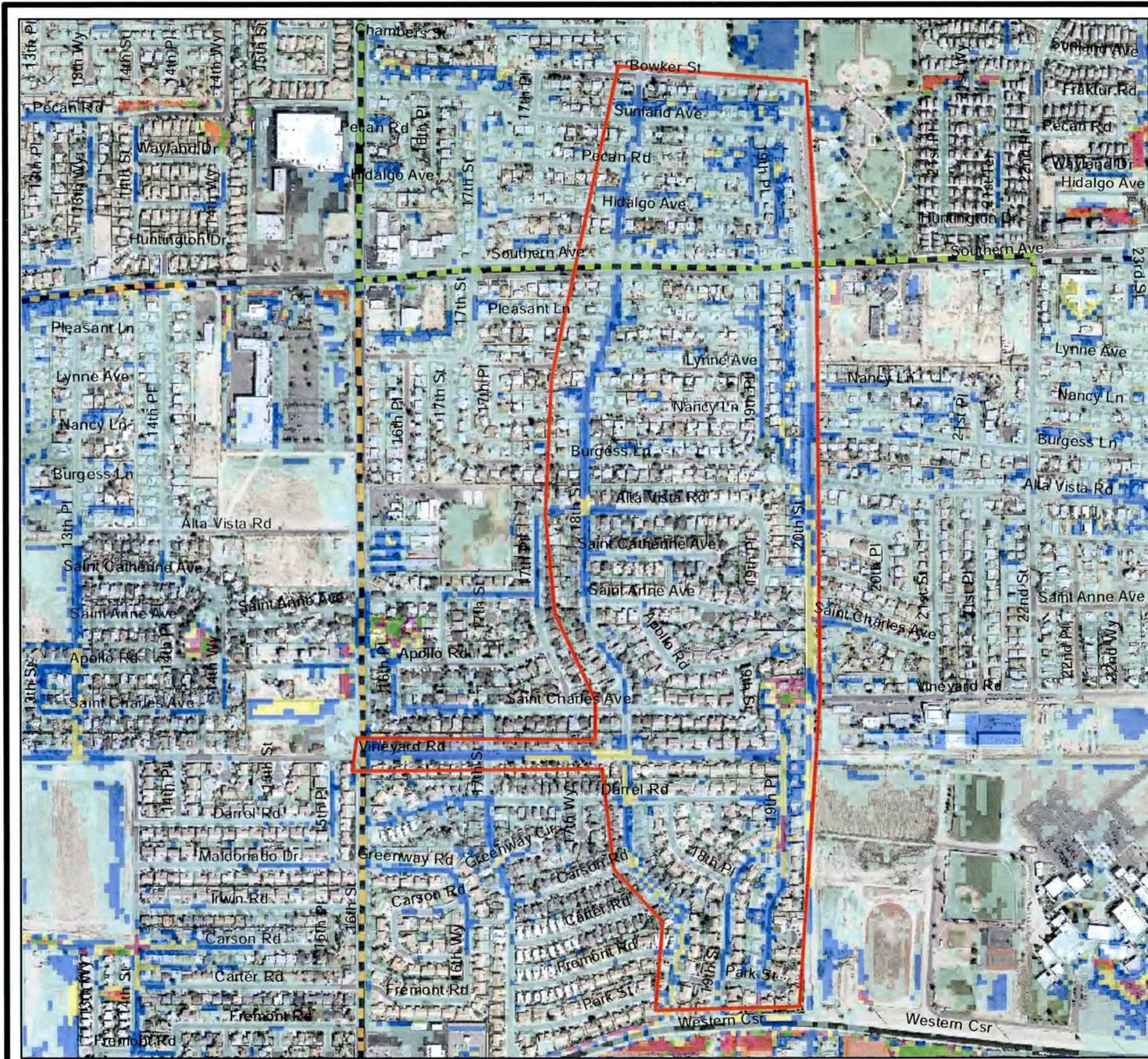
- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 5.7





Legend

Problem Area 6

Ex. Storm Drain (in)

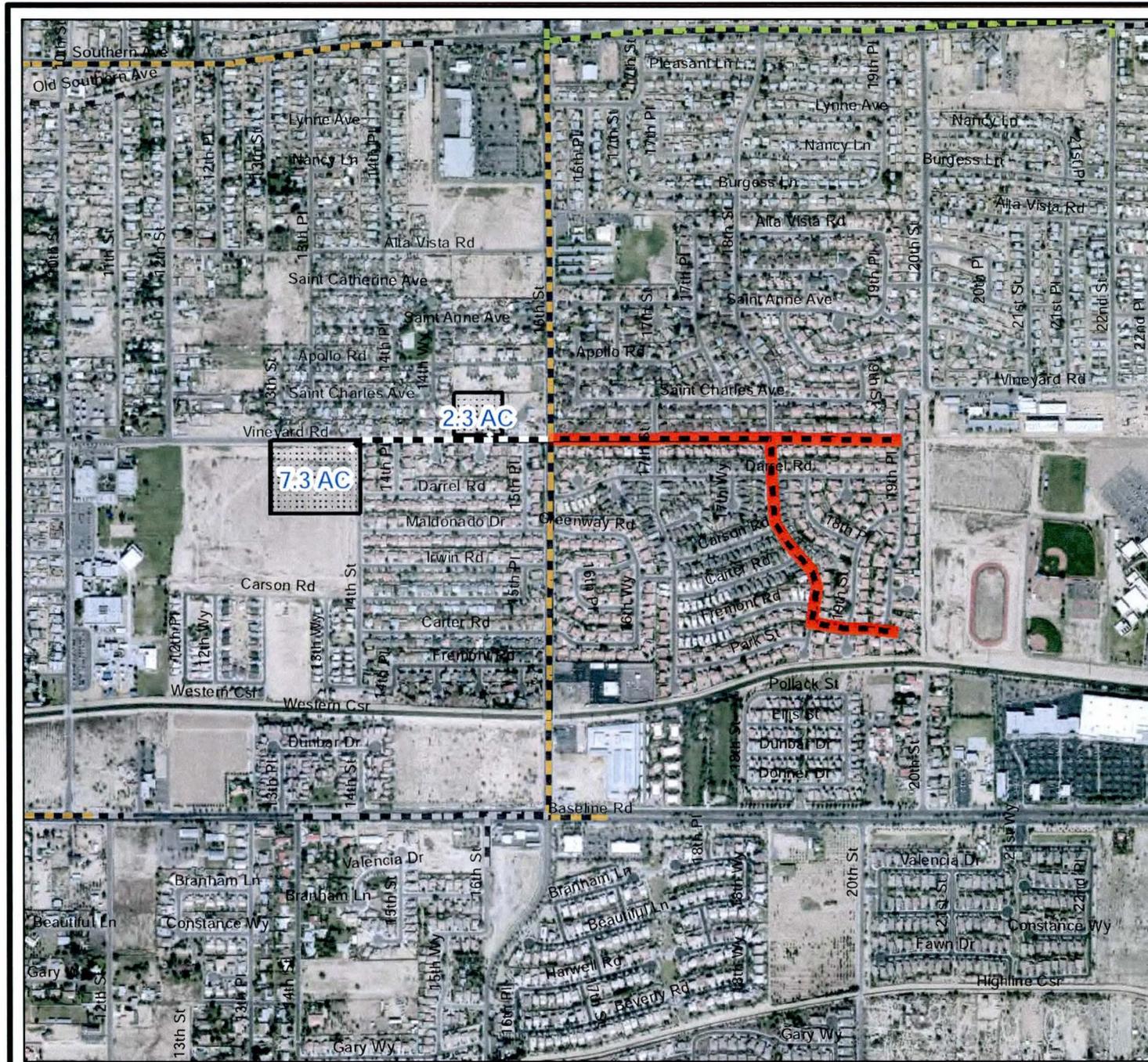
- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Depth Max (ft)

- 0.16 - 0.5
- 0.5 - 1
- 1.01 - 1.5
- 1.51 - 2
- 2.01 - 2.5
- 2.51 - 3
- 3.01 - 3.5
- 3.51 - 4
- 4.01 - 21



Level 1 Alternative
 Formulation Meeting
 Alt 6.0 (No Action)
 F100Y6H Results



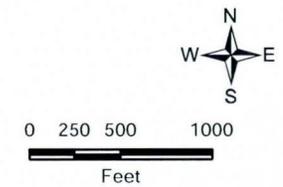
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 6.1

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



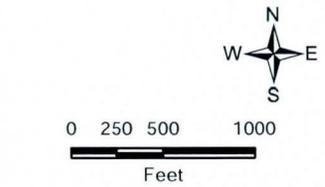
Level 1 Alternative Formulation Meeting
Alternative 6.1



Legend

- Ex. Storm Drain (in)
- 18 - 24
 - 25 - 36
 - 37 - 48
 - 49 - 60
 - 61 - 72
 - 73 - 96

- Alternative 6.2
- Channel
 - Pipe
 - Floodwall
 - Inv Crown
 - Dike/Dam
 - Channel Option
 - Pipe Option
 - Floodwall Option
 - Inv Crown Option
 - Dike/Dam Option
 - Basin
 - Basin Option



Level 1 Alternative Formulation Meeting
Alternative 6.2



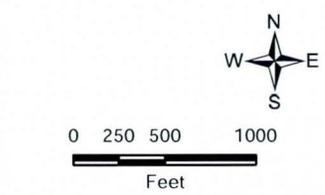
Legend

Ex. Storm Drain (in)

