City of Scottsdale Project No.: 410-TA02A-56047

North Arizona Canal Bank Improvements – Marshall Way to Goldwater Boulevard

FINAL DRAINAGE REPORT

April 2014

Prepared for:

CITY OF SCOTTSDALE
CAPITAL PROJECT MANAGEMENT

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Expires 3/31/2017

ABBREVIATIONS

A	area (units will be specified acres or square feet)
ac	acres
CB	catch basin
cfs	cubic feet per second
cu. ft. or cf	cubic feet
COS or "The City"	City of Scottsdale
DDM-I	Drainage Design Manual — Hydrology; FCDMC, August 2013
DDM-I	Drainage Design Manual — Hydraulics; FCDMC, August 2013
FCDMC	Flood Control District of Maricopa County
FF	First Flush (detention basin for first flush runoff)
FIRM	Flood Insurance Rate Map
fps	feet per second
HGL	hydraulic grade line
hr	hour(s)
in	inch(es)
i or in/hr	Intensity (of rainfall, inches per hour)
min	minute(s)
MH	manhole
MAG	Maricopa Association of Governments
NOAA	National Oceanographic and Atmospheric Administration
PVC	polyvinyl chloride (pipe)
Q	flow (in cubic feet per second)
RCP	Reinforced Concrete Pipe
SRP	Salt River Project
sq. ft. or sf	square feet
Tc	Time of Concentration in minutes
WSEL	Water Surface Elevation (measured in feet)
yr	year

DISCLAIMER

This report is for City of Scottsdale use only, and is not to be distributed to third parties outside of the City of Scottsdale. Background information, design basis, and other data have been furnished to URS by the City of Scottsdale and/or third parties, which URS has used in preparing this report. URS has relied on this information as furnished, and is neither responsible for nor has confirmed the accuracy of this information.

This report has been prepared based on certain key assumptions made by URS which substantially affect the conclusions and recommendations of this report. The version of design standards and manuals used in the design are stated in the body of the report. If the standards or manuals change in the future, they do not necessarily apply to this design. These assumptions listed herein, although thought to be reasonable and appropriate, may not prove to be true in the future. The conclusions and recommendations of URS are conditioned upon these assumptions.

This report is based on data, site conditions and other information that is generally applicable as of December 2013, and the conclusions and recommendations herein are therefore applicable only to that time frame.

1.0 INTRODUCTION

1.1 PURPOSE

The City of Scottsdale (the City) plans to construct landscape and pedestrian improvements for the north bank of the Arizona Canal between Marshall Way and Goldwater Boulevard. The site is bounded by the existing canal bank improvements at Marshall Way on the east and the existing Goldwater Boulevard bridge on the west (see **Figure 1-1**). The canal bank currently serves as a pedestrian corridor, and this project will complete the portion of the canal bank improvements adjacent to the "Broadstone at the Waterfront" project that is currently under construction. The City, in coordination with the Salt River Project (SRP) and the Broadstone project, will improve the canal bank with a new pedestrian path, SRP access underpass beneath Marshall Way, pedestrian lighting, canal freeboard wall, drainage improvements, landscape and irrigation, and other aesthetic enhancements.

1.2 DRAINAGE REPORT SCOPE OF WORK

This Final Drainage Report includes a description of existing drainage conditions, observations from a field review and photo documentation of existing onsite drainage structures and storm drains. The report lists the plans showing previously constructed storm drain improvements along the north bank of the Arizona Canal and describes the recommended drainage improvements to intercept the design storm runoff for the onsite improvements. The results of the hydrologic and preliminary hydraulic analysis are described herein.

1.3 LOCATION

The project is located entirely in the City of Scottsdale, Maricopa County, Arizona. The project falls entirely within the SE quarter of Section 22, Township 2 North, Range 4 East. The centroid of the project site is located at

Latitude	33.5006 degrees North
Longitude	111.9292 degrees West

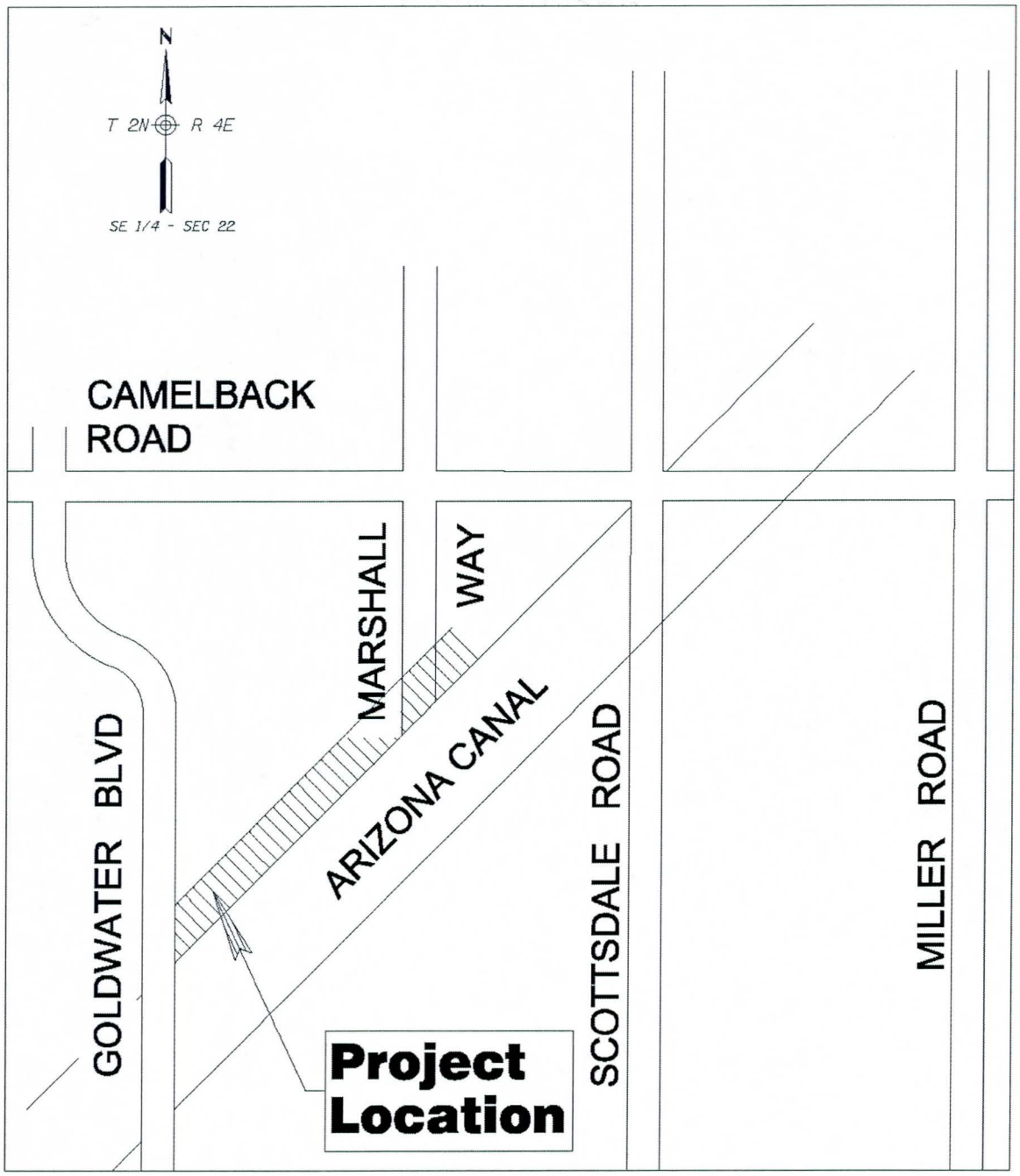

FIGURE 1-1
Vicinity Map

N.T.S.

1.4 DRAINAGE FIELD VISIT

A field visit was performed by URS staff on October 31, 2013. The existing drainage facilities and other existing improvements were photographed. The existing drainage conditions and ongoing development on the lot immediately north of the project site and west of Marshall Way were noted. Drainage related photographs are provided in **Appendix D**.

1.5 TOPOGRAPHY AND LAND USE

The existing ground gently slopes from north to south and terminates at the north bank of the Arizona Canal (see **Figure 1-2**). Although the Arizona Canal drains from northeast to southwest, existing surface runoff from the area north of the canal is collected into an existing Flood Control District of Maricopa County (FCDMC) storm drain that ultimately discharges into Indian Bend Wash, one mile to the east. The existing watershed is almost totally developed as a blend of commercial and high density residential development.

Goldwater Boulevard has a bridge that crosses over the canal. As a result, the roadway embankment forms the westernmost limit of the onsite watershed boundary. A second bridge over the canal is located at Marshall Way and also forms a local divide within the project onsite watershed.

The runoff from existing commercial development located along the east side of Marshall Way and north of the canal is presently collected via a storm drain branch that ties into the FCDMC storm drain. The runoff from ongoing development between Marshall Way and Goldwater Boulevard will be collected into another storm drain system that also discharges into the aforementioned FCDMC storm drain.

Certain segments of the north bank of the Arizona Canal in the area have a 1-foot high concrete freeboard wall along the existing canal wall. As part of this project, similar 1-foot high walls will be installed in sections where there are presently no freeboard walls. The walls are primarily designed to provide freeboard for the irrigation water conveyed in the canal.

The underpass beneath Marshall Way has already been excavated and retaining walls around the perimeter of the cul-de-sac form the north side of the excavation. The existing 12-foot high canal retaining wall forms the south side of the excavation. This project will provide a paved path and drainage improvements in the underpass.

A low retaining wall on the east side of the Marshall Way cul-de-sac presently separates a turf covered area from the existing underpass excavation. There is an existing concrete footpath on the east side of Marshall Way, and a low concrete retaining wall is located on the north side of that footpath.

1.6 HORIZONTAL-VERTICAL SURVEY CONTROL

The datum used for this project design and construction is City of Scottsdale for horizontal control and City of Scottsdale NAVD 88 vertical datum. See the cover sheet of the construction plans for specific survey control point(s) used.

1.7 PREVIOUS DRAINAGE DESIGN STUDIES

The previous drainage report provided by City of Scottsdale for this area is:

- Drainage Report Broadstone Waterfront #K12117 (KLAND Civil Engineers, LLC)

In that report, it was noted that the existing FCDMC storm drain is designed for the 25-year storm. Runoff exceeding the 25-year storm will back onto Via Soleri and when the water level reaches 1278.1 feet elevation, additional flow spills onto Goldwater Boulevard. Therefore, any overflow from the Broadstone development is not expected to discharge into or onto this North Canal Bank project. The 100-year gutter flow along Goldwater Boulevard will not enter this project site (barring any blockages).

The City of Scottsdale did not require the Broadstone development to retain the 100-year, 2-hour storm based on the design parameters from a previous study, which was in effect at the time of that writing for the City of Scottsdale:

- Downtown Infrastructure Master Plan Volume 3 Drainage Study (Boyle Engineering, 1986)

The Broadstone project is located within the Downtown Planning Area and an exemption from the requirement to retain the 100-year, 2-hour rainfall volume was granted by the City of Scottsdale. So no retention or detention is provided on that site.

1.8 DRAINAGE DESIGN STANDARDS

The following standard manuals and publications used for this onsite drainage design include:

- Design Standards & Policy Manual, Chapter 4; City of Scottsdale, January 2010
- Drainage Design Manual – Hydrology; FCDMC, August 2013 (DDM-I)
- Drainage Design Manual – Hydraulics; FCDMC, August 2013 (DDM-II)
- Hydraulic Engineering Circular No. 22, Third Edition; Federal Highway Administration, September 2009 (HEC-22)
- MAG Standards and Specifications
- City of Scottsdale Supplement to MAG Standards and Specifications

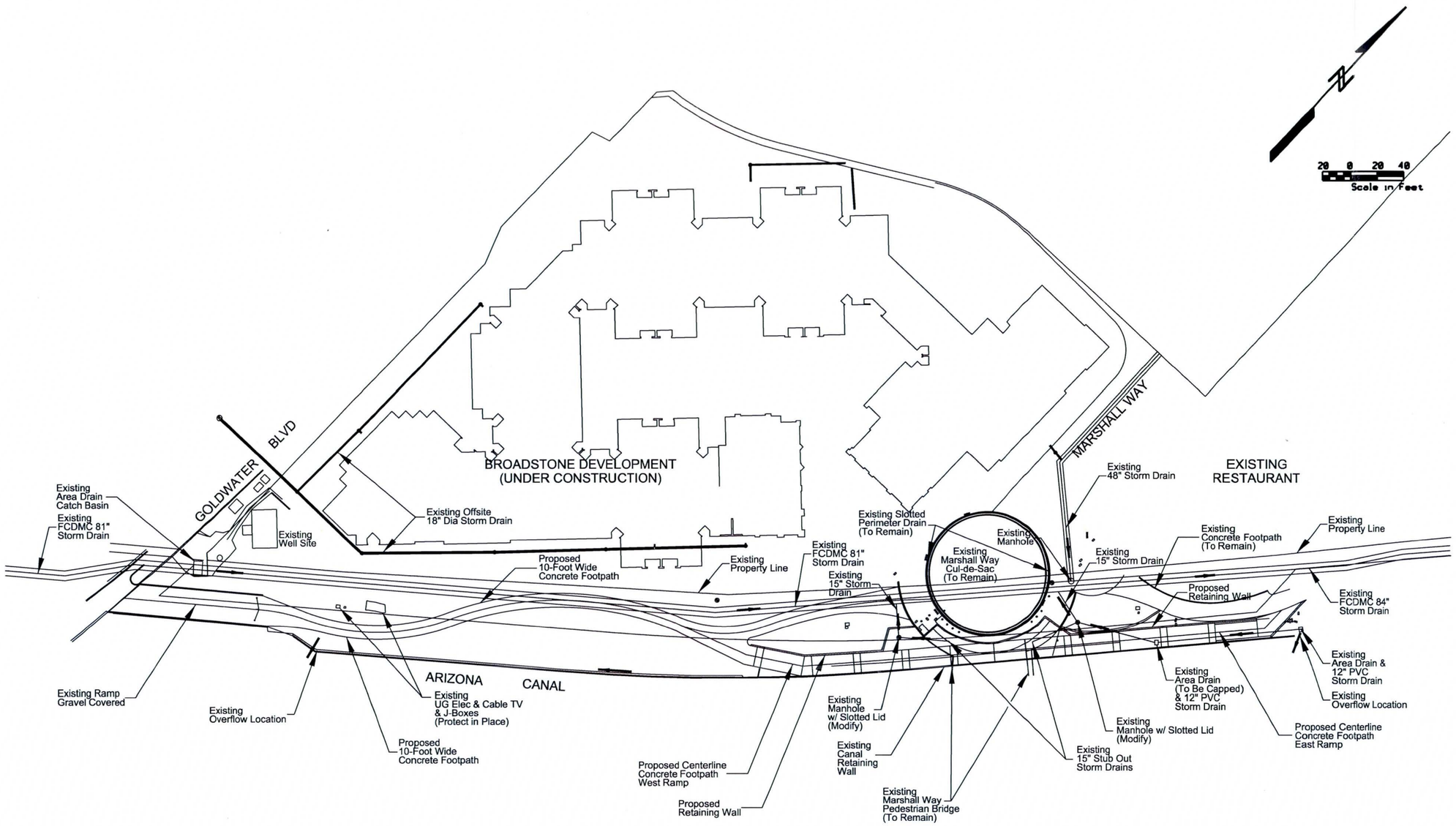

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FIGURE 1-2

SHEET NAME
PROJECT SITE MAP

DATE	REVISION	BY

ENGINEER

MUNICIPAL SERVICES DEPARTMENT
CAPITAL PROJECT MANAGEMENT
7447 E. INDIAN SCHOOL RD.
SCOTTSDALE, ARIZONA 85251

PROJECT TITLE
North Arizona Canal Bank Improvements

SCALE	DESIGNED	DATE	BID. NO.	SHT.
HORIZ. 1"=20	MRF			
VERT. N/A	DRAWN MRF	AS-BUILT	PROJECT NO.	OF

1.8.1 Drainage Parameters Used

The following drainage parameters used in this report are based on the aforementioned drainage standards. All measurements, dimensions, and standards use the SAE system (English units).