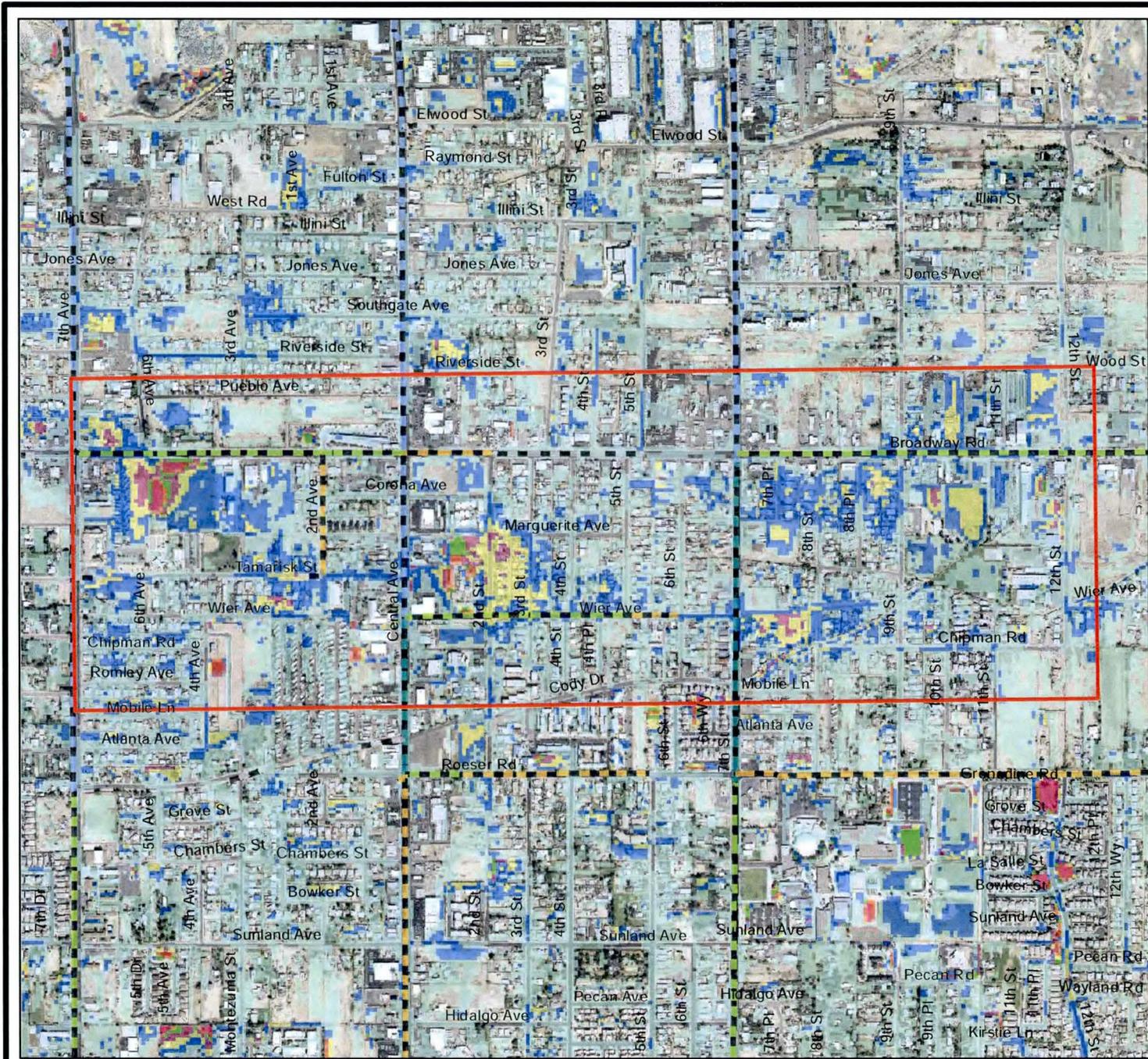
- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 6.3

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative Formulation Meeting
Alternative 6.3



Legend

Problem Area 7

Ex. Storm Drain (in)

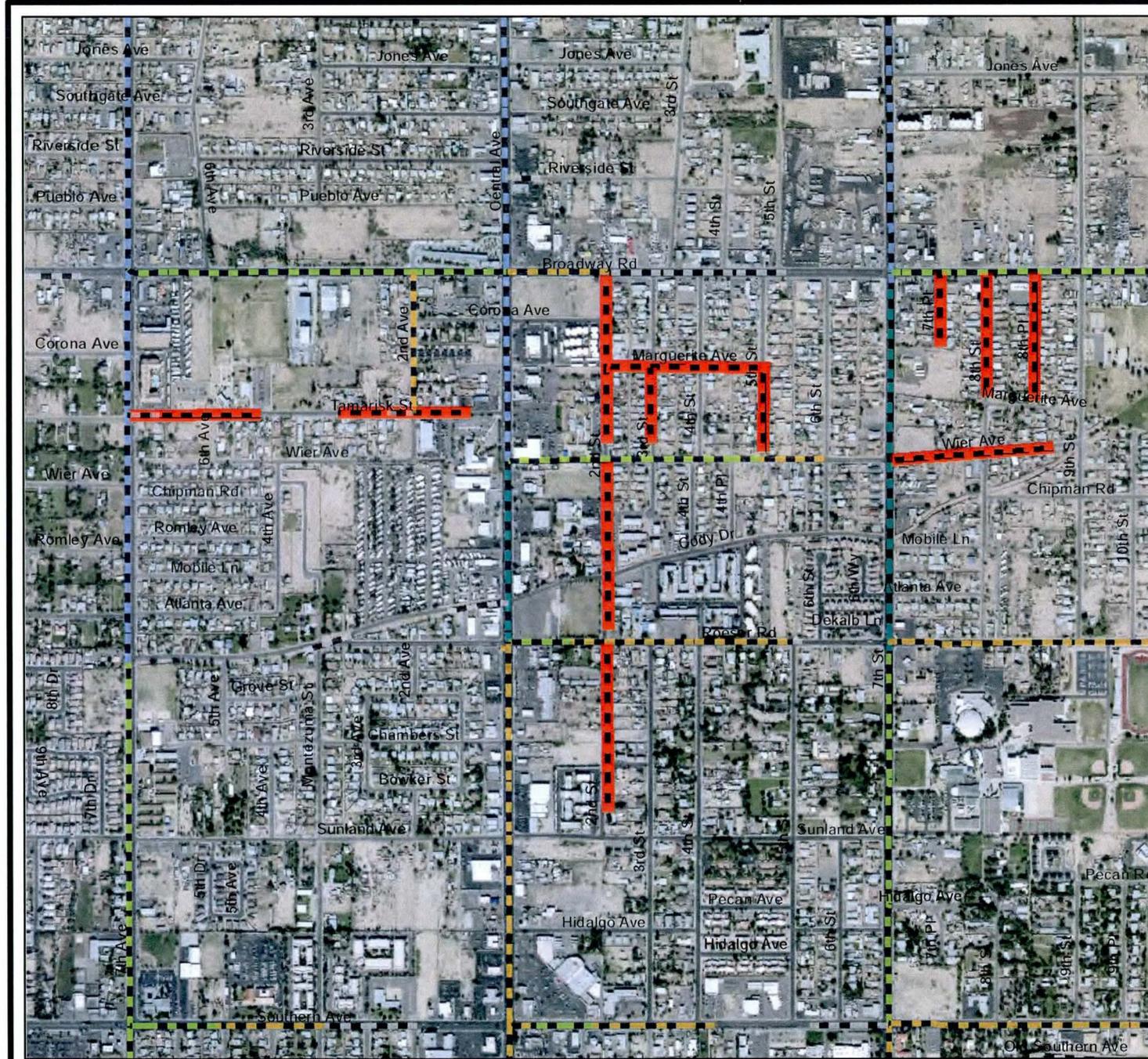
- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Depth Max (ft)

- 0.16 - 0.5
- 0.5 - 1
- 1.01 - 1.5
- 1.51 - 2
- 2.01 - 2.5
- 2.51 - 3
- 3.01 - 3.5
- 3.51 - 4
- 4.01 - 21



Level 1 Alternative
Formulation Meeting
Alt 7.0 (No Action)
F100Y6H Results



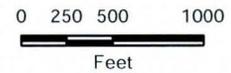
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

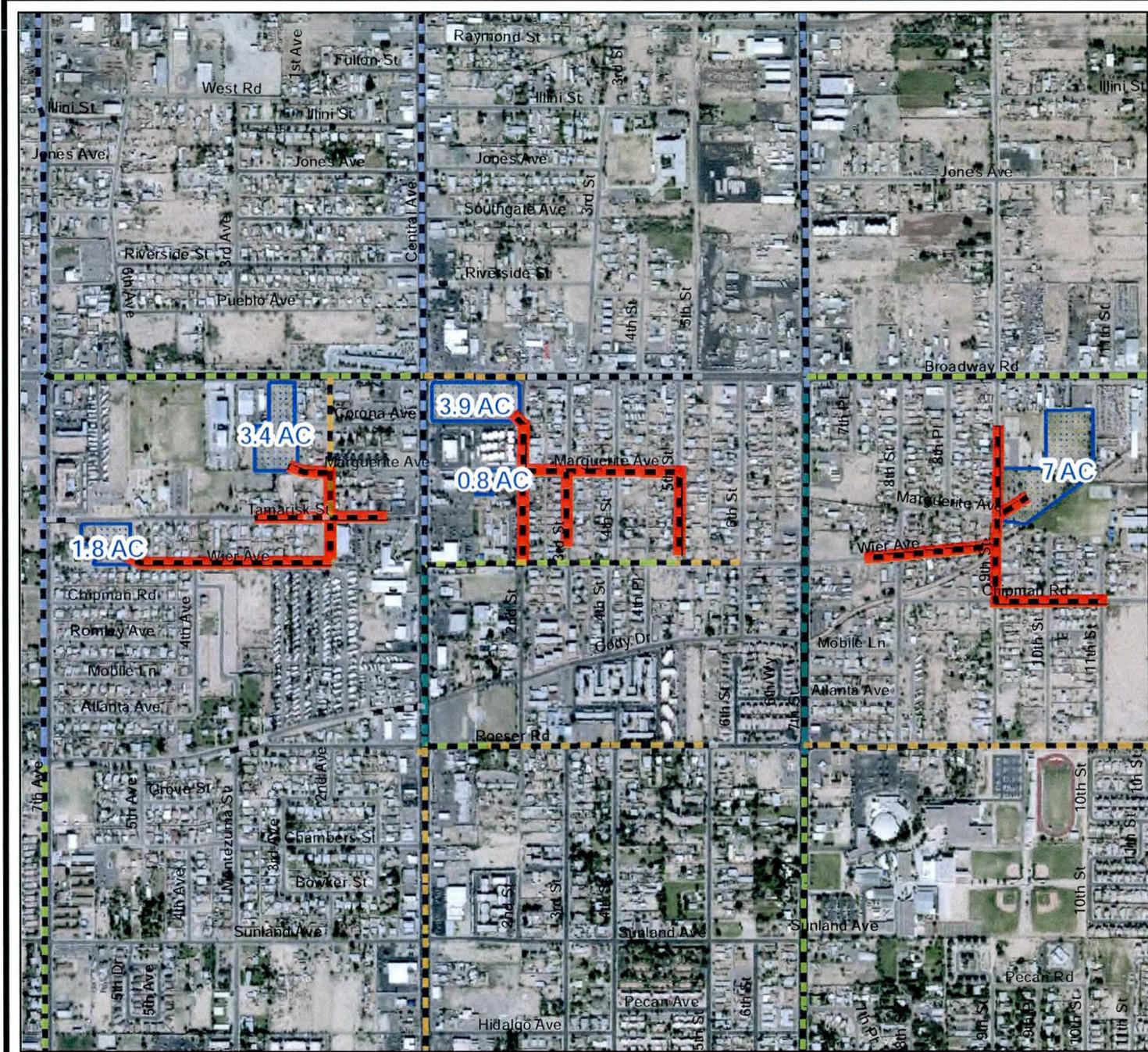
Alternative 7.1

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 7.1



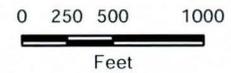
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 7.2

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 7.2

Legend

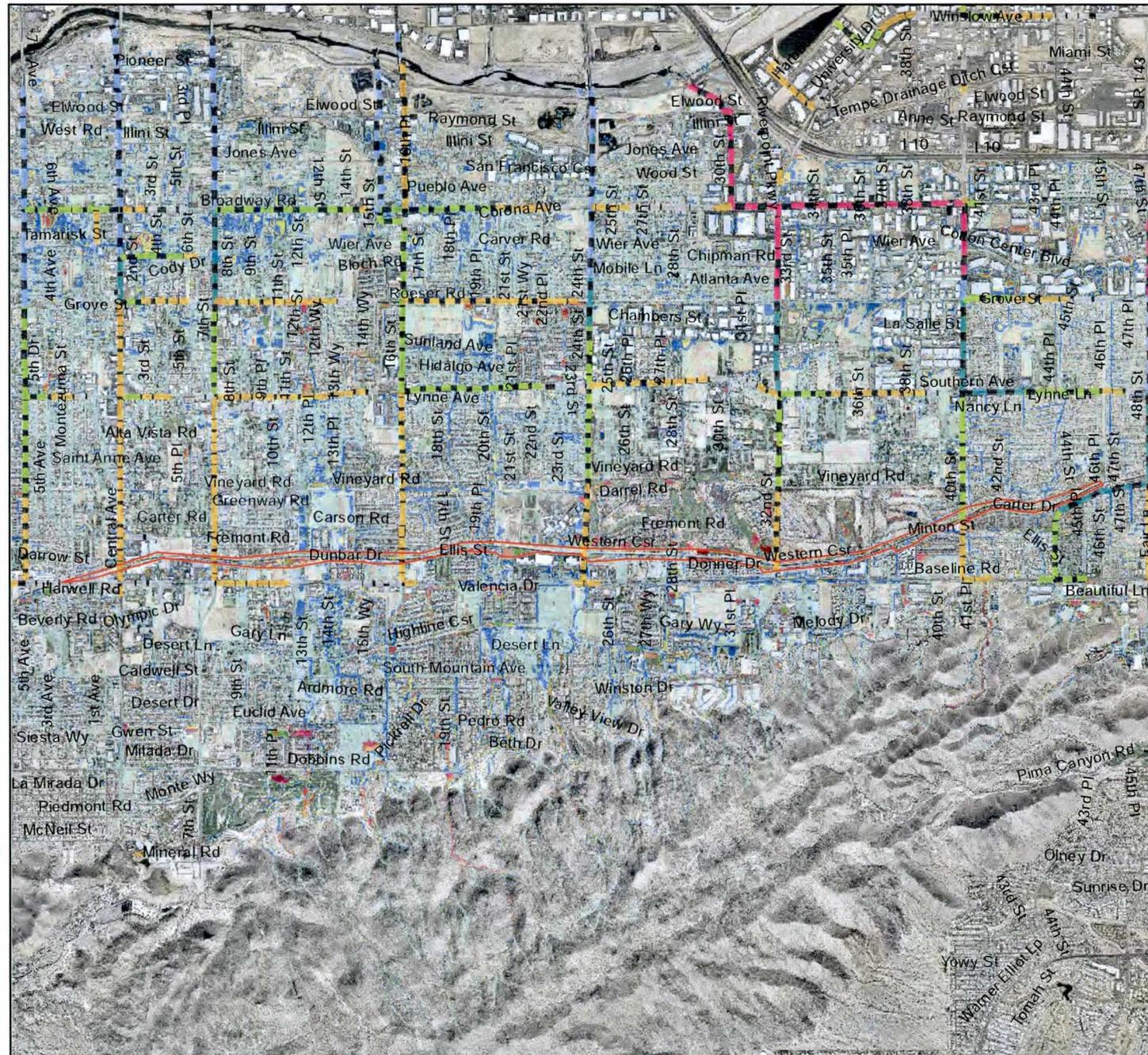
Problem Area 8

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

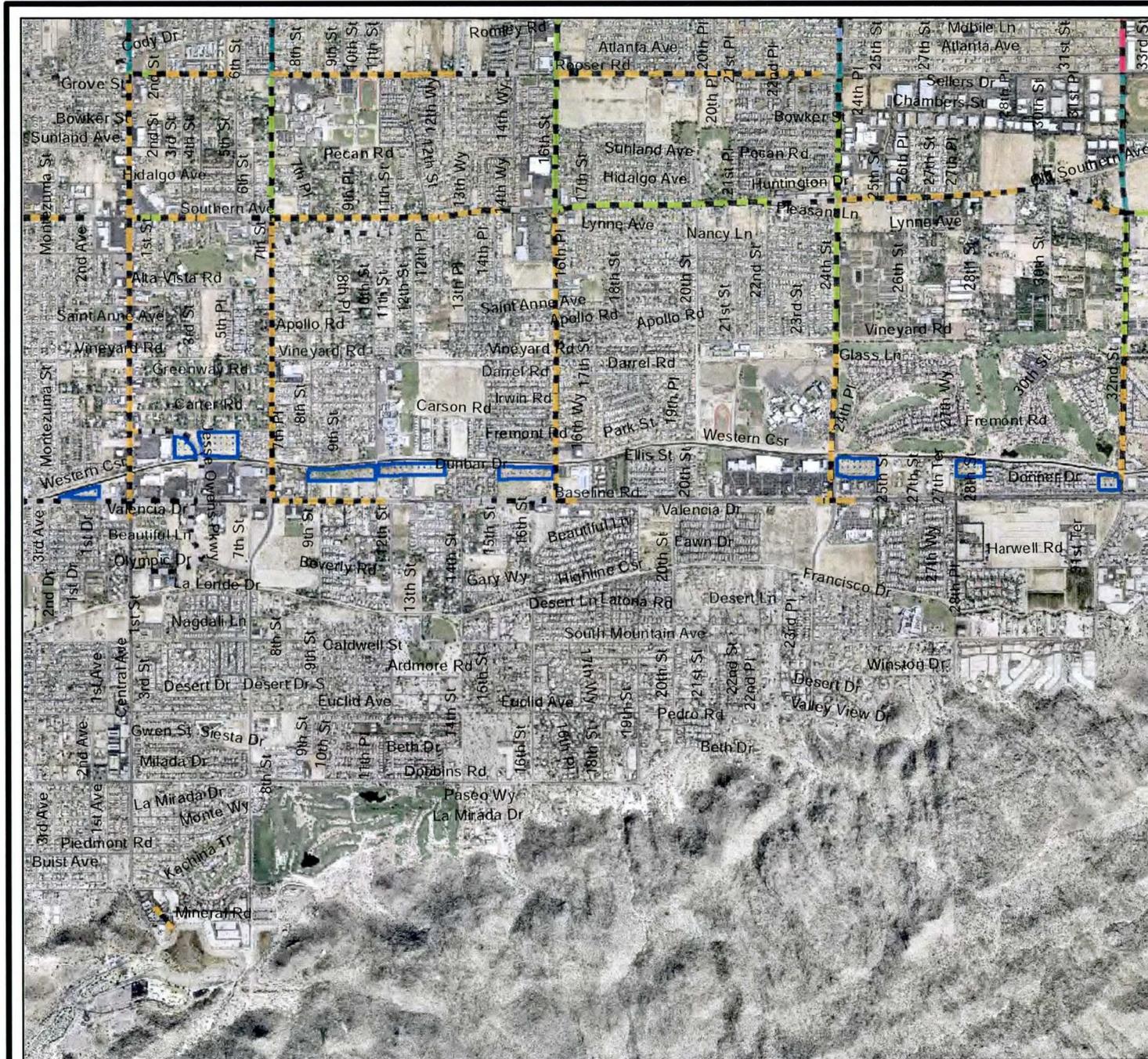
Depth Max (ft)

- 0.16 - 0.5
- 0.5 - 1
- 1.01 - 1.5
- 1.51 - 2
- 2.01 - 2.5
- 2.51 - 3
- 3.01 - 3.5
- 3.51 - 4
- 4.01 - 21



250 000
Feet

Level 1 Alternative Formulation Meeting
Alt 8.0 (No Action)
F100Y6H Results



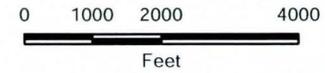
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