- Onsite Drainage Design Storms: 10-year (design storm)
  100-year (check storm)
- Rainfall Intensity and Depth Tables: NOAA Atlas 14 website
- Minimum Time of Concentration: 10-minutes
- First Flush Interception: First 0.5 inch of rainfall
- Rational Method Runoff Coefficients (for 10-year, 100-year)

$C_{10,conc}$ =	0.85	$C_{100,conc}$ =	0.95
$C_{10,bare\ gnd\ \&\ dg}$ =	0.70	$C_{100,bare\ gnd\ \&\ dg}$ =	0.88
$C_{10,turf}$ =	0.25	$C_{100,turf}$ =	0.31
C_{FF} =	1.00		

- Manning's roughness factor (n-values): n_{smooth} = 0.013 (RCP, HDPE and PVC)
- Catch Basin Flow Interception: 100% (all inlets in a sag condition)
- Surface Runoff from Pavement Sheet drain to First Flush basins
- Grate Catch Basins used (see Chapter 3 for catch basins used)
- Clogging Factor for Catch Basin Grates in Sag 50%
- Allowable Clearance — 100-year Hydraulic Grade Line to Grate/Rim Elevation: 6 inches
- Minimum storm drain flow velocity (for full pipe, 10-yr design flow, normal depth) 3 feet per second

1.9 STORM WATER RETENTION/DETENTION POLICY

The aforementioned Downtown Infrastructure Master Plan could not be obtained at the time of this writing. However, the City of Scottsdale Design Standards & Policies Manual, Grading and Drainage Chapter 4, Waiver Requirements Item 5 states that the stormwater retention can be waived if "the project is located within the Downtown Fee Reduction Area as described and approved by City Council Resolution #6238."

Although this Arizona Canal North Bank Improvement project is located within the Downtown Planning Area, it is <u>not eligible</u> for the same exemption from the detention requirement. A phone conversation with Ashley Couch (City of Scottsdale Storm Water Manager, Dec 17, 2013) disclosed that the City of Scottsdale will waive the normal requirement of 100-percent capture of the 100-year, 2-hour runoff from the developed parcel in the Downtown Planning Area, with certain stipulations that are discussed in Chapter 2.

1.10 EXISTING STORM DRAIN NETWORK

The existing FCDMC storm drain trunk line was purportedly designed in 1986 to handle the 25-year storm runoff (developed conditions) from the entire offsite watershed.

No modifications or new junctions with the FCDMC storm drain are needed. For this project, all new storm drains will connect to existing inlets or manholes that are already connected to the FCDMC storm drain.

The FCDMC storm drain is expected to be in a surcharge condition during the 100-year offsite runoff condition (calculated to be up to a 1278.10 water surface in the Broadstone Development Drainage Report). That elevation is at or above all of the grate elevations that are proposed for this pedestrian underpass project. Flow out of the proposed grates due to FCDMC storm drain surcharge cannot be prevented for large area storms exceeding the 25-year storm event.

The time of concentration for the local onsite drainage is expected to be 10 minutes, which is significantly less than the time of concentration for major flows in the FCDMC storm drain. It is reasonable that the local peak runoff can be collected from the project site and discharged into the FCDMC storm drain before the main peak flow would occur in this section of pipe.

Therefore, the assumption used for this drainage report is that the storm drain trunk line will be flowing full (to the existing crown of pipe) for the 10-year and 100-year onsite runoff cases. The flow velocities for the proposed storm drain system is checked using the 10-year storm scenario.

1.11 EXISTING DRAINAGE PATTERNS AND SYSTEMS

The existing FCDMC storm drain trunk line is located approximately 50 feet north of the north bank of the Arizona Canal. The storm drain varies in diameter from 81 inches to 84 inches within the project limits (see **Figure 1-2**).

The existing FCDMC storm drain presently has only one catch basin (CB 418X) which was so labeled to indicate the existing station along the storm drain (Station 417+83.98). Similar designations were used for other junctions along that FCDMC storm drain, namely:

- Existing tee T-423X which is the junction with the existing 15-inch diameter lateral P-155X
- Existing tee T-425X at a junction with an existing 42-inch collector from the north
- Existing manhole (MH)-424X, which is the junction with existing 15-inch diameter lateral P-225X

The runoff along Goldwater Boulevard is contained within the curb and gutter and is collected by curb opening catch basins located approximately 100 feet north of the canal. As stated earlier, no flows will enter the site from Goldwater Boulevard.

The Broadstone Waterfront — Drainage Report (11-06-2012) for that project states that no detention or retention is provided on the Broadstone site. A perimeter storm drain network along the south edge of the development will intercept runoff up to the capacity of the 18-inch diameter pipe (7.5 cfs, see confirming normal depth calculation in Appendix E). According to the

developer's calculations, the 100-year storm flow in that pipe will be 6.8 cfs, which is contained within the pipe. Therefore, no 100-year storm runoff is expected off of the Broadstone development.

Approximately 10 feet east of Goldwater Boulevard and north of the existing ramp, there is an existing 6-foot x 10-foot grate catch basin located directly over the 81-inch diameter FCDMC storm drain. That catch basin is part of a pump station site that is out of the project limits.

The cul-de-sac at Marshall Way drains radially outward to a perimeter trench drain. That drain discharges into an existing manhole (MH-425X) that is located in the existing concrete walk approximately 6 feet east of the perimeter drain. The manhole is located directly over the FCDMC storm drain. The storm drain transitions from 81-inch diameter to 84-inch diameter at that location.

1.11.1 Manholes and Catch Basins Used for Drainage Improvements

Two existing manholes (MH-155X and MH-225X) with slotted lids were installed with the Marshall Way cul-de-sac in anticipation of this underpass project. These two manholes will serve as the outfalls for the new drainage improvements associated with this project.

The manhole (MH-155X) to the west of Marshall Way has a rim elevation that is approximately 3 feet above the existing bottom of excavation. A 15-inch diameter reinforced concrete pipe (RCP) connects the manhole to the existing FCDMC storm drain. A 60-foot long, 15-inch diameter stub-out storm drain has been installed in the east side of the manhole. The stub-out will be utilized to connect a new drain for the underpass to MH-155X.

The second manhole (MH-225X) is located approximately 20 feet east of the Marshall Way perimeter drain, in a turf-covered area. The slotted lid is presently used to capture runoff in the turfed area. A 15-inch diameter RCP connects that manhole with the FCDMC storm drain. A 15-inch diameter, 35-foot long stub-out pipe has been installed in the west side of that manhole. If feasible, the stub-out will be utilized to connect a new drain for the underpass to MH-225X.

Two grate catch basins (CB 200X and CB 205X) are located east of MH-225X along the canal bank. These catch basins collect runoff along the canal bank. The downstream catch basin (CB 205X) discharges through a 12-inch diameter polyvinyl chloride (PVC) pipe into MH-225X.

1.12 EXISTING DRAINAGE PROBLEMS

No existing drainage problems were specifically identified by the City of Scottsdale. However, during the URS drainage field visit, the following minor drainage related problems were observed.

- Erosion rilling was noted along the north canal bank, where existing shallow sheet flow spills over the unprotected bank (on the west end of the project).
- Erosion rilling was more severe in the excavated area to the west of the underpass.
- There is no existing outlet for runoff that collects in the existing low point of the underpass. The existing manhole (MH-155X) rim is set approximately 3 feet too high to

intercept any runoff that collects in the existing underpass excavation. The collected flow must infiltrate the existing ground to dissipate.

- The existing 12-inch diameter PVC storm drains into and out of CB 205X were significantly clogged with silt/sand.

All of the aforementioned observed drainage problems will be remedied with the construction of the footpaths, underpass, retaining walls, and installation of decomposed granite ground cover.

1.13 100-YEAR FLOODPLAIN

The effective Federal Emergency Management Agency Flood Insurance Rate Map (FIRM) for the project site is Map Number 04013C1770L (dated October 16, 2013). There is no existing floodplain shown for the project site. Any floodplain that is shown is limited to the north side of Camelback Road or east of Scottsdale Road (see **Figure 1-3**).

1.14 EXISTING ULTIMATE OUTFALLS

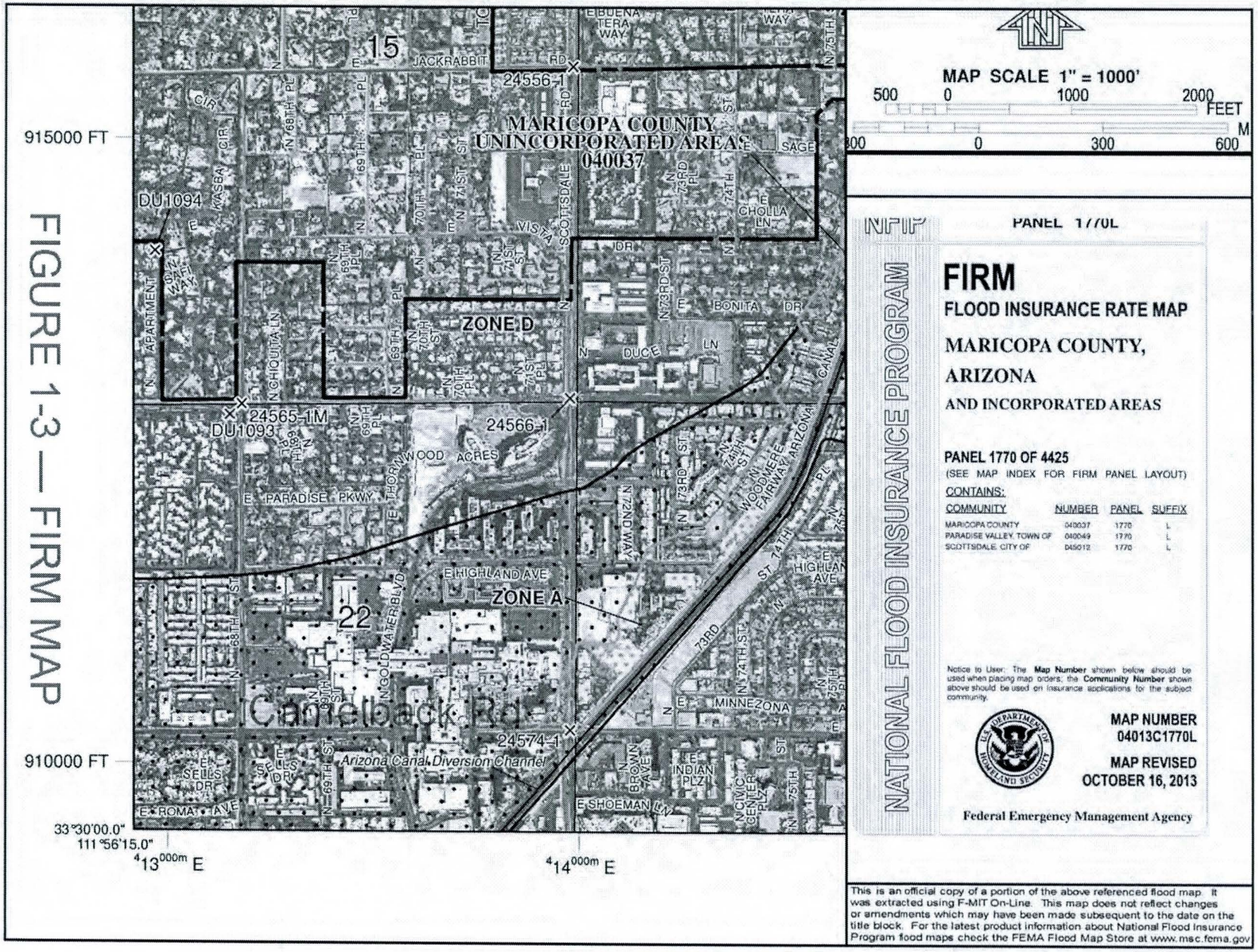
1.14.1 West End

The location of the existing ultimate outfall from the project site is at the bottom of the existing ramp from Goldwater Boulevard. The elevation of the ground there is approximately 1277.8. From that point, any overflow discharges into the Arizona Canal over the bank.

1.14.2 East End

The location of the ultimate outfall from the existing concrete walkway is just north of CB 200X. The elevation of the concrete path there is approximately 1278.73. From that point, any overflow discharges into the CB 200X.

FIGURE 1-3 — FIRM MAP



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1.15 PROPOSED IMPROVEMENTS

The following proposed improvements will affect the onsite drainage (see **Figure 1-2**):

- New 10-foot wide meandering pathway set at existing grade along the north Arizona Canal bank that will connect Goldwater Boulevard to the cul-de-sac at Marshall Way.
- New 14-foot wide concrete paved underpass pathway beneath Marshall Way bridge. The new path will be built with American Disabilities Act compliant ramps.
- The underpass will involve construction of new retaining walls and decomposed granite sideslopes in certain locations.
- New concrete freeboard walls with decorative hand railing will be built on top of the existing concrete canal wall.
- New landscaped areas (decomposed granite or turf) at approximately six locations bounded by the meandering concrete path. The landscaped areas will be used to capture first flush volumes of runoff from improved onsite areas.
- New storm water detention basins to intercept the controlling runoff storage volume.
- New drainage network to bleed off first flush runoff (first inch of runoff) and to convey the full 100-year onsite runoff from this site (see Chapter 3).

1.15.1 Storm Drain Network Coordinates

The northing and easting coordinates for the new storm drain pipe ends are provided on the Grading and Drainage plans.

2.0 HYDROLOGY

2.1 ONSITE WATERSHED OVERVIEW

This section describes the onsite watershed and the methodology used to model the runoff that is used to design the onsite drainage systems. See **Figure A-1** in **Appendix A** for the flow routing and proposed onsite watershed. The FCDMC will allow discharges from this onsite watershed into the FCDMC storm drain and has requested that the First Flush (FF) runoff from the site is retained. Those calculations and assumptions are also described herein.

2.2 RATIONAL METHOD RUNOFF FLOW CALCULATIONS

The Rational method is used to calculate the 10-year and 100-year peak runoff flows that are collected by the proposed storm drain network. This section describes the rainfall and Time of Concentration used, sub-basin delineation, and runoff coefficients used in those calculations (see **Table B-1** in **Appendix B**). The Rational formula is:

$$Q = C\,i\,A$$

Where: Q is in cubic feet per second;
C is runoff coefficient;
i is inches per hour; and
A is area in acres

2.2.1 Design Precipitation Depth and Intensity

The latitude and longitude of the centroid for the project is used as input for the NOAA Atlas 14 precipitation website. The Intensity-Duration-Frequency output is in **Table A-1A, Appendix A**. Likewise, the Depth-Duration-Frequency output is in **Table A-1B, Appendix A**.

Since each catch basin receiving runoff will be in a sag condition, there will be no bypass flow and no routing time needed. For this reason and the short pipe lengths, the minimum time of concentration (Tc) of 10 minutes is used for each storm frequency (10-year and 100-year). Those precipitation intensities are:

$i_{10\text{-yr},10\text{min}} =$ 3.59 inches per hour

$i_{100\text{-yr},10\text{min}} =$ 5.68 inches per hour

2.2.2 Drainage Sub-basins

The right-of-way line that separates the Broadstone project from this project forms the northwest boundary of the onsite watershed (see **Figure 2-1**). Goldwater Boulevard forms the watershed western limit, the north canal bank forms the southeast limit, and a local high point on the existing concrete walk located approximately 200 feet east of Marshall Way forms the eastern limit. The area around the existing pump station is separated from the project site.

Each proposed catch basin has one or more corresponding drainage sub-basins delineated to define the contributing runoff area for that catch basin. The measured areas are shown in acres on the Rational method calculations.

The same sub-basins are used for both the pre-development and post-development conditions. See **Table B-1A** in **Appendix B** for the pre-development conditions. See **Table B-1B** in **Appendix B** for the post-development conditions.

2.2.3 Runoff Coefficients

Separate sets of runoff coefficients (C-values) are used for 10-year storms and 100-year storms. See Chapter 1 for the C-coefficients used for the different ground covers encountered on this site (per the FCDMC table 3.2 excerpt in **Appendix A**).

- The pre-development individual sub-basins are either bare ground, turf or concrete so a single C-value can be used for that area.
- The post-development individual sub-basins have concrete, decomposed granite, or turf ground cover.
- When more than one type of ground cover is used in a given sub-basin, an area-weighted mean C-value is calculated (see **Tables B-1A and Table B-1B** in **Appendix B**).

2.3 STORM WATER DETENTION

The City of Scottsdale will waive the normal detention requirement of 100-percent capture of the 100-year, 2-hour runoff from the developed parcel with the following stipulations:

- Calculate and compare the runoff volumes from the entire parcel for pre-development and post-development conditions
- The required 100-year 2-hour detention volume is the difference between pre- and post-development volumes
- Calculate the First Flush volume (100-percent of the first half inch of rainfall)
- The required detention volume for this site is the greater of the two volumes
- The detention volume can be bled off into the FCDMC storm drain
- The minimum size bleed-off orifice size is 6-inch diameter if no grate or other clog-prevention method is provided (see discussion in Section 2.3.3)

2.3.1 Pre- Versus Post-Development Runoff

$V_{100\text{-yr},2\text{-hr Det Rqd}} = V_{\text{post dev}} - V_{\text{pre dev}}$

$V_{\text{pre dev}} = P_{100\text{-yr},2\text{-hr}} /12 \times \sum CA \times 43560$

$V_{\text{post dev}} = P_{100\text{-yr},2\text{-hr}} /12 \times \sum CA \times 43560$

$\sum C_{100\text{-yr}}A$ is the sum of $C_{100\text{-yr}} \times A$; where A is in Acres

$P_{100\text{-yr},2\text{-hour}} =$ 2.17 inches (see **Table A-1B in Appendix A**)

The results of the Pre- versus Post-Development volume calculations are summarized on **Table B-1B in Appendix B**. The net result is that the post-development condition produces 535 cubic feet less runoff than the pre-development condition. Therefore, the First Flush Detention Volume will be used for the design of the detention basins.

2.3.2 First Flush Detention Volume

The FF volume is 100 percent of the initial ½ inch of rainfall falling within the drainage area, and is defined by the formula:

$$Vol_{FF} = 1.00 \times 43560 \times A \times 0.5 \text{ inch} / 12$$

Where: Vol_{FF} is in cubic feet;
A is in acres

Six FF basins share the same number as the catch basins used to drain them. The FF basin volume calculations are shown in **Appendix D**. The Volume Required for each sub-basin area is shown on the post-development calculations **Table B-1B** in **Appendix B**. The runoff from the east and west ramps of the Marshall Way underpass cannot be stored in FF basins. For this reason, additional volume is provided in the six FF basins to account for this extra volume. The calculations for the volumes provided are shown on **Table B-2** in **Appendix B,** and the results are summarized on **Table 2-1**.

Total Volume Required — 998 cubic feet

Total Volume Provided — 2288 cubic feet

2.3.3 Detention Volume Bleed-Off Time

The City of Scottsdale and FCDMC both require that stored runoff be removed from detention basins within 36 hours from cessation of runoff. Each FF basin will have a primary outlet catch basin with a sized orifice built into the catch basin wall. The orifice will bleed the flow into the catch basin and storm drain system.

The City of Scottsdale normally requires a minimum 6-inch diameter orifice. That orifice size will provide a maximum flow rate of 0.62 cfs with one foot of depth. The average flow rate is assumed to be half of the maximum flow rate, or 0.31 cfs in this case. The largest detention volume on this project is 1306 cubic feet, which would be evacuated within 70.2 minutes. Although it meets the 36-hour bleed-off requirement, it is a very short detention time. So little flow attenuation can be expected.

To provide better flow attenuation for inflow to the FCDMC storm drain, the proposed orifice size is **reduced to 4-inches**. A readily available cone-shaped plastic grate will fit on the front of the orifice to prevent clogging (also known as an "Atrium Grate"). The 4-inch orifice flows at a maximum rate of 0.38 cfs and an average rate of 0.19 cfs, which increases the detention time to 115 minutes (1.91 hours).

2.4 100-YEAR HIGH WATER ELEVATION

The 100-year water surface elevation in each first flush basin is determined by calculating the depth of flow over each catch basin grate for the 100-year peak flow at that catch basin. Each catch basin is assumed to be 50 percent clogged. The detention basins are assumed to be full. See **Table C-1 in Appendix C** for the FlowMaster grate flow calculations.

The finished floor elevations of the nearest existing structures are provided for comparison to the 100-year water surface elevation (WSEL) at each FF basin shown on **Table 2-1**. The existing finished floor elevations are taken from as-built plans for each building (all were based on City of Scottsdale NAVD 88 datum).

Table 2-1 First Flush Basin Summary

FF Basin ID #	Volume Provided (cu ft)	100-yr WSEL	Finished Floor Elevation of Nearest Structure
110	393	1277.58	1282.40
130	1306	1276.12	1282.40
140	382	1277.55	1282.40
225	206	1278.55	1282.50

2.5 STORM DRAIN DESIGN

The existing storm drain network was created based on as-built plans from FCDMC and City of Scottsdale. The actual grate/rim and invert elevations of existing manholes and grate catch basins was surveyed and used to update the respective grate/rim elevations in the model. Some of the FCDMC storm drain (trunk line) manholes could not be located, so the as-built data is the best available information.

The new bleedoff structure grate elevations are set to be 1-foot above the first flush basin that it drains. The new pipes were sized to match the existing downstream pipe sizes in the existing storm drain system. The new pipe slopes were designed to meet or exceed minimum pipe flow velocity requirements (3 fps minimum). See the storm drain schematic and profile sheet in **Appendix C**.

Each inlet is modeled in a sag condition using the unattenuated design storm runoff (10-year). No inflows are modeled for CB 150, CB 215, MH-155X because they are junction structures only. It should be noted that MH 225X will actually function as a catch basin and appears in the StormCad model as CB 225X for the purpose of taking in flow.

The minor losses at each inlet or junction structure are modeled using the HEC22 method. The 10-year hydraulic grade line (HGL) at each inlet and manhole is more than 0.5 foot below the grate or rim in every case. See **Table C-2 Inlet Report** (10-year and 100-year) in **Appendix C**.

The calculated hydraulic data for each storm drain pipe in the network is summarized in **Table C-3 Pipe Report** (10-year and 100-year) in **Appendix C**.

The calculated hydraulic data for each manhole in the network is summarized in **Table C-4 Manhole Report** (10-year and 100-year) in **Appendix C**.

3.0 DRAINAGE CONCEPT

3.1 PROPOSED DRAINAGE IMPROVEMENTS

Three new storm drain branches are proposed to augment existing storm drains on the east and west sides of Marshall Way (see **Figure 3-1**). The pipe numbering convention follows the numbering of the catch basin located at the upstream end of that pipe (i.e., CB 110 flows into Pipe 110). The modifications of existing structures and new drainage inlets and pipes are discussed here.

3.1.1 Existing Drainage Structure Modifications

MH-155X presently does not collect flows from the underpass area. However, the lid will be reset at such an elevation to function as an ultimate overflow inlet for the proposed underpass. This manhole connects via a 15-inch PVC pipe to the FCDMC storm drain.

CB 200X and CB 205X — Existing CB 200X is located near the east end of the proposed east ramp of the underpass. The 12-inch PVC pipe out of that catch basin drains southwest through CB 205X and continues on to connect with existing manhole MH-225X (described below).

MH-225X has a slotted lid that presently collects surface runoff from the adjacent concrete path and turfed area and will continue to do so for the proposed drainage design. The existing manhole base and existing pipes shall be protected in place. However, the existing manhole riser/frame/cover will require temporary removal to facilitate construction of a new retaining wall along the north side of the east ramp of the underpass. First flush basin 225 will be reconstructed to capture runoff and MH 225X will have the riser, frame and slotted cover reset to be 6-inches above the FF basin bottom.

3.1.2 New Storm Drain 100

First flush basin 100 will collect runoff from the existing area north of the proposed concrete path at the west end of the project. The bleedoff structure (CB 100) discharges into pipe 100, which discharges onto the existing shotcrete apron around the existing FCDMC area inlet near the pump station.

3.1.3 New Storm Drain 130-140

First flush basins 130 and 140 will collect runoff from the existing ground level on the west side of Marshall Way. The bleedoff structures for those two basins are CB 130 and CB 140 respectively. Those pipes are interconnected and discharge into an existing manhole MH-155X, which connects via another 15-inch pipe to the FCDMC storm drain.

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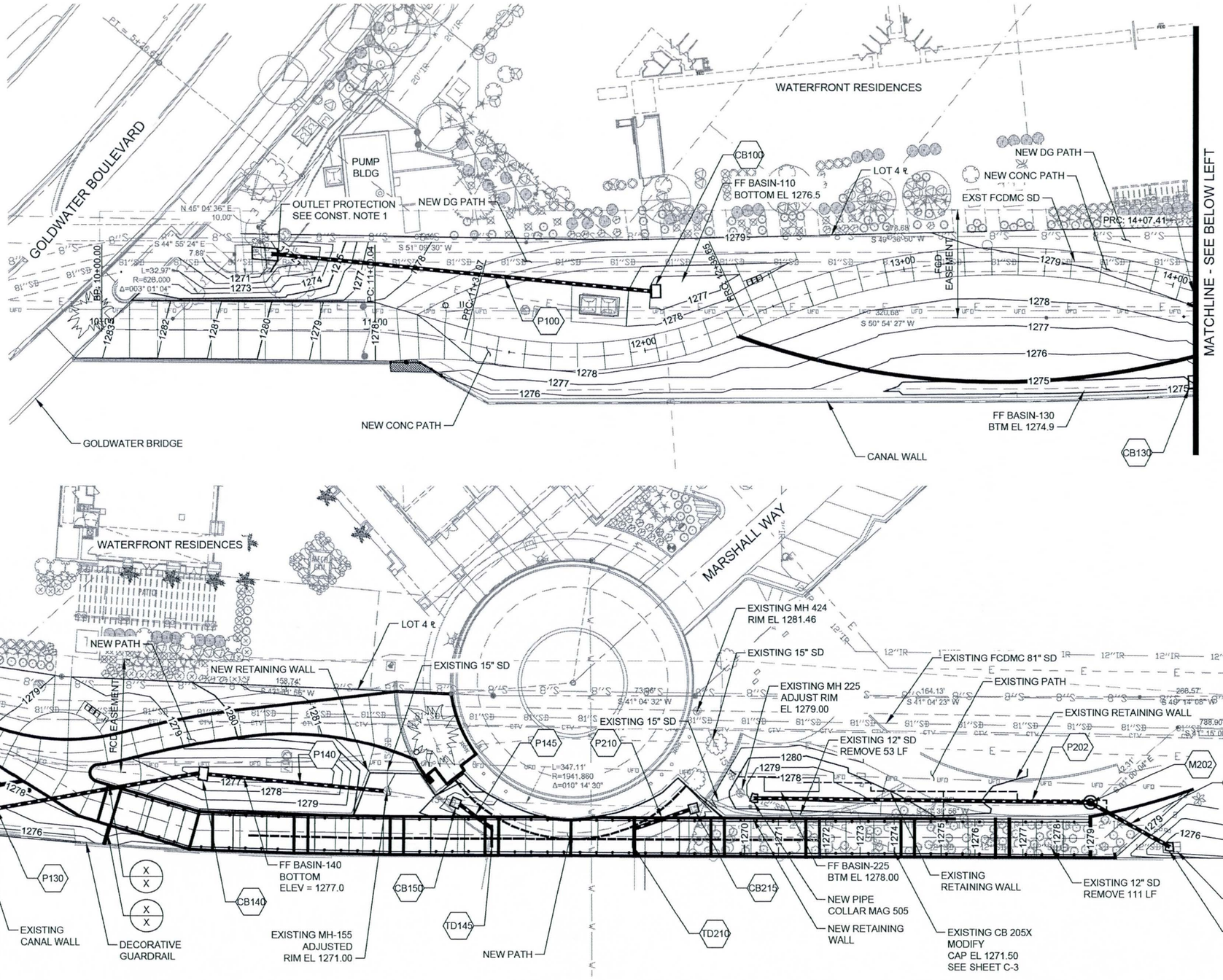

FIGURE 3-1

URS
7720 N. 16th Street, Suite 100
Phoenix, AZ. 85020
(602) 371-1100

BENCHMARK (CITY OF SCOTTSDALE DATUM) AT INTERSECTION OF CAMELBACK ROAD AND MILLER ROAD (76TH STREET)
NORTHING: 910235.45255
EASTING: 699750.59775
NAVD '88 ELEVATION: 1259.425

CONSTRUCTION NOTES

1. INSTALL 4" THICK SHOT-CRETE ON-SLOPE OUTLET PROTECTION, 6' WIDE BY 12' LONG, WITH 2' ABOVE TOP OF STORM DRAIN MITERED END.

* SEE STORM DRAIN PROFILES FOR ALL REMOVAL AND CONSTRUCTION NOTES PERTAINING TO NEW CATCH BASINS, MANHOLES AND STORM DRAINS.

MANHOLE

MH202 MAG 520 BASE AND MAG 522 MANHOLE SHAFT

CATCH BASIN

CB100 MAG 535 (MODIFIED), SEE DETAIL DB, SHEET C-5

CB130 MAG 535 (MODIFIED), SEE DETAIL DB, SHEET C-5

CB140 MAG 535 (MODIFIED), SEE DETAIL DB, SHEET C-5

CB150 MAG 537, SINGLE

CB215 MAG 537, SINGLE

TRENCH DRAIN

SD NO.	TYPE	FT.	NORTHING POINT 'A'	EASTING POINT 'A'	NORTHING POINT 'B'	EASTING POINT 'B'
TD145	DTL DA SHT C-4	8'	909294.37	696369.94	909289.03	696375.90
TD210	DTL DA SHT C-4	8'	909333.65	696404.29	909328.40	696410.33

NOTE: SEE SHEET C-4, DETAIL DA FOR HORIZONTAL CONTROL POINT.

PIPES

SD NO.	SIZE	FT.	NORTHING UPSTREAM INVERT	EASTING UPSTREAM INVERT	NORTHING DOWNSTREAM INVERT	EASTING DOWNSTREAM INVERT
P100	15" HDPE	141'	909045.42	696060.31	909145.08	696236.06
P130	15" HDPE	97'	909145.08	696236.06	909226.24	696285.04
P140	15" HDPE	68'	909227.43	696287.00	909272.39	696334.23
P145	12" PVC	16'	909293.53	696370.49	909290.33	696355.82
P201	12" PVC	33'	909477.55	696539.44	909466.30	696508.18
P202	12" PVC	124'	909466.30	696508.18	909373.79	696425.81
P210	12" PVC	21.3'	909333.13	696405.27	909353.51	696413.40

NOTE: UNDERLINED NORTHING AND EASTING FOR PIPE, CATCH BASIN AND MANHOLE HORIZONTAL CONTROL

SHEET NAME
GRADING AND DRAINAGE PLAN

DATE	REVISION	BY

ENGINEER

MUNICIPAL SERVICES DEPARTMENT
CAPITAL PROJECT MANAGEMENT
7447 E. INDIAN SCHOOL RD.
SCOTTSDALE, ARIZONA 85251

PROJECT TITLE
North Arizona Canal Bank Improvements

SCALE	DESIGNED	DATE	BID. NO.	SHT.
HORIZ. 1" = 20'	MRF			
VERT. N/A	DRAWN MRF	AS-BUILT	PROJECT NO.	OF

Call at least two full working days before you begin excavation.
ARIZONA 811
Dial 8-1-1 or 1-800-STAKE-IT (782-5348)
In Maricopa County: (602) 263-1100

3.1.4 New Storm Drain 145-150

The runoff from the west end of the proposed underpass is collected by a new trench drain (TD 145) located at the base of the west ramp of the underpass. The inlet drains via a new 12-inch PVC into a new MAG standard detail 537 inlet (CB 150), which then drains via an existing 15-inch PVC pipe to MH-155X.

3.1.5 New Storm Drain 201-202

CB 200X is located near the upper end of the east ramp, and is expected to remain in service. However, catch basin CB 205X and Pipe P200X will interfere with the new underpass east ramp and retaining wall. CB 205X and most of the pipes P200X and P205X will be removed.

The flow from CB 200X will be diverted at a new concrete pipe collar (PC 201) into new pipe P201 that will discharge into new manhole MH 202 and on to new pipe P202. The new pipe P202 will be installed after the east ramp retaining wall has been constructed, but prior to backfilling the excavation.

New pipe P202 will connect to a remaining stub of pipe P205X with a second concrete pipe collar (PC203). Pipe P205X presently connects to existing MH-225X, which will remain.

3.1.6 New Storm Drain 210-215

The runoff from the east end of the proposed underpass is collected by a new trench drain (TD 210) located at the base of the east ramp of the underpass. The inlet drains via a new 12-inch PVC into a new MAG standard detail 537 inlet (CB 215), which then drains via an existing 15-inch PVC pipe to MH-225X.

3.2 PROPOSED INLETS

The four inlet types proposed are:

- Area Inlet Catch Basins: MAG Standard Detail 535
- Manholes with 30-inch slotted covers Neenah Model R-2586
- Minor Drains/New Pipe Junctions: MAG Standard Detail 537, single
- Walkway Drains (w/ bicycle-safe grates) Linear Trench Drains

3.2.1 Area Inlet Catch Basins

The landscaped areas will be depressed below the adjacent concrete paths and the MAG 535 grate-covered catch basins are recommended for the interception of collected runoff. The first flush (FF) volume for the contributing area will be retained prior to any inflow occurring at a given inlet. Each catch basin will be set into the side slope of the FF detention basin, with the grate set 12 inches above basin bottom.