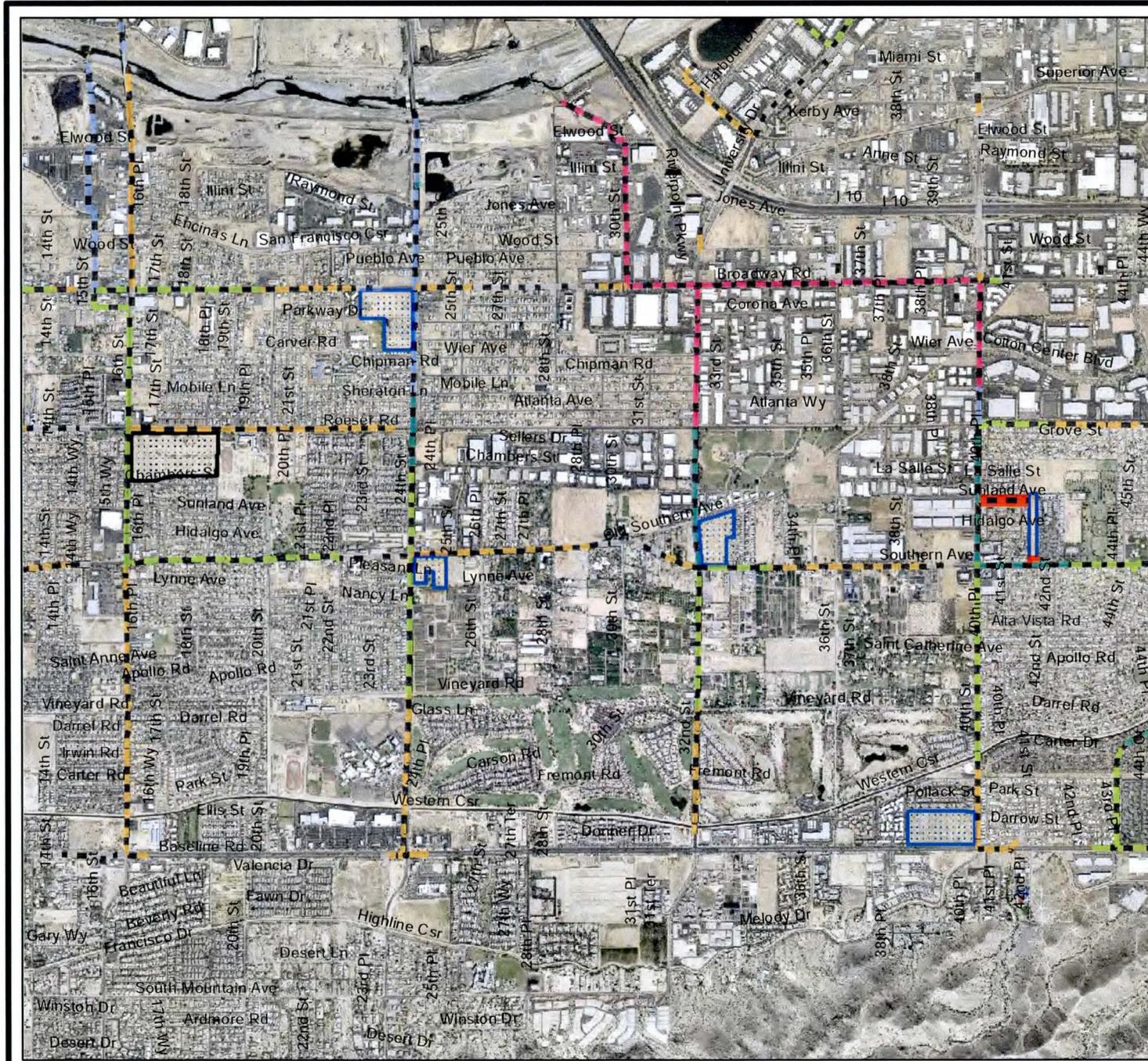
Alternative 8.1

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative
Formulation Meeting

Alternative 8.1



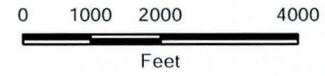
Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 8.2

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Level 1 Alternative Formulation Meeting
Alternative 8.2



APPENDIX B
EVALUATION
MATRIX

Level 1 Alternative Evaluation Matrix - Meeting Consensus

Alternative		Flood Mitigation Effectiveness	Community Acceptance	Land & Resource Compatibility	Relative Cost	Include in Level 2 Analysis?	Comments
ID	Description						
1.0	No Action: Conditions to remain as existing					Yes	Not Rated. No Action alternatives will be considered in Level 2.
1.1	Multiple Basins and Channels: Series of retention basins connected by channels and pipes.	+	=	+	-	Yes	COP have plans to extend a storm drain down 14th St. and general approval to utilize the Circle K park to address flooding issues.
1.2	TCCGC Retention Basin & Dobbins Channel: Utilize TCCGC for retention. A channel along Dobbins to divert flow to basin.	+	-	+	+	Yes	
1.3	TCCGC Development Stipulations: Provide additional retention for offsite flow & control flow to Dobson Creek basins					Combine w/others	Not Rated. A possible component of other alternatives.
1.4	Local Storm Drain System (16th St) & Basins: Storm drain system that outlet to retention basins	+	+	+	-	Yes	Combine 1.4 & 1.9 into a single alternative. Utilizing a 14th St alignment (see Alt 1.1) generally preferable.
1.5	Dobson Creek Basin Modifications: Increase capacity/functionality of Dobson Creek retention basins	-	-	-	-	No	
1.6	Floodwalls Primarily along Highline Canal but potentially other locations.					Combine w/others	Not Rated. A possible component of other alternatives. Potential concerns include liability and ownership issues.
1.7	Use Roads for Conveyance: Modify roads to increase drainage functionality (inverted roads, drainage ditches, C&G)					No	Not Rated. Generally roads will not be used for conveyance. There may be exceptions in isolated locates.
1.8	Dams (with outlet): Construct FRS to retain mountain runoff. Levees could also be used to divert flow.	+	-	-	-	No	Generally, long term maintenance, potential liability, land acquisition/impact, permitting/certification and other considerations override potential benefits in this location.
1.9	Large Diameter Storm Drain (16th St): Install new storm drain to increase existing system capacity and extend system into problem areas.	+	+	+	-	Combine with 1.4	See Alt 1.4

Level 1 Alternative Evaluation Matrix - Meeting Consensus

Alternative		Flood Mitigation	Community	Land & Resource	Relative	Include in	Comments
ID	Description	Effectiveness	Acceptance	Compatibility	Cost	Level 2 Analysis?	
2.0	No Action: Conditions to remain as existing					Yes	Not Rated. No Action alternatives will be considered in Level 2.
2.1	Local Storm Drain System (16th & 20th St) & Basins: Storm drain system that outlet to retention basins	+	+	=	-	Yes	Combine parts of 2.1, 2.4 & 3.3 into a single alternative. Partial take of properties not acceptable (eliminate any such basin recommendations)
2.2	Use Roads for Conveyance: Modify roads to increase drainage functionality (inverted roads, drainage ditches, C&G)	-	-	=	-	No	Not Rated. Generally roads will not be used for conveyance. There may be exceptions in isolated locates.
2.3	Dams (with outlets): Construct FRS to retain mountain runoff. Levees could also be used to divert flow.	+	-	-	-	No	Generally, long term maintenance, potential liability, land acquisition/impact, permitting/certification and other considerations override potential benefits in this location.
2.4	Large Diameter Storm Drain (16th St): Install new storm drain to increase existing system capacity and extend system into problem areas.	+	+	=	-	Combine with 2.1	See Alt 2.1

Level 1 Alternative Evaluation Matrix - Meeting Consensus

Alternative		Flood Mitigation Effectiveness	Community Acceptance	Land & Resource Compatibility	Relative Cost	Include in Level 2 Analysis?	Comments
ID	Description						
3.0	No Action: Conditions to remain as existing					Yes	Not Rated. No Action alternatives will be considered in Level 2.
3.1	Local Storm Drain System (20th St) & Basins: Storm drain system that outlet to basins along Highline Canal.					Combine with 2.1	Not Rated. Consider as a component of Alt. 2.1.
3.2	Channelize Flow to Basins (20th PI): Improve/construct channels to convey flow to basins along the Highline Canal.	-	-	-	-	No	Unlikely to be able to fit channel through developed parcels without significant takes.
3.3	Channelize Flow & Use Roads (21st PI): Improve/construct channels to convey flow to basins along the Highline Canal.					Combine with 2.1	Not Rated. Possible component of Alt. 2.1. Limited use of inverted roads along Euclid and/or 21st PI may be acceptable.
3.4	Highline Canal Storm Drain: Construct storm drain along Highline to capture and convey flow to retention basins.					Combine with 2.1	Not Rated. Consider as a possible component of Alt. 2.1. Best location for storm drain outside of SRP within the Pines at S. Mtn.
3.5	Multiple Basins and Channels: Channelize flow & construct basins along existing drainage path. Outlet to basins along Highline Canal.	+	-	+	-	Yes	
3.6	Use Roads for Conveyance to Local Basins: Modify roads to increase drainage functionality (inverted roads, drainage ditches, C&G)					No	Not Rated. Generally roads will not be used for conveyance. There may be exceptions in isolated locates.
3.7	Dams (with outlets): Construct FRS to retain mountain runoff. Levees could also be used to divert flow.					No	Not Rated. Maint., liability, land acquisition/impact, permitting, certification & other considerations override potential benefits.
3.8	Large Diameter Storm Drain (24th St): Install new storm drain to increase existing system capacity and extend system into problem areas.	+	+	+	-	Yes	

Level 1 Alternative Evaluation Matrix - Meeting Consensus

Alternative		Flood Mitigation Effectiveness	Community Acceptance	Land & Resource Compatibility	Relative Cost	Include in Level 2 Analysis?	Comments
ID	Description						
4.0	No Action: Conditions to remain as existing					Yes	Not Rated. No Action alternatives will be considered in Level 2.
4.1	Multiple Basins and Local Storm Drain (S. Mtn Ave): Basins along Winston Dr and Highline Canal with a local storm drain system to connect & convey flow.	+	-	-	=	Yes	For Level 2, consider utilizing existing basin along S. Mtn Ave to convey flow east, to the park. Limit new basin to park area only (no school).
4.2	Local Storm Drain & Local Basin (32nd St): Storm drain along S. Mtn Ave (possibly a channel) to basin NE of Highline Canal/32nd St.	-	-	=	-	No	Costly with little return. Benefits only a few properties.
4.3	Highline Storm Drain & Local Basin (32nd/36th St): Storm drain along Highline (possibly a channel) to basin along 32nd St. and/or 36th St	+	-	=	-	No	Costly with little return. Benefits only a few properties.
4.4	Floodwalls Primarily along Highline Canal at Cortland Point but potentially other locations.	=	-	+	=	No	Generally no (as presented) due to potential concerns including liability, maintenance, construction on private properties, and ownership issues.
4.5	Cortland Point Basins/Channels : Construct basins and/or channels along Highline Canal (south of Cortland Point).	+	+	+	=	Yes	Preferable to have the channel on the south side of Highline Canal and eliminate basins with the exception of the basin north of Highline.
4.6	Dams (with outlets): Construct FRS to retain mountain runoff. Levees could also be used to divert flow.	+	-	-	-	No	

Level 1 Alternative Evaluation Matrix - Meeting Consensus

Alternative		Flood Mitigation	Community	Land & Resource	Relative	Include in	Comments
ID	Description	Effectiveness	Acceptance	Compatibility	Cost	Level 2 Analysis?	
5.0	No Action: Conditions to remain as existing					Yes	Not Rated. No Action alternatives will be considered in Level 2.
5.1	Highline Basin : Construct basin S of the Highline Canal. Outlet to Blossom Hills drainage corridor.	=	-	-	-	No	Existing conditions are such that flood mitigation efforts are not considered necessary.
5.2	Baseline Rd Basins : Construct basins S of the Baseline Road	=	-	-	-	No	Existing conditions are such that flood mitigation efforts are not considered necessary.
5.3	Divert flow to 42nd Pl/Baseline Basin : Divert flow directed towards building to a basin along the Highline Canal (SE of 42nd Pl/Baseline)	=	-	-	-	No	Benefits only a single commercial/industrial building. Costs associated with flood mitigation result in little return.
5.4	44th St Basins : Construct basins along Highline (~44th St alignment) to retain mountain runoff.	=	-	-	-	No	Benefits only a single commercial/industrial building. Costs associated with flood mitigation result in little return.
5.5	Beverly Rd Basin : Inline basin to wash prior to larger culvert/bridge.	=	-	-	-	No	
5.6	Dams (with outlets): Construct FRS to retain mountain runoff. Levees could also be used to divert flow.	+	-	-	-	No	Not Rated. Maint., liability, land acquisition/impact, permitting, certification & other considerations override potential benefits.
5.7	Large Diameter Storm Drain (40th St): Install new storm drain to increase existing system capacity and extend system into problem areas.	+	+	+	-	Yes	Consider a small basin to help reduce peak flows.