As described in Chapter 2, a 4-inch diameter orifice is recommended in the front face of each detention basin outlet catch basin (modified MAG Det 535). The invert of the 4-inch orifice will

be set with the invert at the detention basin bottom. So the centroid of the orifice will be 1.5-inches above the basin bottom.

A pre-manufactured PVC cone shaped grate (also known as an "atrium grate") is readily available for 4-inch PVC pipe at most hardware stores. This will reduce clogging and can be readily replaced if damaged or stolen.

3.2.2 Existing Manholes with Slotted Lids

There are two existing manholes (MH-155 and MH-225) that will serve as the primary junctions for all of the new storm drain branches constructed for this project. MH-155X is located just west of Marshall Way and MH-225X is located just east of Marshall Way. Both manholes will require some degree of modification for this project. Both will have slotted covers in the final configuration.

MH-155X — As part of the construction of the new west ramp for the underpass, a new 14-foot high retaining wall will be constructed west and north of the existing manhole MH-155X. At present, we anticipate that the existing manhole can be protected in place during the construction of the new retaining wall. After completion of the ramp and retaining wall construction, the existing manhole riser, frame and lid will be reset to match the proposed finished grade of the decomposed granite covered area. The new elevation of the rim will be 2.4-feet above the lowest part of the underpass ramps. This slotted manhole lid will serve as a redundant backup for the catch basins that will be installed in the underpass. However, this manhole is not expected to have any significant inflows during the design storm.

MH-225X — The existing MH-225X riser, frame and lid will need to be temporarily removed to accommodate construction of a new retaining wall for the east ramp. The existing pipes and manhole base will be protected in place. When the new retaining wall is complete, the MH-225X manhole riser, frame and lid will be reset to be approximately 6 inches above the reinstalled turf. The back edge of the manhole rim will be set even with the adjacent turf covered slope. This manhole is expected to take any runoff that exceeds the first flush volume in FF Basin 225.

3.2.3 New Pipe Junctions

Adjacent to the toe of slope for each underpass ramp, a new MAG 537 single-wide grate catch basin will be constructed on each respective 15-inch stub-out pipe. Each of these 2-foot square, grate catch basins will primarily serve as junction structures for new adjacent trench drains. The grates will be set approximately 0.1-foot above the low point of the underpass to serve as safety overflow inlets in the event of clogging of the trench drain inlets described in the next section.

- West ramp — CB 150 constructed on Pipe 150X
- East ramp — CB 215 constructed on Pipe 215X

3.2.4 Trench Drain Inlets

Pre-manufactured trench drains that are 6 inches wide x 8 feet long (total length) will be installed at the ends of the east and west underpass ramps. Each trench drain will be centered on the path and are comprised of a 2-foot long, 6-inch wide pre-manufactured catch basin and 6 linear feet of 6-inch wide trench drain. Only the 6-inch wide ADA compliant grate is visible on the concrete underpass pathway. The catch basins are positioned to miss the footings of the adjacent structures.

Due to the confined space of the underpass, it will not be possible to contain the first flush volume from the east and west ramps. To mitigate this, additional storage volume will be provided at each of the FF basins that will be constructed elsewhere on the project. In addition, the special catch basin at each location will have a fitted debris filter to intercept solids that are not stopped by the trench drain grate. The debris filters will require periodic inspection and cleaning, as part of routine operation and maintenance activities.

New 12-inch diameter PVC pipe will connect each trench drain assembly to the adjacent MAG 537 catch basin.

- West ramp — TD 145 connects to CB 150
- East ramp — TD 210 connects to CB 215

3.3 PROPOSED SURFACE DRAINAGE ULTIMATE OUTFALLS

Because the capacity of the FCDMC storm drain is for the 25-year storm, the hydraulic grade line (HGL) for a 100-year storm in that system could back up into the proposed drainage features for this project. During such regional flooding, the underpass can be expected to be flooded. That flood water can be expected to route to one or both of the following two outfalls. As the HGL in the FCDMC storm drain lowers, the local onsite flooding will quickly dissipate.

3.3.1 West End

The location of the ultimate outfall for the proposed concrete path will be at approximately the same location as the existing case. That new overflow elevation will be 1277.96. This will be approximately 1-foot below the finished grade of the north property line (elevation 1279 according to Broadstone grading plans). Flows exceeding the 100-year storm will overflow into the canal.

3.3.2 East End

The location of the ultimate outfall for the proposed east ramp for the underpass will be at Station 54+00. That new overflow elevation will be 1279.00. This will be approximately 3.1 feet below the existing concrete walkway near the adjacent restaurant. Any overflow would discharge into CB 200X, which will remain. The canal freeboard wall top elevation at this location is 1276.4. Flows exceeding the 100-year storm will overflow into the canal.

APPENDIX A

PRECIPITATION TABLES & DRAINAGE AREA MAP

TABLE A-1 - PRECIPITATION INTENSITY

NOAA Atlas 14, Volume 1, Version 5
Location name: Scottsdale, Arizona, US*
Coordinates: 33.5006, -111.9292
Elevation: 1280ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval(years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	2.21 (1.85-2.69)	2.88 (2.42-3.52)	3.92 (3.28-4.76)	4.72 (3.91-5.70)	5.78 (4.73-6.96)	6.62 (5.34-7.92)	7.46 (5.90-8.90)	8.33 (6.48-9.92)	9.48 (7.18-11.3)	10.4 (7.69-12.4)
10-min	1.68 (1.40-2.05)	2.20 (1.85-2.68)	2.98 (2.49-3.62)	3.59 (2.98-4.33)	4.40 (3.59-5.30)	5.03 (4.06-6.02)	5.68 (4.49-6.78)	6.34 (4.93-7.55)	7.22 (5.47-8.62)	7.89 (5.86-9.43)
15-min	1.39 (1.16-1.69)	1.81 (1.53-2.21)	2.46 (2.06-2.99)	2.96 (2.46-3.58)	3.64 (2.97-4.38)	4.16 (3.36-4.98)	4.70 (3.71-5.60)	5.24 (4.07-6.24)	5.96 (4.52-7.12)	6.52 (4.84-7.80)
30-min	0.934 (0.782-1.14)	1.22 (1.03-1.49)	1.66 (1.39-2.01)	2.00 (1.66-2.41)	2.45 (2.00-2.95)	2.80 (2.26-3.35)	3.16 (2.50-3.77)	3.53 (2.74-4.20)	4.02 (3.04-4.79)	4.39 (3.26-5.25)
60-min	0.578 (0.484-0.704)	0.755 (0.636-0.921)	1.03 (0.858-1.25)	1.24 (1.03-1.49)	1.52 (1.24-1.82)	1.73 (1.40-2.08)	1.96 (1.55-2.33)	2.18 (1.70-2.60)	2.49 (1.88-2.97)	2.72 (2.02-3.25)
2-hr	0.335 (0.286-0.400)	0.434 (0.370-0.520)	0.580 (0.492-0.691)	0.692 (0.580-0.823)	0.845 (0.701-0.998)	0.962 (0.788-1.13)	1.08 (0.874-1.28)	1.21 (0.954-1.42)	1.37 (1.06-1.61)	1.50 (1.13-1.78)
3-hr	0.243 (0.206-0.293)	0.312 (0.265-0.377)	0.410 (0.347-0.494)	0.487 (0.409-0.584)	0.596 (0.492-0.709)	0.682 (0.556-0.810)	0.773 (0.618-0.917)	0.867 (0.682-1.03)	0.997 (0.761-1.18)	1.10 (0.821-1.31)
6-hr	0.147 (0.127-0.173)	0.186 (0.161-0.219)	0.238 (0.206-0.280)	0.280 (0.240-0.327)	0.337 (0.285-0.391)	0.382 (0.318-0.442)	0.429 (0.351-0.496)	0.476 (0.382-0.552)	0.541 (0.424-0.628)	0.593 (0.453-0.690)
12-hr	0.082 (0.071-0.095)	0.103 (0.090-0.120)	0.130 (0.113-0.151)	0.152 (0.131-0.176)	0.181 (0.155-0.209)	0.204 (0.172-0.234)	0.227 (0.189-0.261)	0.250 (0.205-0.288)	0.281 (0.225-0.326)	0.306 (0.240-0.356)
24-hr	0.049 (0.043-0.055)	0.062 (0.055-0.070)	0.080 (0.071-0.091)	0.095 (0.084-0.107)	0.115 (0.101-0.130)	0.131 (0.114-0.147)	0.148 (0.128-0.166)	0.165 (0.142-0.185)	0.188 (0.160-0.212)	0.207 (0.175-0.234)
2-day	0.026 (0.023-0.030)	0.034 (0.030-0.038)	0.044 (0.039-0.050)	0.053 (0.047-0.059)	0.064 (0.057-0.073)	0.074 (0.065-0.083)	0.084 (0.073-0.094)	0.094 (0.081-0.106)	0.108 (0.093-0.123)	0.120 (0.101-0.136)
3-day	0.019 (0.017-0.021)	0.024 (0.021-0.027)	0.031 (0.028-0.035)	0.037 (0.033-0.042)	0.046 (0.040-0.052)	0.053 (0.046-0.059)	0.060 (0.052-0.067)	0.068 (0.058-0.076)	0.078 (0.067-0.088)	0.087 (0.073-0.098)
4-day	0.015 (0.013-0.017)	0.019 (0.017-0.021)	0.025 (0.022-0.028)	0.030 (0.026-0.033)	0.037 (0.032-0.041)	0.042 (0.037-0.047)	0.048 (0.042-0.054)	0.054 (0.047-0.061)	0.063 (0.054-0.071)	0.071 (0.059-0.080)
7-day	0.009 (0.008-0.011)	0.012 (0.011-0.014)	0.016 (0.014-0.018)	0.019 (0.017-0.021)	0.023 (0.020-0.026)	0.027 (0.023-0.030)	0.031 (0.026-0.034)	0.035 (0.030-0.039)	0.040 (0.034-0.045)	0.045 (0.038-0.051)
10-day	0.007 (0.006-0.008)	0.009 (0.008-0.010)	0.012 (0.011-0.014)	0.014 (0.013-0.016)	0.018 (0.015-0.020)	0.020 (0.018-0.023)	0.023 (0.020-0.026)	0.026 (0.022-0.029)	0.030 (0.026-0.034)	0.033 (0.028-0.038)
20-day	0.004 (0.004-0.005)	0.006 (0.005-0.006)	0.007 (0.007-0.008)	0.009 (0.008-0.010)	0.011 (0.009-0.012)	0.012 (0.011-0.013)	0.013 (0.012-0.015)	0.015 (0.013-0.017)	0.017 (0.015-0.019)	0.018 (0.016-0.021)
30-day	0.003 (0.003-0.004)	0.004 (0.004-0.005)	0.006 (0.005-0.006)	0.007 (0.006-0.008)	0.008 (0.007-0.009)	0.009 (0.008-0.010)	0.010 (0.009-0.012)	0.012 (0.010-0.013)	0.013 (0.011-0.015)	0.014 (0.012-0.016)
45-day	0.003 (0.002-0.003)	0.003 (0.003-0.004)	0.004 (0.004-0.005)	0.005 (0.005-0.006)	0.006 (0.006-0.007)	0.007 (0.006-0.008)	0.008 (0.007-0.009)	0.009 (0.008-0.010)	0.010 (0.008-0.011)	0.011 (0.009-0.012)
60-day	0.002 (0.002-0.002)	0.003 (0.003-0.003)	0.004 (0.003-0.004)	0.004 (0.004-0.005)	0.005 (0.005-0.006)	0.006 (0.005-0.006)	0.006 (0.006-0.007)	0.007 (0.006-0.008)	0.008 (0.007-0.009)	0.008 (0.007-0.009)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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TABLE A-2 PRECIPITATION DEPTH

NOAA Atlas 14, Volume 1, Version 5
Location name: Scottsdale, Arizona, US*
Coordinates: 33.5006, -111.9292
Elevation: 1280ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval(years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.184 (0.154-0.224)	0.240 (0.202-0.293)	0.327 (0.273-0.397)	0.393 (0.326-0.475)	0.482 (0.394-0.580)	0.552 (0.445-0.660)	0.622 (0.492-0.742)	0.694 (0.540-0.827)	0.790 (0.598-0.943)	0.864 (0.641-1.03)
10-min	0.280 (0.234-0.341)	0.366 (0.308-0.446)	0.497 (0.415-0.604)	0.598 (0.496-0.722)	0.734 (0.599-0.883)	0.839 (0.677-1.00)	0.947 (0.749-1.13)	1.06 (0.821-1.26)	1.20 (0.911-1.44)	1.32 (0.976-1.57)
15-min	0.347 (0.290-0.423)	0.453 (0.382-0.553)	0.616 (0.515-0.748)	0.741 (0.615-0.895)	0.910 (0.743-1.09)	1.04 (0.839-1.25)	1.17 (0.928-1.40)	1.31 (1.02-1.56)	1.49 (1.13-1.78)	1.63 (1.21-1.95)
30-min	0.467 (0.391-0.569)	0.610 (0.514-0.744)	0.829 (0.693-1.01)	0.998 (0.828-1.21)	1.23 (1.00-1.47)	1.40 (1.13-1.68)	1.58 (1.25-1.89)	1.76 (1.37-2.10)	2.01 (1.52-2.40)	2.20 (1.63-2.63)
60-min	0.578 (0.484-0.704)	0.755 (0.636-0.921)	1.03 (0.858-1.25)	1.24 (1.03-1.49)	1.52 (1.24-1.82)	1.73 (1.40-2.08)	1.96 (1.55-2.33)	2.18 (1.70-2.60)	2.49 (1.88-2.97)	2.72 (2.02-3.25)
2-hr	0.670 (0.571-0.800)	0.867 (0.739-1.04)	1.16 (0.984-1.38)	1.38 (1.16-1.65)	1.69 (1.40-2.00)	1.92 (1.58-2.27)	2.17 (1.75-2.55)	2.41 (1.91-2.84)	2.74 (2.12-3.23)	3.00 (2.27-3.55)
3-hr	0.730 (0.618-0.880)	0.937 (0.797-1.13)	1.23 (1.04-1.48)	1.46 (1.23-1.75)	1.79 (1.48-2.13)	2.05 (1.67-2.43)	2.32 (1.86-2.75)	2.60 (2.05-3.08)	2.99 (2.29-3.55)	3.31 (2.46-3.93)
6-hr	0.879 (0.760-1.04)	1.11 (0.967-1.31)	1.43 (1.23-1.68)	1.68 (1.44-1.96)	2.02 (1.71-2.34)	2.29 (1.90-2.65)	2.57 (2.10-2.97)	2.85 (2.29-3.30)	3.24 (2.54-3.76)	3.55 (2.71-4.13)
12-hr	0.982 (0.859-1.14)	1.24 (1.08-1.44)	1.57 (1.37-1.82)	1.83 (1.58-2.12)	2.18 (1.87-2.52)	2.45 (2.07-2.82)	2.73 (2.27-3.14)	3.01 (2.47-3.47)	3.39 (2.71-3.92)	3.68 (2.90-4.29)
24-hr	1.17 (1.04-1.32)	1.49 (1.32-1.69)	1.93 (1.71-2.18)	2.28 (2.02-2.57)	2.76 (2.43-3.11)	3.14 (2.74-3.53)	3.54 (3.07-3.98)	3.95 (3.40-4.45)	4.52 (3.85-5.09)	4.97 (4.19-5.61)
2-day	1.26 (1.13-1.43)	1.62 (1.44-1.83)	2.12 (1.89-2.40)	2.53 (2.24-2.85)	3.09 (2.73-3.48)	3.54 (3.10-3.99)	4.02 (3.50-4.53)	4.51 (3.90-5.09)	5.20 (4.44-5.88)	5.76 (4.87-6.53)
3-day	1.34 (1.19-1.51)	1.71 (1.52-1.94)	2.25 (2.00-2.54)	2.69 (2.38-3.03)	3.30 (2.90-3.72)	3.80 (3.32-4.27)	4.32 (3.75-4.86)	4.87 (4.19-5.48)	5.64 (4.80-6.36)	6.27 (5.28-7.08)
4-day	1.41 (1.25-1.60)	1.81 (1.60-2.04)	2.38 (2.11-2.69)	2.85 (2.52-3.21)	3.51 (3.08-3.95)	4.05 (3.53-4.55)	4.62 (4.00-5.19)	5.22 (4.48-5.88)	6.08 (5.15-6.84)	6.78 (5.68-7.64)
7-day	1.57 (1.39-1.78)	2.01 (1.78-2.27)	2.65 (2.35-2.99)	3.17 (2.80-3.58)	3.91 (3.43-4.40)	4.50 (3.93-5.06)	5.13 (4.44-5.78)	5.80 (4.98-6.54)	6.75 (5.72-7.61)	7.51 (6.30-8.49)
10-day	1.70 (1.51-1.93)	2.18 (1.94-2.46)	2.88 (2.55-3.24)	3.44 (3.04-3.87)	4.23 (3.71-4.74)	4.86 (4.24-5.44)	5.53 (4.80-6.20)	6.24 (5.37-7.00)	7.22 (6.14-8.11)	8.02 (6.75-9.02)
20-day	2.10 (1.87-2.35)	2.70 (2.40-3.02)	3.56 (3.17-3.99)	4.21 (3.74-4.71)	5.09 (4.50-5.69)	5.77 (5.08-6.45)	6.46 (5.66-7.23)	7.16 (6.24-8.02)	8.10 (7.00-9.10)	8.83 (7.57-9.92)
30-day	2.45 (2.17-2.75)	3.15 (2.80-3.53)	4.15 (3.69-4.65)	4.91 (4.35-5.49)	5.93 (5.23-6.63)	6.72 (5.90-7.50)	7.53 (6.58-8.40)	8.35 (7.26-9.31)	9.45 (8.15-10.6)	10.3 (8.82-11.5)
45-day	2.83 (2.53-3.17)	3.65 (3.26-4.09)	4.81 (4.29-5.38)	5.67 (5.04-6.34)	6.80 (6.03-7.60)	7.65 (6.76-8.55)	8.51 (7.49-9.52)	9.37 (8.21-10.5)	10.5 (9.14-11.8)	11.4 (9.83-12.8)
60-day	3.13 (2.81-3.50)	4.05 (3.62-4.52)	5.32 (4.76-5.94)	6.25 (5.58-6.97)	7.46 (6.64-8.31)	8.35 (7.41-9.31)	9.25 (8.17-10.3)	10.1 (8.91-11.3)	11.3 (9.87-12.6)	12.1 (10.6-13.6)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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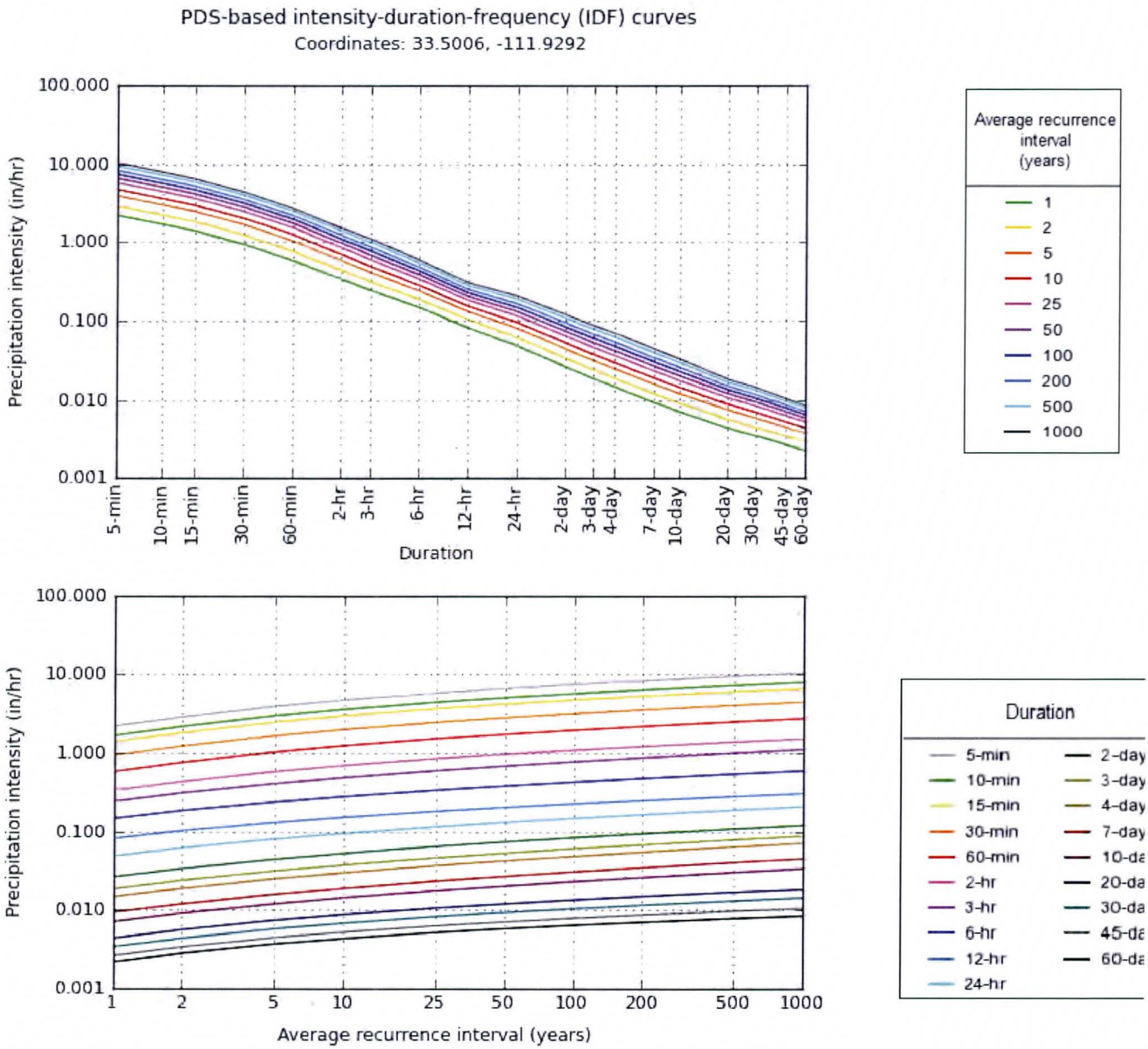
PF graphical



NOAA/NWS/OHD/HDSC

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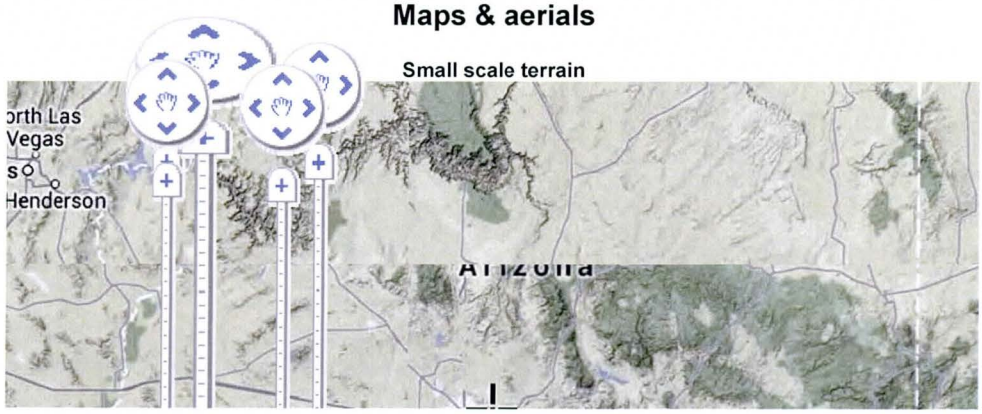
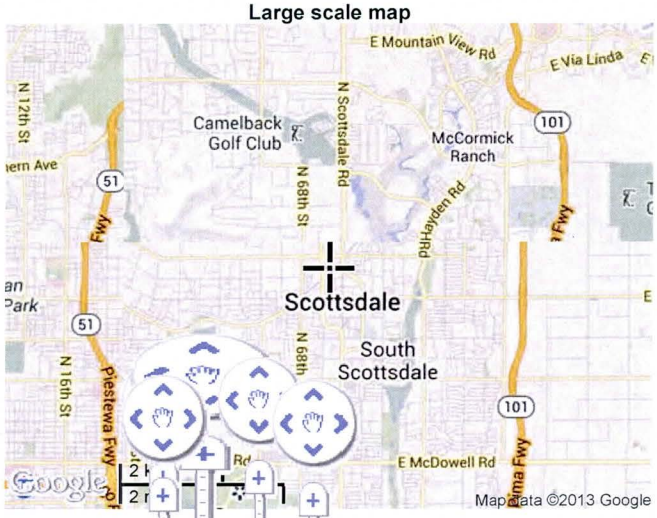
Maps & aerials

Small scale terrain



Large scale map



Large scale aerial

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
Office of Hydrologic Development
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Table 3.2
RUNOFF COEFFICIENTS FOR MARICOPA COUNTY

Land Use Code	Land Use Category	Runoff Coefficients by Storm Frequency[1, 2]							
		2-10 Year		25 Year		50 Year		100 Year	
		min	max	min	max	min	max	min	max
VLDR	Very Low Density Residential[3, 4]	0.33	0.42	0.36	0.50	0.40	0.60	0.45	0.65
LDR	Low Density Residential[3, 4]	0.42	0.48	0.46	0.55	0.50	0.64	0.53	0.70
MDR	Medium Density Residential[3, 4]	0.48	0.65	0.53	0.72	0.58	0.78	0.60	0.80
MFR	Multiple Family Residential[3, 4]	0.65	0.75	0.72	0.83	0.78	0.90	0.82	0.94
I1	Industrial 1[3]	0.60	0.70	0.66	0.77	0.72	0.84	0.75	0.88
I2	Industrial 2[3]	0.70	0.80	0.77	0.88	0.84	0.95	0.88	0.95
C1	Commercial 1[3]	0.55	0.65	0.61	0.72	0.66	0.78	0.69	0.81
C2	Commercial 2[3]	0.75	0.85	0.83	0.94	0.90	0.95	0.94	0.95
P	Pavement and Rooftops	0.75	0.85	0.83	0.94	0.90	0.95	0.94	0.95
GR	Gravel Roadways & Shoulders	0.60	0.70	0.66	0.77	0.72	0.84	0.75	0.88
AG	Agricultural	0.10	0.20	0.11	0.22	0.12	0.24	0.13	0.25
LPC	Lawns/Parks/Cemeteries	0.10	0.25	0.11	0.28	0.12	0.30	0.13	0.31
DL1	Desert Landscaping 1	0.55	0.85	0.61	0.94	0.66	0.95	0.69	0.95
DL2	Desert Landscaping 2	0.30	0.40	0.33	0.44	0.36	0.48	0.38	0.50
NDR	Undeveloped Desert Rangeland	0.30	0.40	0.33	0.44	0.36	0.48	0.38	0.50
NHS	Hillslopes, Sonoran Desert	0.40	0.55	0.45	0.60	0.48	0.66	0.50	0.70
NMT	Mountain Terrain	0.50	0.70	0.65	0.80	0.70	0.90	0.75	0.90

Notes:

1. Runoff coefficients for 25-, 50- and 100-Year storm frequencies were derived using adjustment factors of 1.10, 1.20 and 1.25, respectively, applied to the 2-10 Year values with an upper limit of 0.95.

2. The ranges of runoff coefficients shown for urban land uses were derived from lot coverage standards specified in the zoning ordinances for Maricopa County.

3. Runoff coefficients for urban land uses are for lot coverage only and do not include the adjacent street and right-of-way, or alleys.

4, Values are based on the NDR terrain class. Values should be increased for NHS and NMT terrain classes by the difference between NHS (or NMT) and the NDR C values, up to a maximum of 0.95. Engineering judgement should be used.

5. Maricopa County has adopted specific values of C for each land use and storm frequency in the Drainage Policies and Standards for Maricopa County, Arizona (Maricopa County, 2007). These are the standard default values. The engineer/hydrologist may develop a computed composite value of C based on actual land uses, but must fully document the computations and assumptions and submit them to Maricopa County for approval. Many jurisdictions in Maricopa County may have adopted specific C coefficient values and procedures. The user should check with the appropriate agency before proceeding.

URS
7720 N. 16th Street, Suite 100
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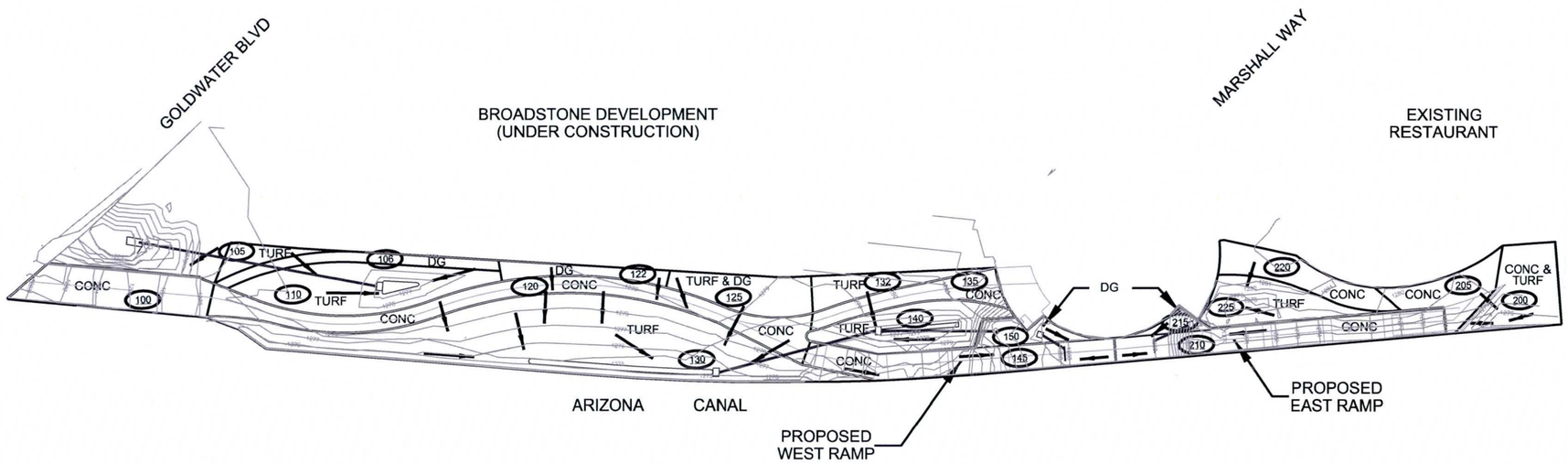

LEGEND

	ONSITE DRAINAGE AREA BOUNDARY
	FLOW DIRECTION
110	DRAINAGE AREA NUMBER
CONC & DG	GROUND COVER DG = Decomposed Granite TURF = Grass Covered CONC = Concrete or AC Pavement

20 0 20 40
Scale in Feet

FIGURE A-1

SHEET NAME: DRAINAGE AREA MAP

DATE | REVISION | BY

ENGINEER

MUNICIPAL SERVICES DEPARTMENT
CAPITAL PROJECT MANAGEMENT
7447 E. INDIAN SCHOOL RD.
SCOTTSDALE, ARIZONA 85251

PROJECT TITLE: North Arizona Canal Bank Improvements

SCALE	DESIGNED	DATE	BID. NO.	SHT.
HORIZ. 1"=20	MRF			
VERT. N/A	DRAWN MRF	AS-BUILT	PROJECT NO.	OF

APPENDIX B

HYDROLOGIC & DETENTION CALCULATIONS

TABLE B-1A

NORTH ARIZONA CANAL BANK IMPROVEMENTS

ONSITE RATIONAL RUNOFF CALCULATIONS — PRE-DEVELOPMENT

Catch Basin Number	Sub-Basin Number	Pvmt C_{10yr} 0.85 Area (sf)	DG C_{10yr} 0.7 Area (sf)	Turf C_{10yr} 0.25 Area (sf)	CA 10yr (ac)	Runoff Q_{10} 3.59	Pvmt C_{100yr} 0.95 Area (sf)	DG C_{100yr} 0.88 Area (sf)	Turf C_{100yr} 0.31 Area (sf)	CA 100yr (ac)	Runoff Q_{100} 5.68	Precip Depth $P_{100yr,2hr}$ (in)	Pre-Dev Volume (cu.ft.)
	100		2420		0.039			2420		0.049			
	105		544		0.009			544		0.011			
	106		981		0.016			981		0.020			
	110		3225		0.052			3225		0.065			
110	**Total**			**Sum CA >>>>**	**0.115**	**0.41**			**Sum CA >>>>**	**0.145**	**0.82**	2.17	**433**
	120	4061			0.079		4061			0.089			
	122		744		0.012			744		0.015			
	125		1586		0.025			1586		0.032			
	130		9759		0.157			9759		0.197			
130	**Total**			**Sum CA >>>>**	**0.274**	**0.98**			**Sum CA >>>>**	**0.333**	**1.89**	2.17	**2283**
	132		999		0.016			999		0.020			
	135		1350		0.022			1350		0.027			
	140		2330		0.037			2330		0.047			
140	**Total**			**Sum CA >>>>**	**0.075**	**0.27**			**Sum CA >>>>**	**0.095**	**0.54**	2.17	**184**
	150		740		0.012			740		0.015			
	145		2699		0.043			2699		0.055			
145	**Total**			**Sum CA >>>>**	**0.055**	**0.20**			**Sum CA >>>>**	**0.069**	**0.39**	2.17	**100**
	200	990		990	0.025		990		990	0.029			
	205	1372			0.027		1372			0.030			
200	**Total**			**Sum CA >>>>**	**0.052**	**0.19**			**Sum CA >>>>**	**0.059**	**0.33**	2.17	**71**
	210		2909		0.047			2909		0.059			
	215		307		0.005			307		0.006			
210	**Total**			**Sum CA >>>>**	**0.052**	**0.19**			**Sum CA >>>>**	**0.065**	**0.37**	2.17	**87**
	220	1548			0.030		1548			0.034			
	225			1766	0.010				1766	0.013			
225	**Total**			**Sum CA >>>>**	**0.040**	**0.14**			**Sum CA >>>>**	**0.046**	**0.26**	2.17	**44**