Level 1 Alternative Evaluation Matrix - Meeting Consensus

Alternative		Flood Mitigation Effectiveness	Community Acceptance	Land & Resource Compatibility	Relative Cost	Include in Level 2 Analysis?	Comments
ID	Description						
6.0	No Action: Conditions to remain as existing					Yes	Not Rated. No Action alternatives will be considered in Level 2.
6.1	Storm Drain System (Vineyard & 20th St) & Basins: Storm drain system to local retention basins and/or existing storm drain system.	+	+	+	=	Yes	Survey of homes in cul-de-sacs (and other locations) might be appropriate to determine extent of flood hazard.
6.2	Floodwall and Diversion of Flow to Basins (20th St): Divert flow to basin(s) on SMCC property.	-	-	-	+	No	
6.3	Storm Drain System (18th & 20th St) & Basins: New main lines along 18th St & 20th St. Outlet to existing system or to basins N of Southern.	+	+	+	-	Yes	Potentially add other laterals where appropriate (e.g. Apollo Rd)

Level 1 Alternative Evaluation Matrix - Meeting Consensus

Alternative		Flood Mitigation	Community	Land & Resource	Relative	Include in	Comments
ID	Description	Effectiveness	Acceptance	Compatibility	Cost	Level 2 Analysis?	
7.0	No Action: Conditions to remain as existing					Yes	Not Rated. No Action alternatives will be considered in Level 2.
7.1	Expand Existing Storm Drain System: Extend laterals connected to existing storm drain system to problem areas.	+	+	+	=	Yes	Preferable option if existing storm drain system can handle. Consider basins (Alt 7.2) depending upon Level 2 investigations/analyses.
7.2	Local Storm Drain System & Basins: New local storm drain system that outlet to local retention basins.	+	=	+	=	Yes	Consideration to be given to including COP/park property on Broadway (~8th Ave) for retention.
8.0	No Action: Conditions to remain as existing					Yes	Not Rated. It was decided that ponding along the canal should be addressed upon development. No Action is proposed.
8.1	Basins along Western Canal: Consolidate ponding along Western Canal. Possible also provide relief to storm drain systems.					No	Not Rated. Generally measure would address undeveloped parcels which could/should address the issues upon development.
8.2	Storm Drain Relief Basins: Identify/utilize basins throughout study area for storm drain relief & to maximize storm drain capacities.					No	Not Rated. A general assessment of storm drain capacity based upon more tradition analyses may be considered in Level 2.

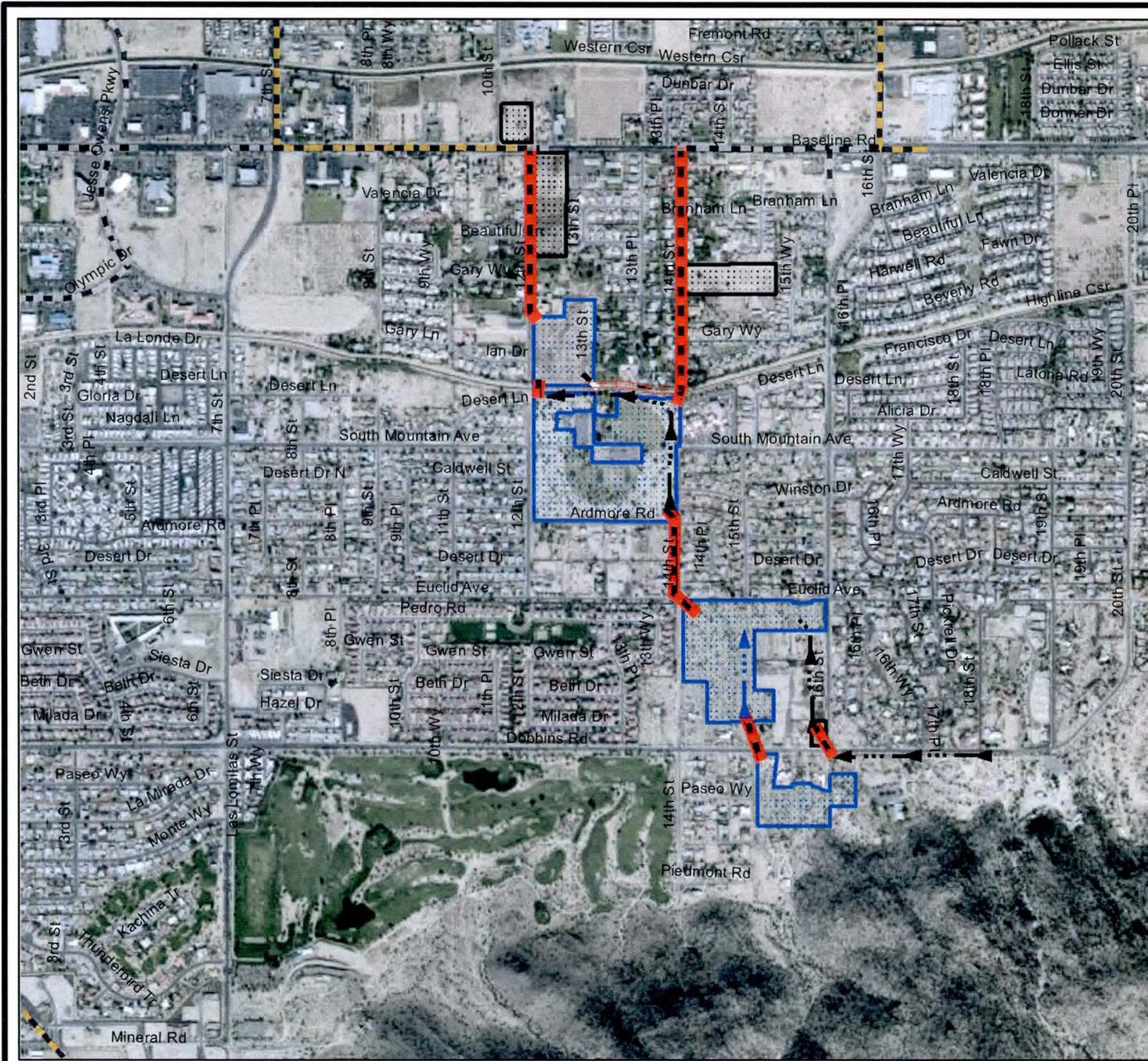
Rating	
+	Positive / Favorable
=	Neutral
-	Negative / Unfavorable

Definition of Evaluation Criteria

Evaluation Criteria	Factors to Consider	
Costs (qualitative & relative to other problem area alternatives)	Design & Construction	Costs associated with the alternative design and construction.
	Operation & Maintenance	Costs associated with the constructed alternative's long term operation and maintenance.
	Long Term Economic	Potential long term economic losses (or benefits if favorable) to the community. (via lost tax revenue, lost/improved business conditions)
	ROW / Land Acquisition	Costs associated with the acquiring of ROW and/or land for alternative improvements.
Flood Mitigation Effectiveness	Flood Mitigation	Effectiveness in eliminating and/or reducing flood hazards in both area and magnitude.
	Level of Protection	Ability of the alternative to achieve a 100-yr level of flood protection.
	Potential for Property or Economic Damage	Ability to minimize the potential for property or other economic damage
	Emergency Access	Ability to improve and maintain effective emergency access during flood events.
Community Acceptance	Community Plans	Solution is consistent or compatible with goals and objectives of adopted general and specific area plans
	General Public Acceptance	Level of impact to individual or community properties, resources, or amenities
	Stakeholder Acceptance	Level of impact to stakeholder public amenities, land values, and operational and maintenance responsibilities
	Agency Acceptance	Level of impact to agency public amenities, resources, land values, and operational and maintenance responsibilities
Land & Resource Compatibility	Multi-Use Opportunities Parks & Recreation	Value of opportunities based on neighborhood, community, and regional needs; and meeting the goals and objectives of adopted community plans
	Open Space	Value of open space based on neighborhood, community, and regional needs; adjacent land compatibilities, and meeting the goals and objectives of adopted community plans
	Landscape Aesthetic	Compatibility with existing or future landscape character
	Cultural/Biological Resources	Level of impact on vegetation, habitat, wildlife, geological, prehistoric and historic, and other natural resources



APPENDIX C
LEVEL 2 ALTERNATIVES
EXHIBITS



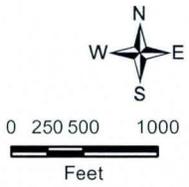
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Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

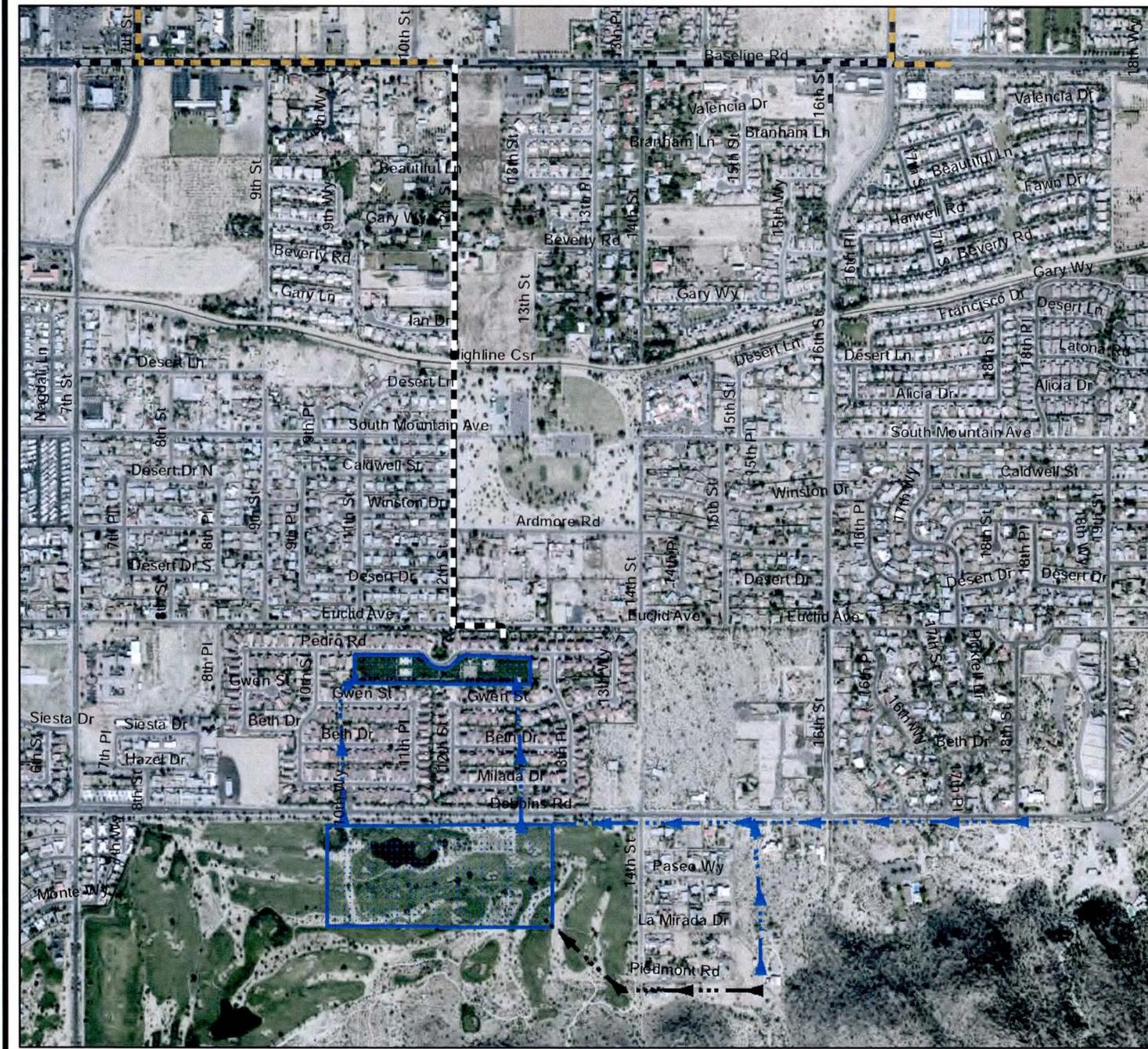
Alternative 1.1

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



**Preliminary Level 2
Alternative**

Alternative 1.1



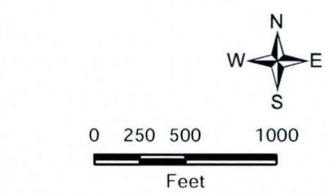
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Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

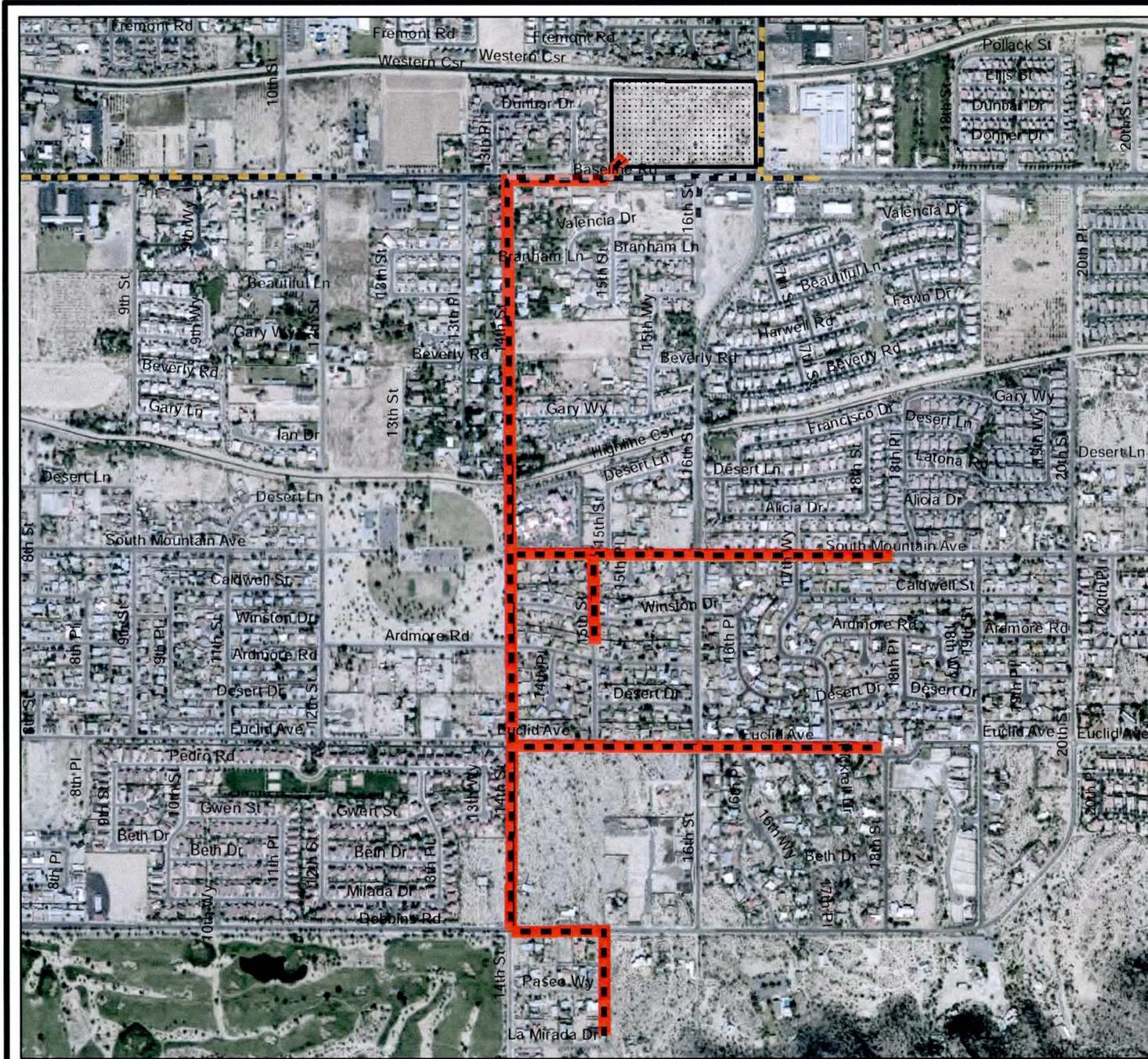
Alternative 1.2

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Preliminary Level 2
Alternative

Alternative 1.2



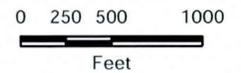
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Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

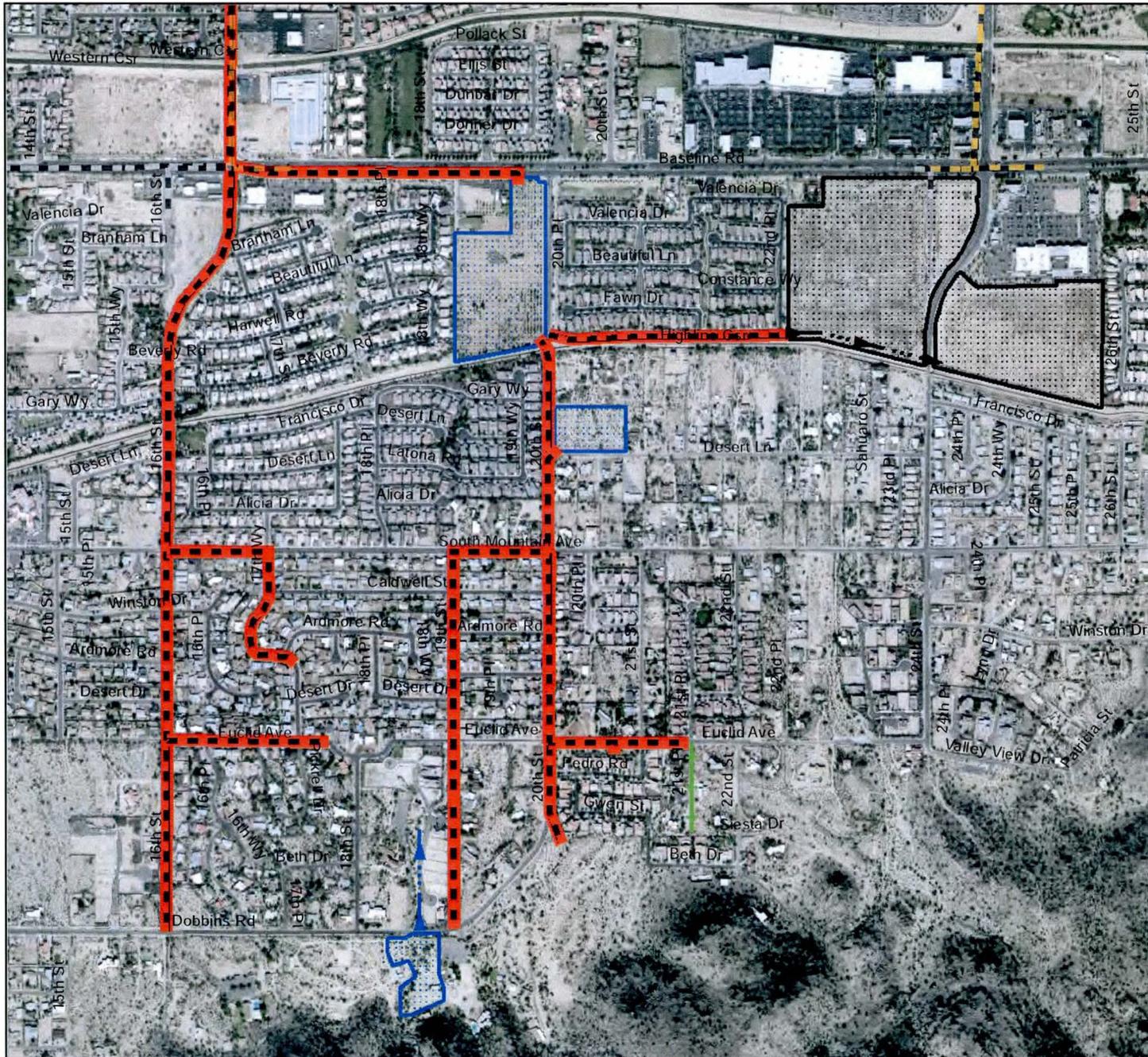
Alternative 1.4

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Preliminary Level 2
Alternative

Alternative 1.4



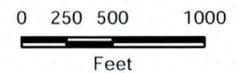
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Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