Total Post-Development Volume (Cu Ft) **3202**
Total Pre-Development Volume (Cu Ft)
Required Retention Volume $V_{100yr,2hr}$

NOTES:

1) Runoff coefficients for 10-year storm: Bare Gnd & DG C=0.70; TURF C=0.25; PVMT C=0.85
2) Runoff coefficients for 100-year storm: Bare Gnd & DG C=0.88; TURF C=0.31; PVMT C=0.95
3) $\sum CA_{10} = C_{pvmt,10yr} \times A_{pvmt} + C_{DG,10yr} \times A_{DG} + C_{turf,10yr} \times A_{turf}$ for each sub-basin
   $\sum CA_{100} = C_{pvmt,100yr} \times A_{pvmt} + C_{DG,100yr} \times A_{DG} + C_{turf,100yr} \times A_{turf}$ for each sub-basin
   Sum CA = $\sum (\sum CA_{10})$ for the group of sub-basins
4) Precipitation Intensites are taken from NOAA Atlas 14 website. $i_{10yr,10min}$ = 3.59 in/hr; $i_{100yr,10min}$ = 5.68 in/hr
5) Pre-development runoff volume = Vpre = $CA_{100} \times 43560 \times P / 12$; Where V (cu ft), CA_{100} runoff coeff, $P_{100,2}$ (inch)

TABLE B-1B

NORTH ARIZONA CANAL BANK IMPROVEMENTS

ONSITE RATIONAL RUNOFF CALCULATIONS — POST-DEVELOPMENT

Catch Basin Number	Sub-Basin Number	Pvmt C_{10yr} 0.85 Area (sf)	DG C_{10yr} 0.7 Area (sf)	Turf C_{10yr} 0.25 Area (sf)	CA 10yr (ac)	Total Area (ac)	Weighted Average C10	Runoff Q_{10} 3.59	Pvmt C_{100yr} 0.95 Area (sf)	DG C_{100yr} 0.88 Area (sf)	Turf C_{100yr} 0.31 Area (sf)	CA 100yr (ac)	Weighted Average C100	Runoff Q_{100} 5.68	Precip Depth $P_{100yr,2hr}$ (in)	Post-Dev Volume (cu.ft.)	Pre-Dev Volume (cu.ft.)	Post - Pre Volume (cu.ft.)	First Flush Runoff Coefficient	First Flush Vol (cu.ft.) 0.5	Total FF Vol (cu.ft.)
	100	2420			0.047				2420			0.053							1.00	96	
	105			544	0.003						544	0.004							1.00	8	
	106		981		0.016					981		0.020							1.00	36	
	110			3225	0.019						3225	0.023							1.00	42	
110	**Total**			**Sum CA >>>>**	**0.085**	**0.165**	**0.514**	**0.30**			**Sum CA >>>>**	**0.099**	**0.604**	**0.56**	2.17	**204**	**433**	**-229**			**86**
	120	4061			0.079				4061			0.089							1.00	161	
	122		744		0.012					744		0.015							1.00	28	
	125		793	793	0.017					793	793	0.022							1.00	40	
	130			9759	0.056						9759	0.069							1.00	127	
130	**Total**			**Sum CA >>>>**	**0.165**	**0.371**	**0.444**	**0.59**			**Sum CA >>>>**	**0.195**	**0.525**	**1.11**	2.17	**782**	**2283**	**-1502**			**356**
	132			999	0.006						999	0.007							1.00	13	
	135	1350			0.026				1350			0.029							1.00	54	
	140			2330	0.013						2330	0.017							1.00	31	
140	**Total**			**Sum CA >>>>**	**0.045**	**0.107**	**0.423**	**0.16**			**Sum CA >>>>**	**0.053**	**0.495**	**0.30**	2.17	**58**	**184**	**-126**			**98**
	150	740			0.014				740			0.016							1.00	30	
	145	2699			0.053				2699			0.059							1.00	107	
145	**Total**			**Sum CA >>>>**	**0.067**	**0.079**	**0.850**	**0.24**			**Sum CA >>>>**	**0.075**	**0.950**	**0.43**	2.17	**116**	**100**	**16**			**137**
	200	990		990	0.025				990		990	0.029							1.00	52	
	205	1372			0.027				1372			0.030							1.00	55	
200	**Total**			**Sum CA >>>>**	**0.052**	**0.077**	**0.673**	**0.19**			**Sum CA >>>>**	**0.059**	**0.761**	**0.33**	2.17	**71**	**71**	**0**			**107**
	210	2909			0.057				2909			0.063							1.00	116	
	215	307			0.006				307			0.007							1.00	13	
210	**Total**			**Sum CA >>>>**	**0.063**	**0.074**	**0.850**	**0.23**			**Sum CA >>>>**	**0.070**	**0.950**	**0.40**	2.17	**101**	**87**	**14**			**129**
	220	1548			0.030				1548			0.034							1.00	62	
	225			1766	0.010						1766	0.013							1.00	23	
225	**Total**			**Sum CA >>>>**	**0.040**	**0.076**	**0.530**	**0.14**			**Sum CA >>>>**	**0.046**	**0.609**	**0.26**	2.17	**44**	**44**	**0**			**85**

Total Post-Development Volume (Cu Ft) **1376**

Total Pre-Development Volume (Cu Ft) **3202**

Required Retention Volume $V_{100yr,2hr}$ **-1826** (Decrease in Runoff)

Total FF Volume Required (Cu Ft) **998**

(Therefore, FF Volume Governs Design)

NOTES:

1) Runoff coefficients for 10-year storm: Bare Gnd & DG C=0.70; TURF C=0.25; PVMT C=0.85
2) Runoff coefficients for 100-year storm: Bare Gnd & DG C=0.88; TURF C=0.31; PVMT C=0.95
3) $\sum CA_{10} = C_{pvmt,10yr} \times A_{pvmt} + C_{DG,10yr} \times A_{DG} + C_{turf,10yr} \times A_{turf}$ for each sub-basin
   $\sum CA_{100} = C_{pvmt,100yr} \times A_{pvmt} + C_{DG,100yr} \times A_{DG} + C_{turf,100yr} \times A_{turf}$ for each sub-basin
   Sum CA = $\sum (\sum CA_{10})$ for the group of sub-basins
4) Precipitation Intensites are taken from NOAA Atlas 14 website. $i_{10yr,10min}$ = 3.59 in/hr; $i_{100yr,10min}$ = 5.68 in/hr
5) Post-development runoff volume = Vpost = $CA_{100} \times 43560 \times P / 12$; Where V (cu ft), CA_{100} runoff coeff, $P_{100,2}$ (inch)
6) Pre-development Retention Volumes calculated on Table B-1A
7) The 100-year, 2-hour retention requirement is Post-Development Volume - Pre-Development Volume

By: DES
Ckd: DJS

TABLE B-2

NORTH ARIZONA CANAL BANK IMPROVEMENTS
FIRST FLUSH RETENTION VOLUMES PROVIDED

Catch Basin Number	Required FF Vol (cu.ft.)	A1 (sq.ft.)	A2 (sq.ft.)	E1 Elev (ft)	E2 Elev (ft)	Delta E (ft)	Side Slope (H:1)	Conic Volume (cuft) Provided
110	86	797	100	1278.00	1276.50	1.00	4	393
130	356	2677	318	1276.00	1274.90	1.00	10	1306
140	98	770	100	1277.50	1276.50	1.00	4	382
145	137	no detention possible						
200	107	no detention possible						
210	129	no detention possible						
225	85	336	100	1279.00	1278.00	1.00	4	206
Total FF Volume Rqd	**998**			**Total FF Volume Provided**				**2288**

APPENDIX C

HYDRAULIC CALCULATIONS

4" Bleedoff Orifice

Project Description

Solve For	Discharge

Input Data

Headwater Elevation	1.00	ft
Centroid Elevation	0.17	ft
Tailwater Elevation	0.00	ft
Discharge Coefficient	0.61	
Diameter	0.33	ft

Results

Discharge	0.38	ft^3/s
Headwater Height Above Centroid	0.83	ft
Tailwater Height Above Centroid	-0.17	ft
Flow Area	0.09	ft^2
Velocity	4.47	ft/s

TABLE C-1

NORTH ARIZONA CANAL BANK IMPROVEMENTS

GRATE CATCH BASIN HYDRAULICS (100-Year Storm)

CB Number	Q_{100} Discharge (ft^3/s)	Left Side Slope (ft/ft (H:V or %)	Right Side Slope (ft/ft (H:V or %)	Grate Width (ft)	Grate Length (ft)	Grate Type	Clogging (%)	Depth (ft)	Grate Elev	100-yr WSEL	Active Grate Weir Length (ft)	Notes
110	0.56	4	4	2.00	3.42	P-50 mm (P-1-7/8")	50	0.08	1277.50	1277.58	8.84	
130	1.11	10	Vertical	2.00	3.42	P-50 mm (P-1-7/8")	50	0.12	1276.00	1276.12	8.84	
140	0.30	4	4	2.00	3.42	P-50 mm (P-1-7/8")	50	0.05	1277.50	1277.55	8.84	
145	0.43	1.60%	1.60%	0.50	8.00	P-0.51" x 5.45"	50	0.04	1268.36	1268.40	17.00	New trench drain at bottom of west ramp
200	0.33	4	4	2.00	3.42	P-50 mm (P-1-7/8")	50	0.05	1275.35	1275.40	8.84	Existing grate catch basin, Not a FF basin outlet
210	0.40	1.00%	8.00%	0.50	8.00	P-0.51" x 5.45"	50	0.04	1268.43	1268.47	17.00	New trench drain at bottom of east ramp
225	0.26	4	4	2.80	2.80	P-50 mm (P-1-7/8")	50	0.05	1278.50	1278.55	8.84	Actual inlet is round (slotted MH lid). Square grate dimensions shown approximate the perimeter distance of the circular lid.

NOTES:

1) Flows are Q100 peak flow from Table B-1. Flows are assumed to be unattenuated (no reduction due to First Flush retention basins).
2) Area inlet catch basins (MAG Std Detail 535) are used for all inlets except:
   CB 145, CB 210 which are trench drains, and MH 225 which is a manhole with slotted lid.
3) Depth of flow is calculated using Bentley FlowMaster hydraulic model for Trench Drain in Sag condition.
4) CB 150 and CB 215 are MAG 537 single grate catch basins that are used primarily as junction structures, and function as backup outlets for the underpass. No Q100 inflows are anticipated.

Scenario: 100yr Proposed

TABLE C-2

NORTH ARIZONA CANAL BANK IMPROVEMENTS
STORMCAD INLET REPORT
(10-YEAR STORM)

Label	Intercepted Rational Flow (ft^3/s)	Downstream Conduit Flow (ft^3/s)	Structure Type	Inlet Location	Elevation (Ground) (ft)	Set Grate/Rim to Ground Elevation?	Elevation (Grate/Rim) (ft)	Local Pipe Matching Constraints?	Elevation (Sump) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	HEC-22 Benching Method	Headloss (ft)	Clogging Factor (%)	Grate Length (ft)	Width (ft)	Side Slope (Ditch) (H:V)
CB-100	0.31	0.31	Box Structure	In Sag	1,276.50	FALSE	1,277.50	FALSE	1,273.50	1,273.71	1,273.71	HEC-22 Energy	Flat	0.00	50	3.4	2.0	4
CB-130	0.60	0.60	Box Structure	In Sag	1,274.90	FALSE	1,275.90	FALSE	1,270.70	1,271.00	1,271.00	HEC-22 Energy	Flat	0.00	50	3.4	2.0	10
CB-140	0.16	0.75	Box Structure	In Sag	1,276.50	FALSE	1,277.50	FALSE	1,270.02	1,270.37	1,270.36	HEC-22 Energy	Flat	0.01	50	3.4	2.0	4
CB-145	0.24	0.24	Box Structure	In Sag	1,268.40	FALSE	1,268.36	FALSE	1,266.52	1,266.72	1,266.72	HEC-22 Energy	Flat	0.00	50	0.5	8.0	12.5
CB-150	0.00	0.24	Box Structure	In Sag	1,268.50	TRUE	1,268.50	FALSE	1,265.20	1,265.46	1,265.46	HEC-22 Energy	Flat	0.00	50	2.0	2.0	50
CB-200X	0.19	0.19	Box Structure	In Sag	1,275.35	TRUE	1,275.35	FALSE	1,271.85	1,272.05	1,272.05	HEC-22 Energy	Flat	0.00	50	3.4	2.5	50
CB-210	0.23	0.23	Box Structure	In Sag	1,268.43	TRUE	1,268.43	FALSE	1,266.52	1,266.72	1,266.72	HEC-22 Energy	Flat	0.00	50	0.5	8.0	12.5
CB-215	0.00	0.23	Box Structure	In Sag	1,268.50	TRUE	1,268.50	FALSE	1,265.18	1,265.44	1,265.44	HEC-22 Energy	Flat	0.00	50	2.0	2.0	50
CB-225X	0.15	0.56	Circular Structure	In Sag	1,278.00	FALSE	1,278.50	FALSE	1,265.13	1,265.42	1,265.42	HEC-22 Energy	Half	0.00	50	0.0	3.0	4
CB-418X	239.90	239.90	Box Structure	In Sag	1,271.00	TRUE	1,271.00	FALSE	1,257.18	1,262.98	1,262.98	HEC-22 Energy	Flat	0.00	50	10.0	6.0	100
CB-425.1X	85.68	85.68	Box Structure	In Sag	1,274.00	TRUE	1,274.00	FALSE	1,260.00	1,262.88	1,262.88	HEC-22 Energy	Flat	0.00	50	10.0	3.5	100

(100-YEAR STORM)