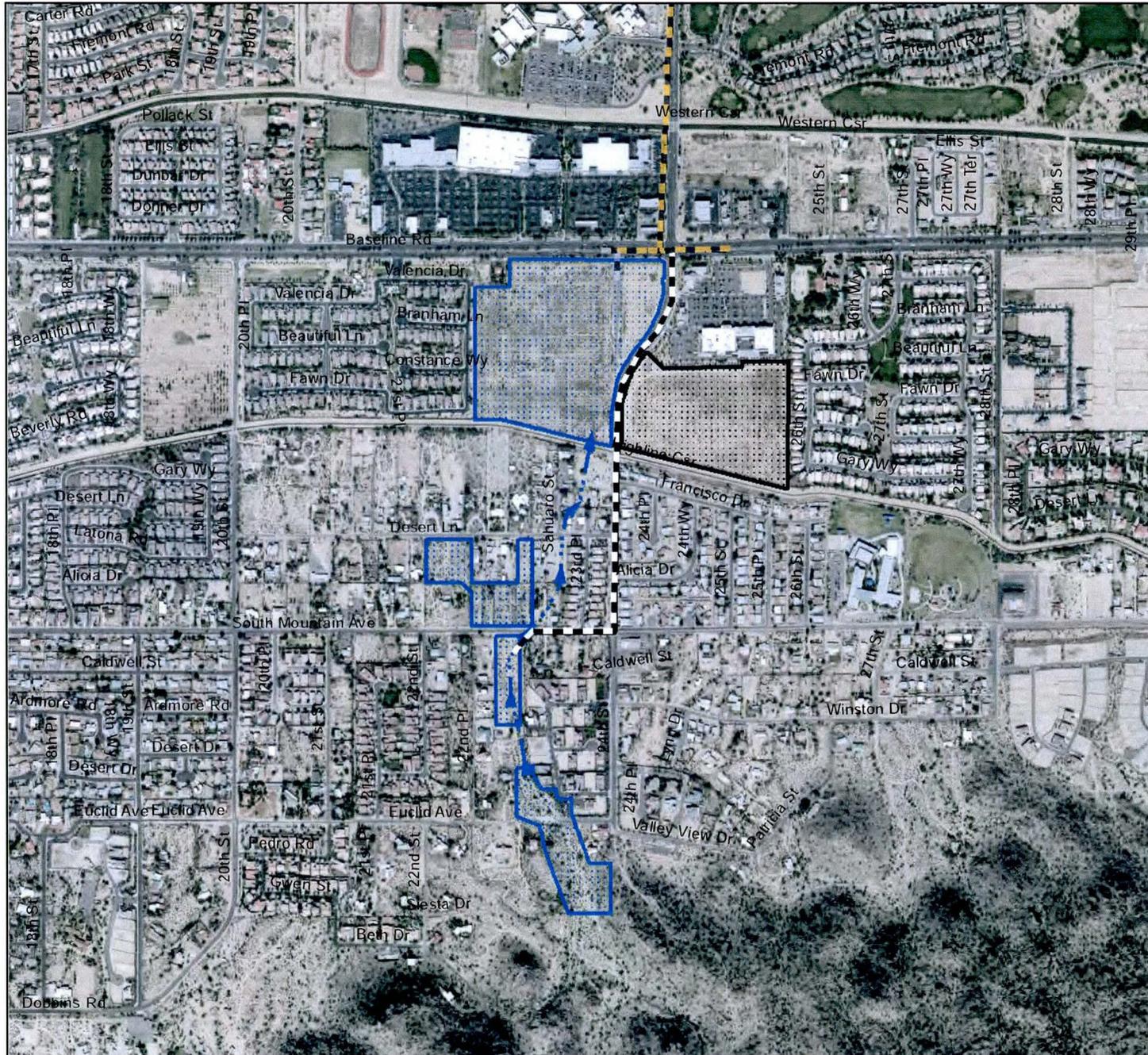
Alternative 2.1

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Preliminary Level 2
Alternative

Alternative 2.1



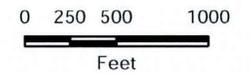
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Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 3.5

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Preliminary Level 2
Alternative

Alternative 3.5



Legend

Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 3.8

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Preliminary Level 2
Alternative

Alternative 3.8



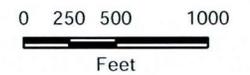
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Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 4.1

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Preliminary Level 2
Alternative

Alternative 4.1



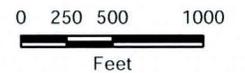
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Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

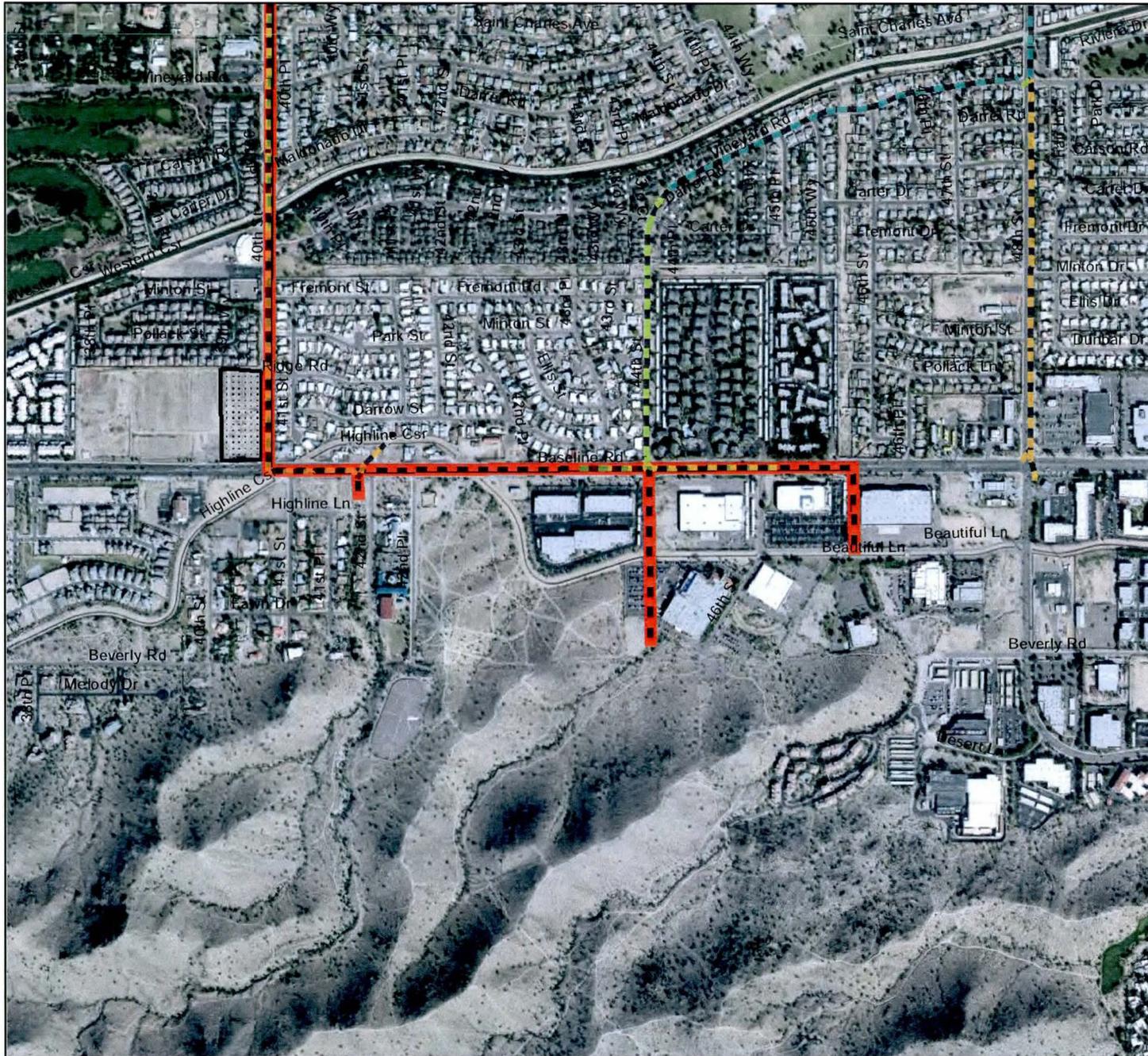
Alternative 4.5

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Preliminary Level 2
Alternative

Alternative 4.5



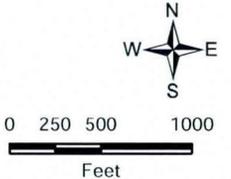
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Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 5.7

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Preliminary Level 2
Alternative

Alternative 5.7



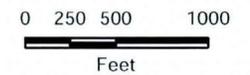
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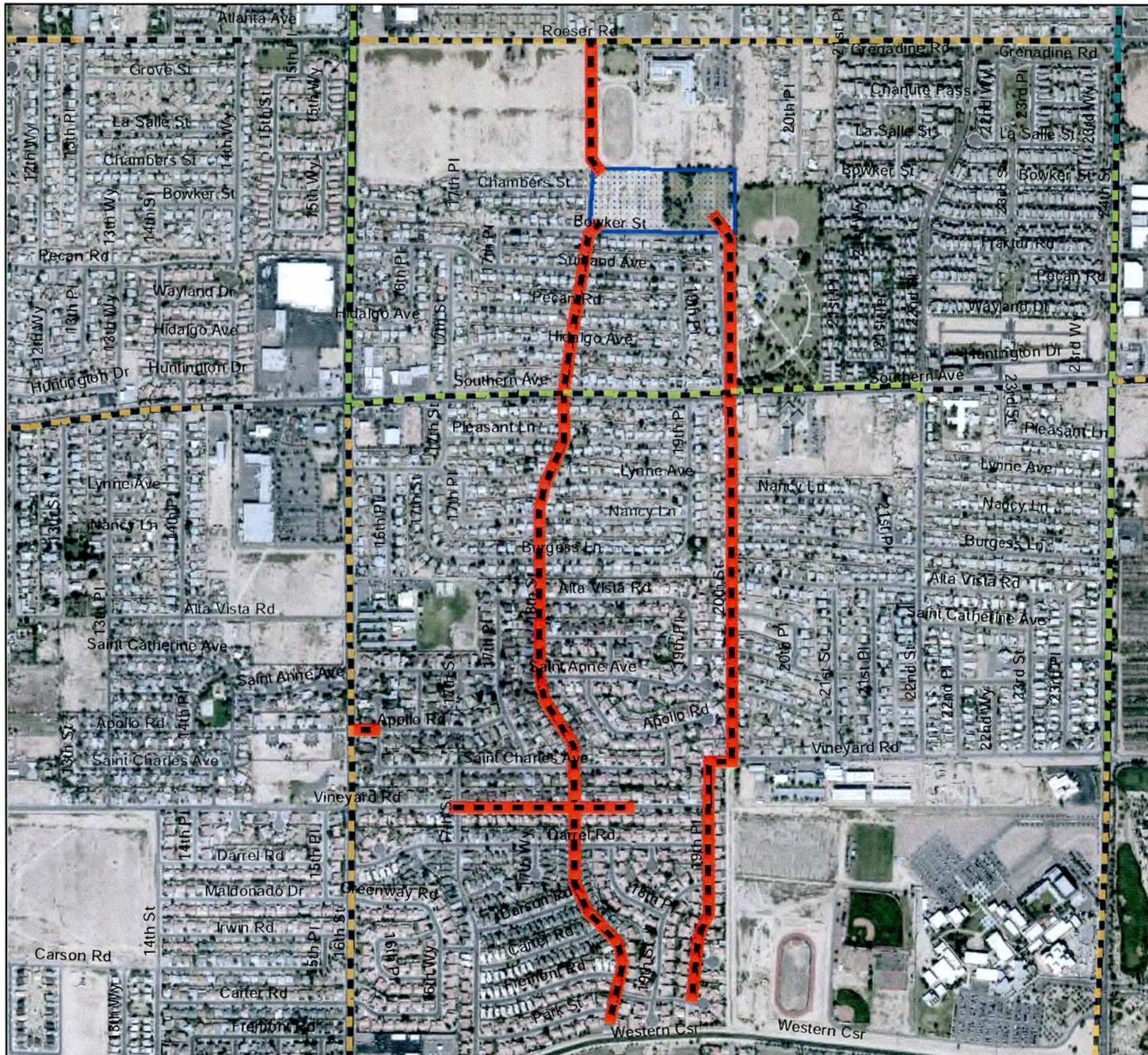
- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 6.1

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Preliminary Level 2
Alternative
Alternative 6.1



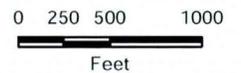
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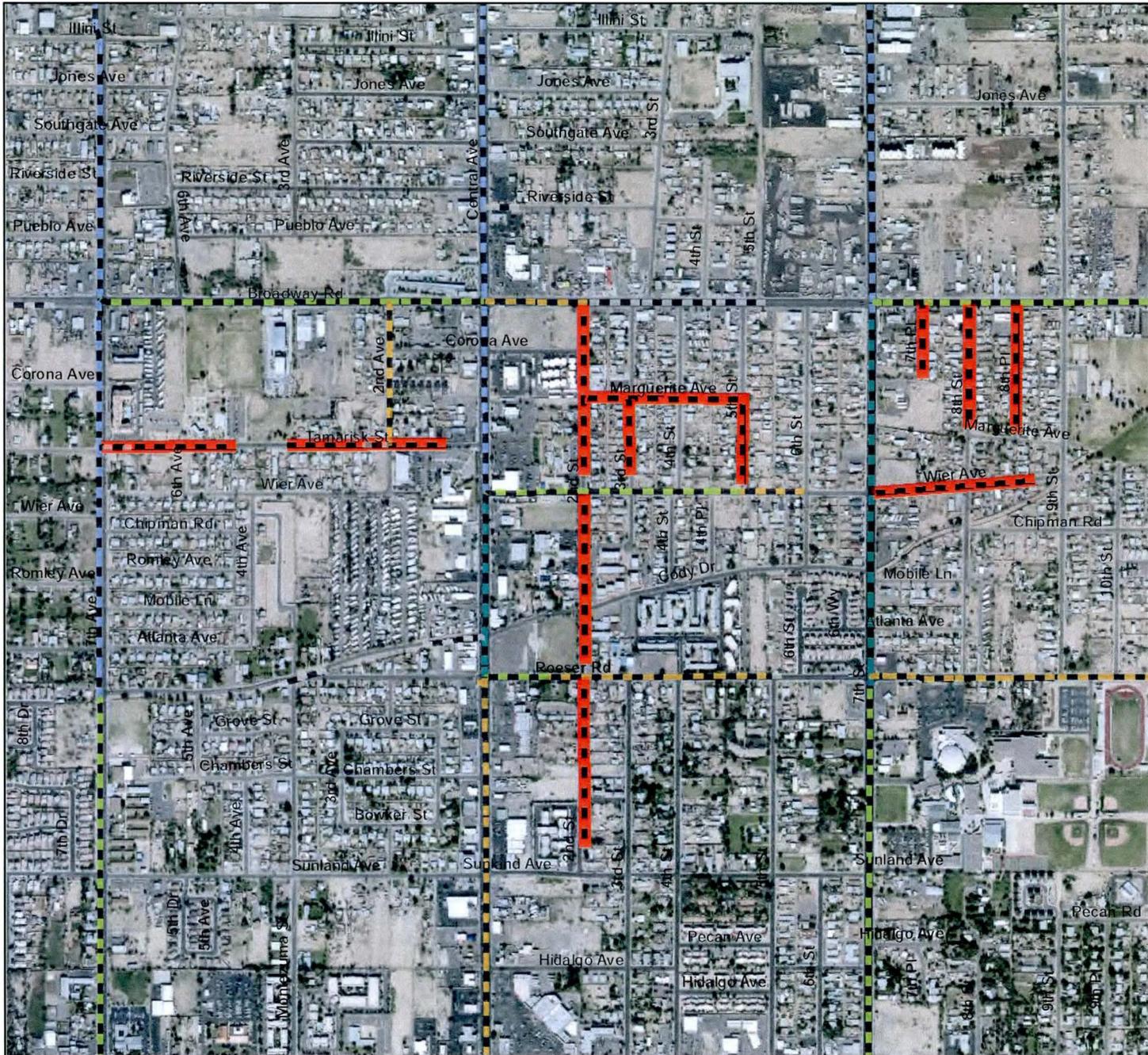
- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 6.3

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Preliminary Level 2
Alternative
Alternative 6.3



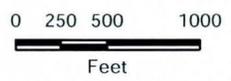
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Ex. Storm Drain (in)

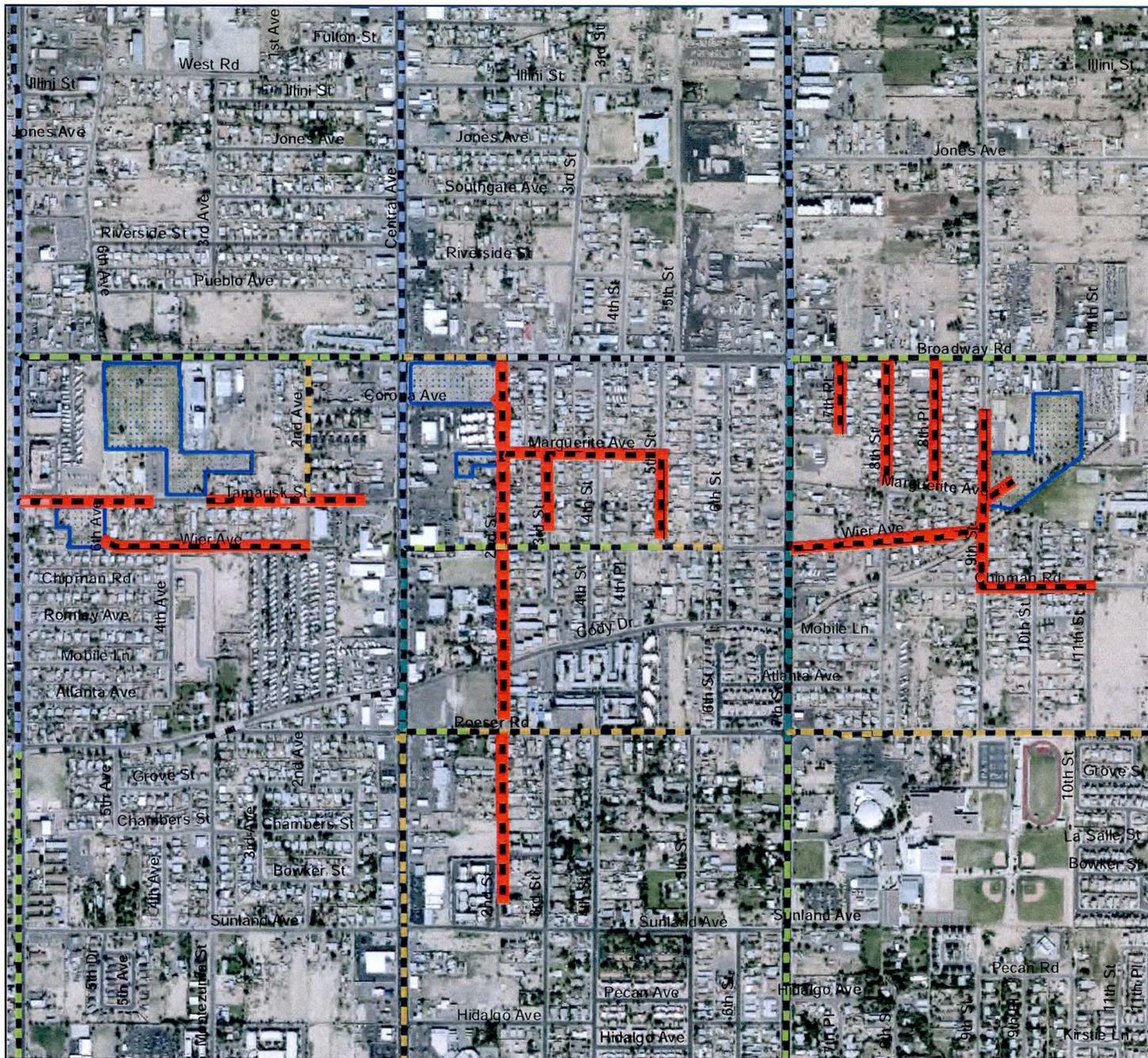
- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 7.1

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Preliminary Level 2
Alternative
Alternative 7.1



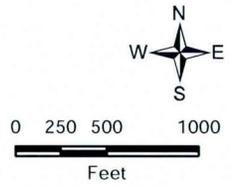
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Ex. Storm Drain (in)

- 18 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72
- 73 - 96

Alternative 7.2

- Channel
- Pipe
- Floodwall
- Inv Crown
- Dike/Dam
- Channel Option
- Pipe Option
- Floodwall Option
- Inv Crown Option
- Dike/Dam Option
- Basin
- Basin Option



Preliminary Level 2
Alternative
Alternative 7.2