Label	Intercepted Rational Flow (ft^3/s)	Downstream Conduit Flow (ft^3/s)	Structure Type	Inlet Location	Elevation (Ground) (ft)	Set Grate/Rim to Ground Elevation?	Elevation (Grate/Rim) (ft)	Local Pipe Matching Constraints?	Elevation (Sump) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	HEC-22 Benching Method	Headloss (ft)	Clogging Factor (%)	Grate Length (ft)	Width (ft)	Side Slope (Ditch) (H:V)
CB-100	0.90	0.90	Box Structure	In Sag	1,276.50	FALSE	1,277.50	FALSE	1,273.50	1,273.87	1,273.87	HEC-22 Energy	Flat	0.00	50	3.4	2	4
CB-130	1.12	1.12	Box Structure	In Sag	1,274.90	FALSE	1,275.90	FALSE	1,270.70	1,271.12	1,271.12	HEC-22 Energy	Flat	0.00	50	3.4	2	10
CB-140	0.30	1.40	Box Structure	In Sag	1,276.50	FALSE	1,277.50	FALSE	1,270.02	1,270.51	1,270.49	HEC-22 Energy	Flat	0.02	50	3.4	2	4
CB-145	0.43	0.43	Box Structure	In Sag	1,268.40	FALSE	1,268.36	FALSE	1,266.52	1,266.79	1,266.79	HEC-22 Energy	Flat	0.00	50	0.5	8	12.5
CB-150	0.00	0.43	Box Structure	In Sag	1,268.50	TRUE	1,268.50	FALSE	1,265.20	1,265.84	1,265.84	HEC-22 Energy	Flat	0.00	50	2	2	50
CB-200X	0.42	0.42	Box Structure	In Sag	1,275.35	TRUE	1,275.35	FALSE	1,271.85	1,272.15	1,272.15	HEC-22 Energy	Flat	0.00	50	3.4	2.5	50
CB-210	0.40	0.40	Box Structure	In Sag	1,268.43	TRUE	1,268.43	FALSE	1,266.52	1,266.78	1,266.78	HEC-22 Energy	Flat	0.00	50	0.5	8	12.5
CB-215	0.00	0.40	Box Structure	In Sag	1,268.50	TRUE	1,268.50	FALSE	1,265.18	1,265.53	1,265.53	HEC-22 Energy	Flat	0.00	50	2	2	50
CB-225X	0.13	0.95	Circular Structure	In Sag	1,278.00	FALSE	1,278.50	FALSE	1,265.13	1,265.52	1,265.51	HEC-22 Energy	Half	0.00	50	0	3	4
CB-418X	363.12	363.12	Box Structure	In Sag	1,271.00	TRUE	1,271.00	FALSE	1,257.18	1,267.09	1,267.09	HEC-22 Energy	Flat	0.00	50	10	6	100
CB-425.1X	151.30	151.30	Box Structure	In Sag	1,274.00	TRUE	1,274.00	FALSE	1,260.00	1,266.48	1,266.48	HEC-22 Energy	Flat	0.00	50	10	3.5	100

TABLE C-3

NORTH ARIZONA CANAL BANK IMPROVEMENTS
STORMCAD PIPE REPORT
(10-YEAR STORM)

Label	Start Node	Stop Node	Length (Scaled) (ft)	Diameter (in)	Material	Manning's n	Pipe Slope (ft/ft)	Invert (Upstream) (ft)	Invert (Downstream) (ft)	Total Flow (ft^3/s)	Capacity (Full Flow) (ft^3/s)	Velocity (Average) (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Head Loss (ft)	Cover (Start) (ft)	Cover (Stop) (ft)	Deflection Angle (degrees)	Froude Number
P100	CB-100	OUT-100	141.0	15	Concrete	0.013	0.014	1273.50	1,271.50	0.31	7.69	3.05	1273.71	1271.67	2.04	1.75	0.00	(N/A)	1.57
P130	CB-130	CB-140	96.8	15	Concrete	0.013	0.007	1270.70	1,270.02	0.60	5.41	2.9	1271.00	1270.37	0.63	2.95	5.23	165.47	1.15
P140	CB-140	MH-155	67.7	15	Concrete	0.013	0.059	1270.02	1,266.00	0.75	15.71	6.57	1270.36	1266.19	4.17	5.23	3.75	85.28	3.24
P145	CB-145	CB-150	15.9	12	PVC	0.013	0.067	1266.52	1,265.45	0.24	9.21	5.05	1266.72	1265.56	1.16	0.88	2.05	154.60	3.22
P150X	CB-150	MH-155	25.6	15	PVC	0.013	0.005	1265.20	1,265.06	0.24	4.74	2.03	1265.46	1265.46	0.00	2.05	4.69	99.00	0.98
P155X	MH-155	T-423X	28.0	15	PVC	0.013	0.252	1265.06	1,258.00	0.98	32.44	11.83	1265.45	1262.34	3.11	4.69	21.75	89.89	6.53
P200X	CB-200X	PC-201	4.3	12	PVC	0.013	0.002	1271.85	1,271.84	0.19	1.78	1.47	1272.05	1272.03	0.03	2.50	3.72	148.37	0.66
P201	PC-201	MH-202	33.2	12	PVC	0.013	0.015	1271.84	1,271.35	0.19	4.34	2.75	1272.02	1271.53	0.49	3.72	6.97	151.48	1.56
P202	MH-202	PC-203	123.9	12	PVC	0.013	0.047	1271.35	1,265.58	0.19	7.69	4.1	1271.53	1265.76	5.76	6.97	11.42	160.88	2.67
P205X	PC-203	CB-225X	5.5	12	PVC	0.013	0.075	1265.58	1,265.13	0.19	9.76	4.85	1265.76	1265.42	0.33	11.42	11.87	137.02	3.34
P210	CB-210	CB-215	22.0	12	PVC	0.013	0.049	1266.52	1,265.45	0.23	7.86	4.43	1266.72	1265.57	1.15	0.91	2.05	179.78	2.76
P215X	CB-215	CB-225X	19.0	15	Concrete	0.013	0.003	1265.18	1,265.13	0.23	3.31	1.55	1265.44	1265.42	0.01	2.07	11.62	81.41	0.69
P225X	CB-225X	MH-424X	30.4	15	Concrete	0.013	0.257	1265.13	1,257.42	0.56	32.75	10.07	1265.42	1262.08	3.34	11.62	22.79	60.93	6.39
P418X	CB-418X	T-423X	504.4	81	Concrete	0.013	0.001	1257.18	1,256.65	239.90	188.00	6.7	1262.98	1261.99	0.99	7.07	17.60	173.17	0.45
P423X	T-423X	MH-424X	115.7	81	Concrete	0.013	0.001	1256.65	1,256.56	236.65	161.49	6.61	1261.89	1261.56	0.32	17.60	18.15	178.92	0.45
P424X	MH-424X	T-423X	12.2	81	Concrete	0.013	0.003	1256.56	1,256.52	236.95	334.72	10.14	1261.50	1261.49	0.01	18.15	17.62	179.12	0.95
P425.1X	CB-425.1X	T-423X	89.5	42	Concrete	0.013	0.038	1260.00	1,256.62	85.68	196.06	19.69	1262.88	1261.57	1.31	10.50	20.77	91.17	3.11
P425X	T-423X	OUT-425X	198.9	84	Concrete	0.013	0.004	1256.52	1,255.78	321.27	389.54	11.31	1261.36	1260.50	0.86	17.37	16.22	(N/A)	0.95

(100-YEAR STORM)

Label	Start Node	Stop Node	Length (Scaled) (ft)	Diameter (in)	Material	Manning's n	Pipe Slope (ft/ft)	Invert (Upstream) (ft)	Invert (Downstream) (ft)	Total Flow (ft^3/s)	Capacity (Full Flow) (ft^3/s)	Velocity (Average) (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Head Loss (ft)	Cover (Start) (ft)	Cover (Stop) (ft)	Deflection Angle (degrees)	Froude Number
P100	CB-100	OUT-100	141.0	15	Concrete	0.013	0.014	1273.50	1,271.50	0.90	7.6900	4.19	1273.87	1271.79	2.08	1.75	0.00	(N/A)	1.64
P130	CB-130	CB-140	96.8	15	Concrete	0.013	0.007	1270.70	1,270.02	1.12	5.4100	3.47	1271.12	1270.51	0.61	2.95	5.23	165.47	1.16
P140	CB-140	MH-155	67.7	15	Concrete	0.013	0.059	1270.02	1,266.00	1.40	15.7100	7.91	1270.49	1266.25	4.24	5.23	3.75	85.28	3.32
P145	CB-145	CB-150	15.9	12	PVC	0.013	0.067	1266.52	1,265.45	0.43	9.2100	5.99	1266.79	1265.84	0.95	0.88	2.05	154.60	3.32
P150X	CB-150	MH-155	25.6	15	PVC	0.013	0.005	1265.20	1,265.06	0.43	4.7400	2.4	1265.84	1265.84	0.00	2.05	4.69	99.00	1
P155X	MH-155	T-423X	28.0	15	PVC	0.013	0.252	1265.06	1,258.00	1.81	32.4400	14.23	1265.83	1265.86	-0.02	4.69	21.75	89.89	6.74
P200X	CB-200X	PC-201	4.3	12	PVC	0.013	0.002	1271.85	1,271.84	0.42	1.7800	1.85	1272.15	1272.12	0.03	2.50	3.72	148.37	0.67
P201	PC-201	MH-202	33.2	12	PVC	0.013	0.015	1271.84	1,271.35	0.42	4.3400	3.5	1272.11	1271.62	0.49	3.72	6.97	151.48	1.61
P202	MH-202	PC-203	123.9	12	PVC	0.013	0.047	1271.35	1,265.58	0.42	7.6900	5.23	1271.62	1265.86	5.76	6.97	11.42	160.88	2.79
P205X	PC-203	CB-225X	5.5	12	PVC	0.013	0.075	1265.58	1,265.13	0.42	9.7600	6.18	1265.85	1265.52	0.33	11.42	11.87	137.02	3.5
P210	CB-210	CB-215	22.0	12	PVC	0.013	0.049	1266.52	1,265.45	0.40	7.8600	5.25	1266.78	1265.60	1.18	0.91	2.05	179.78	2.84
P215X	CB-215	CB-225X	19.0	15	Concrete	0.013	0.003	1265.18	1,265.13	0.40	3.3100	1.83	1265.53	1265.52	0.01	2.07	11.62	81.41	0.71
P225X	CB-225X	MH-424X	30.4	15	Concrete	0.013	0.257	1265.13	1,257.42	0.95	32.7500	11.82	1265.51	1265.40	0.11	11.62	22.79	60.93	6.58
P418X	CB-418X	T-423X	504.4	81	Concrete	0.013	0.001	1257.18	1,256.65	363.12	188.0000	10.15	1267.09	1265.12	1.98	7.07	17.60	173.17	0.69
P423X	T-423X	MH-424X	115.7	81	Concrete	0.013	0.001	1256.65	1,256.56	360.33	161.4900	10.07	1264.89	1264.44	0.45	17.60	18.15	178.92	0.68
P424X	MH-424X	T-423X	12.2	81	Concrete	0.013	0.003	1256.56	1,256.52	360.86	334.7200	10.08	1264.33	1264.28	0.05	18.15	17.62	179.12	0.68
P425.1X	CB-425.1X	T-423X	89.5	42	Concrete	0.013	0.038	1260.00	1,256.62	151.30	196.0600	15.73	1266.48	1264.47	2.01	10.50	20.77	91.17	2.78
P425X	T-423X	OUT-425X	198.9	84	Concrete	0.013	0.004	1256.52	1,255.78	510.58	389.5400	13.27	1264.05	1262.78	1.27	17.37	16.22	(N/A)	0.88

TABLE C-4

NORTH ARIZONA CANAL BANK IMPROVEMENTS
STORMCAD IMANHOLE REPORT
(10-YEAR STORM)

Label	Pipe Flow (ft^3/s)	Structure Type	Elevation (Ground) (ft)	Elevation (Grate/Rim) (ft)	Elevation (Invert in 1) (ft)	Elevation (Invert in 2) (ft)	Elevation (Invert Out) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	HEC-22 Benching Method	Headloss (ft)	Diameter (in)	Bolted Cover?	Drop Structure ?
T-423X	236.65	Transition Node	1,281.00	1,281.00	1,258.00	1,256.65	1,256.65	1,261.99	1,261.89	HEC-22 Energy	Depressed	0.11	36	TRUE	TRUE
MH-424X	236.95	Circular Structure	1,281.46	1,281.46	1,256.56	1,257.42	1,256.56	1,261.56	1,261.50	HEC-22 Energy	Depressed	0.06	87	FALSE	TRUE
MH-155	0.98	Circular Structure	1,271.00	1,271.00	1,265.06	1,266.00	1,265.06	1,265.46	1,265.45	HEC-22 Energy	Half	0.01	48	FALSE	TRUE
MH-202	0.19	Circular Structure	1,279.32	1,279.32	1,271.35	(N/A)	1,271.35	1,271.53	1,271.53	HEC-22 Energy	Half	0.00	48	FALSE	TRUE
PC-201	0.19	Transition Node	1,276.56	1,272.86	1,271.84	(N/A)	1,271.84	1,272.03	1,272.02	HEC-22 Energy	Depressed	0.01	24	TRUE	TRUE
PC-203	0.19	Transition Node	1,278.00	1,266.60	1,265.58	(N/A)	1,265.58	1,265.76	1,265.76	HEC-22 Energy	Depressed	0.01	24	TRUE	TRUE
T-423X	321.27	Transition Node	1,280.89	1,288.00	1,256.52	1,256.62	1,256.52	1,261.49	1,261.36	HEC-22 Energy	Depressed	0.13	36	TRUE	TRUE

(100-YEAR STORM)

Label	Pipe Flow (ft^3/s)	Structure Type	Elevation (Ground) (ft)	Elevation (Grate/Rim) (ft)	Elevation (Invert in 1) (ft)	Elevation (Invert in 2) (ft)	Elevation (Invert Out) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	HEC-22 Benching Method	Headloss (ft)	Diameter (in)	Bolted Cover?	Drop Structure ?
T-423X	360.33	Transition Node	1,281.00	1,281.00	1,258.00	1,256.65	1,256.65	1,265.12	1,264.89	HEC-22 Energy	Depressed	0.23	36	TRUE	TRUE
MH-424X	360.86	Circular Structure	1,281.46	1,281.46	1,256.56	1,257.42	1,256.56	1,264.44	1,264.33	HEC-22 Energy	Depressed	0.11	87	FALSE	TRUE
MH-155	1.81	Circular Structure	1,271.00	1,271.00	1,265.06	1,266.00	1,265.06	1,265.84	1,265.83	HEC-22 Energy	Half	0.01	48	FALSE	TRUE
MH-202	0.42	Circular Structure	1,279.32	1,279.32	1,271.35	(N/A)	1,271.35	1,271.62	1,271.62	HEC-22 Energy	Half	0.00	48	FALSE	TRUE
PC-201	0.42	Transition Node	1,276.56	1,272.86	1,271.84	(N/A)	1,271.84	1,272.12	1,272.11	HEC-22 Energy	Depressed	0.02	24	TRUE	TRUE
PC-203	0.42	Transition Node	1,278.00	1,266.60	1,265.58	(N/A)	1,265.58	1,265.86	1,265.85	HEC-22 Energy	Depressed	0.01	24	TRUE	TRUE
T-423X	510.58	Transition Node	1,280.89	1,288.00	1,256.52	1,256.62	1,256.52	1,264.28	1,264.05	HEC-22 Energy	Depressed	0.23	36	TRUE	TRUE

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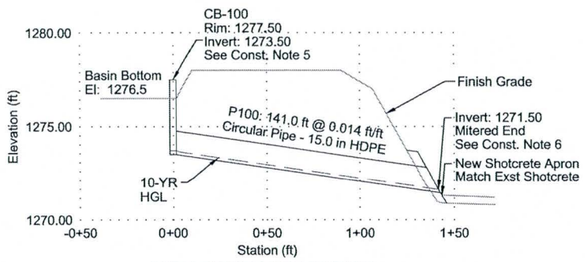
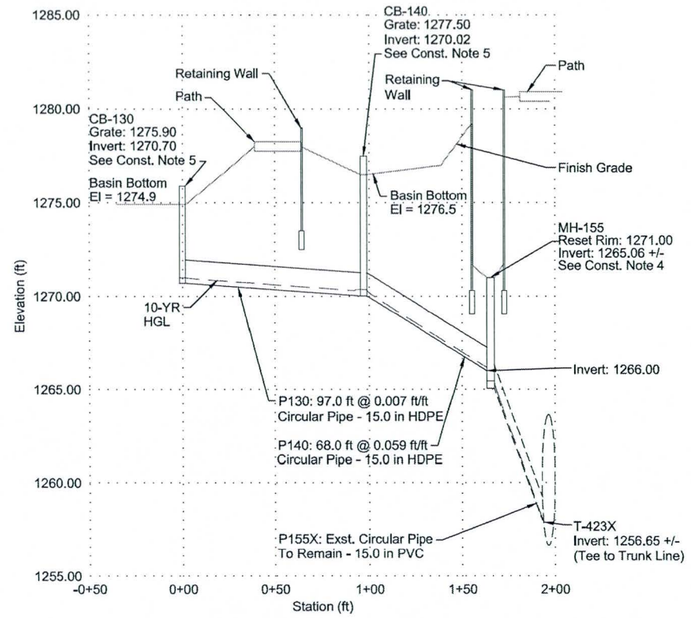
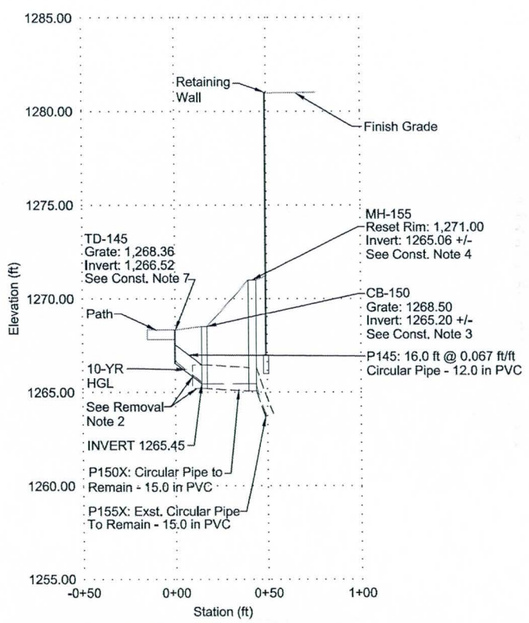


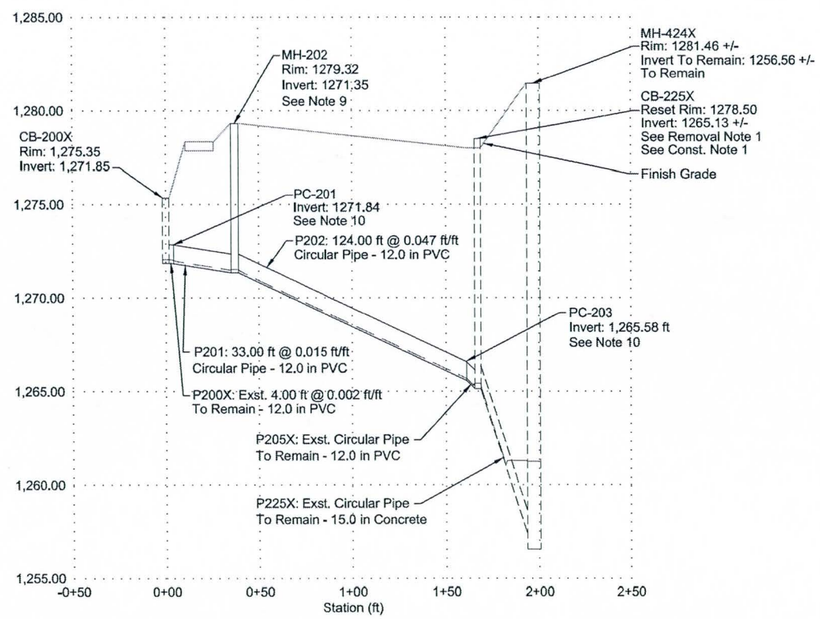
NEW STORM DRAIN P100



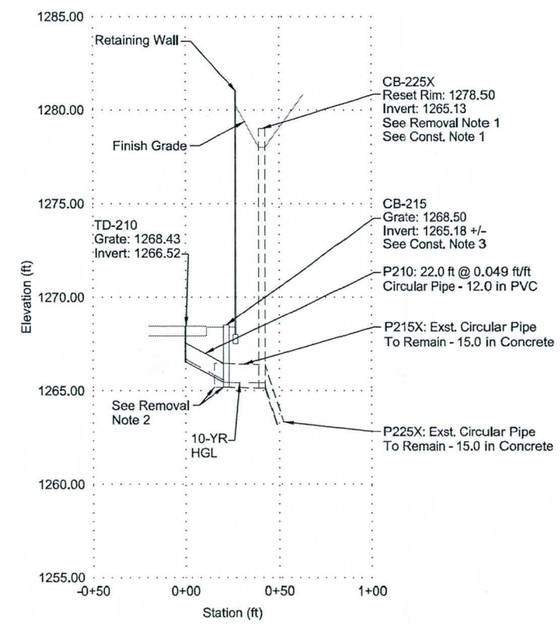
NEW STORM DRAIN P130 - P140



NEW STORM DRAIN P145 - P150



NEW STORM DRAIN P201 - P202



NEW STORM DRAIN P210 - P215

40 0 40 80
SCALE IN FEET

Call at least two full working days before you begin excavation.
ARIZONA 811
Arizona Blue Stake, Inc.
Dial 8-1-1 or 1-800-STAKE-IT (782-5348)
In Maricopa County: (602) 263-1100

URS
7720 N. 16th Street, Suite 100
Phoenix, AZ. 85020
(602) 371-1100

REMOVAL NOTES

1. REMOVE EXISTING MANHOLE RISER, FRAME AND COVER. PROTECT IN PLACE EXISTING MANHOLE BASE AND CONNECTING STORM DRAINS.
2. SAWCUT EXISTING 15" PIPE AND REMOVE PIPE STUB.

CONSTRUCTION NOTES

1. PENDING COMPLETION OF NEW ADJACENT RETAINING WALL, INSTALL NEW MANHOLE RISER, FRAME AND SLOTTED COVER.
2. SAWCUT EXISTING CATCH BASIN AT CAP ELEVATION. INSTALL NEW 12-INCH DIAMETER PVC PIPE WITHIN CATCH BASIN AND GROUT ENDS. FILL VOIDS AROUIND PIPE WITH CONCRETE UP TO SAWCUT LINE.
3. SAWCUT EXISITNG PIPE AND INSTALL NEW MAG STD. DET. 537 CATCH BASIN. ORIENT CATCH BASIN AS REQUIRED TO ALLOW INSTALLATION OF NEW 12" PVC FROM TRENCH DRAIN.
4. RESET MANHOLE FRAME AND SLOTTED COVER PER MAG STD. DTL. 522
5. CONSTRUCT BLEED-OFF ORIFICE, DETAIL DB
6. INSTALL STORM DRAIN WITH MITERED END SET FLUSH WITH SHOTCRETE OUTLET APRON.
7. INSTALL TRENCH DRAIN PER DETAIL DA
8. SEE GRADING AND DRAINAGE PLAN FOR ALL NEW STORM DRAIN PIPE END COORDINATES
9. CONSTRUCT NEW MANHOLE PER MAG STD. DTL. 520 AND 522
10. CONSTRUCT NEW PIPE COLLAR

SHEET NAME: STORM DRAIN PROFILES

DATE	REVISION	BY

ENGINEER

MUNICIPAL SERVICES DEPARTMENT
CAPITAL PROJECT MANAGEMENT
7447 E. INDIAN SCHOOL RD.
SCOTTSDALE, ARIZONA 85251

PROJECT TITLE: North Arizona Canal Bank Improvements

SCALE	DESIGNED	DATE	BID NO.	SHT.
HORIZ. 1" = 40'	MRF			
VERT. 1" = 4'	DRAWN MRF	AS-BUILT	PROJECT NO.	OF

APPENDIX D

EXISTING SITE CONDITIONS (PHOTOS)

Arizona Canal North Bank

Existing Drainage Conditions

10/31/2013

East end of project; View N along Goldwater Blvd

Existing ramp to Goldwater Blvd; View NE

Existing grate on 81" Storm Drain & Well Pump Station; Panorama SW to N

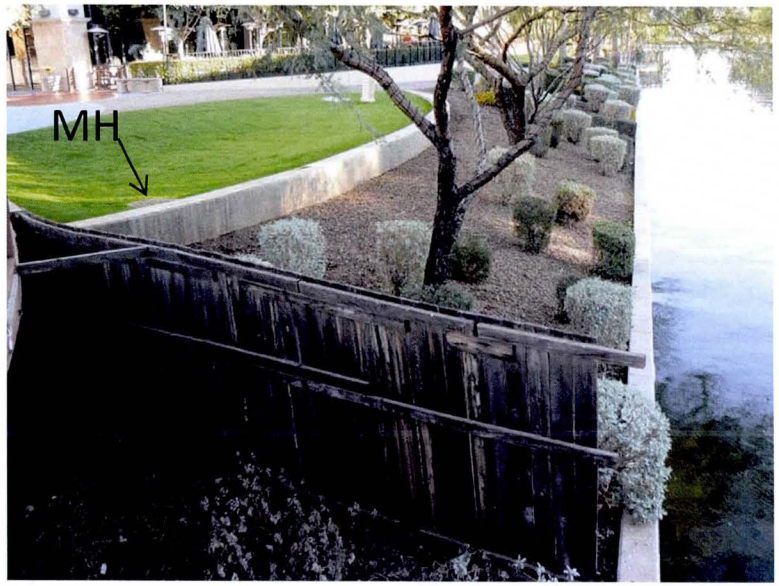
Near end of ramp to Goldwater Blvd; View NE along AZ Canal

Existing North Bank of AZ Canal

Approximately 200 feet NE of Goldwater Blvd; View NE

Existing freeboard wall and decorative railing; View NE

Existing area at proposed west ramp location;
View SW from Marshall Way; Note existing MH-155X w/ slotted lid



Existing area at proposed east ramp location;
View NE from Marshall Way; Note existing MH-225X w/ slotted lid

West side of existing cul-de-sac at Marshall Way; View E

East side of existing cul-de-sac at Marshall Way; View W
Note perimeter trench drain and MH-424X over 81" storm drain

Existing retaining wall for cul-de-sac & MH-155X; View E

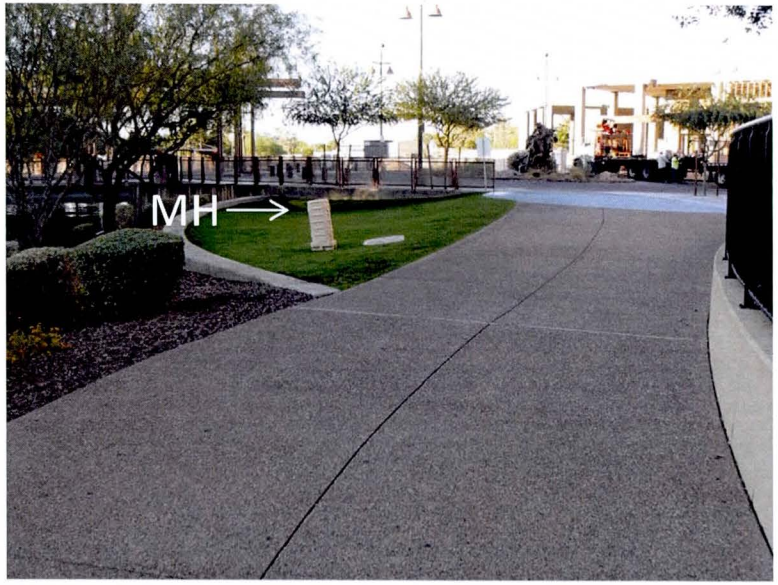
Existing retaining wall for cul-de-sac; View N

Existing excavation for proposed west ramp; View NE

Existing girders and grated walkway over west ramp; View NE
Note existing AZ Canal north bank retaining wall at right

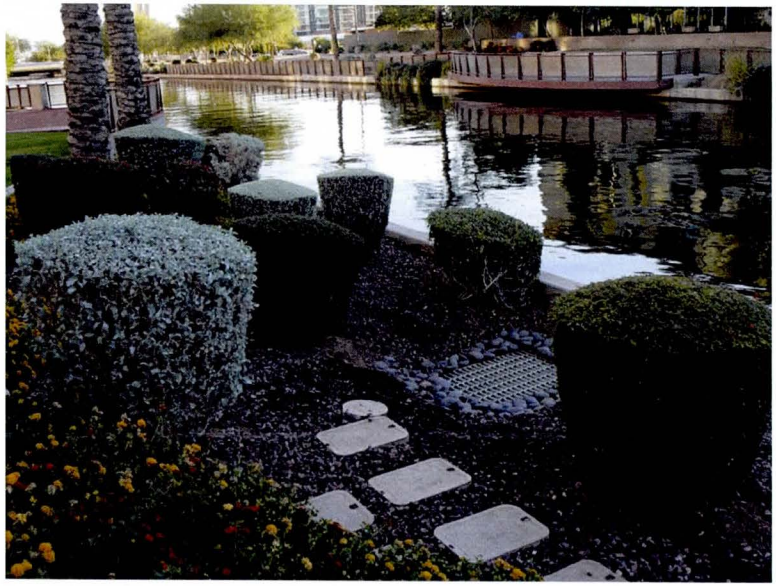
Existing grated walkway over east ramp; Panorama N to NE; Note existing AZ Canal north bank retaining wall at right

Existing MH-225X with slotted lid on east side of Marshall Way; View NE



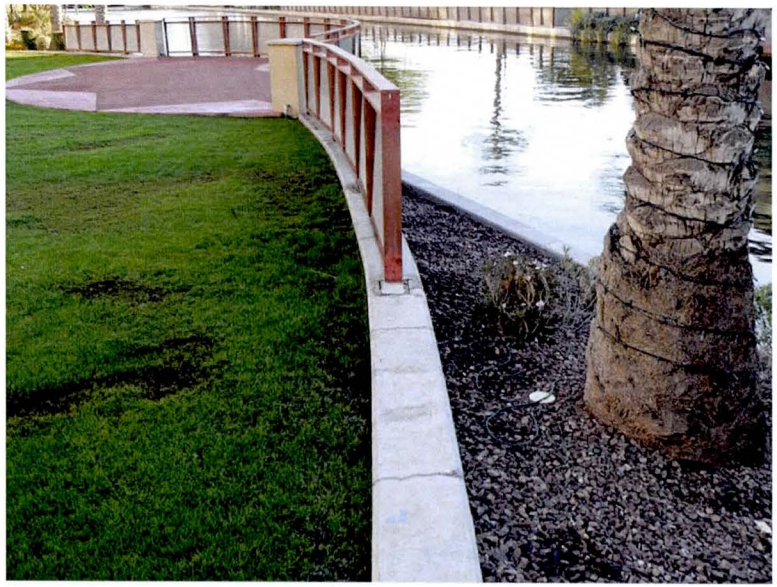
Existing walkway near proposed junction with east ramp; View W

Existing CB-205X at mid-point of proposed east ramp; View NE



Existing CB-200X at east end of proposed east ramp; View E

Existing walkway east of proposed east ramp; View NE



Existing low retaining wall and decorative hand rail east of project.

Existing perimeter drain and MH-424X on east side of Marshall Way; View N

Marshall Way north of project area; View N
Note catch basin at right

Existing paved area on east side of Marshall Way, restaurant at right

Same paved area; View NW
Note existing low retaining wall to be removed

Existing west ramp area and AZ Canal; View SSW
Note new construction for “Broadstone at the Waterfront” development
MH-155X at far left

APPENDIX E

OTHER DRAINAGE REPORTS (EXCERPTS)

KLAND CIVIL ENGINEERS

Drainage Report

Broadstone Waterfront

#K12117

Prepared for:

Alliance Residential Co.
2415 East Camelback Road, Suite 600
Phoenix, AZ 85016

Prepared by:

KLAND Civil Engineers, L.L.C.
7227 North 16th Street, Suite 217
Scottsdale, Arizona 85020

Submitted to:

City of Scottsdale
7447 E. Indian School Road
Scottsdale, Arizona 85251

Registered Professional Engineer (Civil)
CERTIFICATE NO. 31695
LESLIE J. KLAND
Date Signed 11-6-12
ARIZONA, U.S.A.
Expires: 09/30/~~12~~ 15

Revised November 6, 2012
Revised August 30, 2012
July 25, 2012

1.0 SECTION I – OVERALL DRAINAGE

1.1.0 DESCRIPTION OF EXISTING DRAINAGE CONDITIONS

1.1.1 Existing Site

The site is currently vacant land with an old pavement parking lot from the previous retail development. A well site is located in the southwest corner of the site. The east half of the site has been planted with grass for holding community events. Fill was brought into the site during previous developments to remove the area from a FEMA Zone A and put the site into a Zone X.

1.1.2 Existing On-Site Drainage

The existing site currently retains no storm water runoff. Roughly half the site currently drains to Via Soleri or Marshall Way and half of the site drains to existing inlets adjacent to the Arizona Canal. Existing storm drain in Via Soleri and Marshall Way collects the storm water and drain to an existing 81-inch storm drain that runs adjacent to the canal. The 81-inch storm drain that runs parallel to the canal has the capacity for a 25 year storm event according to the City of Scottsdale "Downtown Infrastructure Master Plan Volume 3 Drainage Study" by Boyle Engineering Corporation, dated December, 1986. Storm water in excess of the 25 year storm event overflows into the Arizona Canal. The first overflow for Via Soleri is to Goldwater Boulevard and north towards Camelback Road. Storm water that does not make it into the inlet on Goldwater will eventually overflow along our west property line to the canal.

The overflow elevation for Marshall Way is at the southeast corner of our site at an elevation of 1281.21. The elevation of the Arizona Canal along our property frontage is roughly at an elevation of 1276.6.

See Appendix 3 for ALTA Survey and Topographic Survey.

1.1.3 Off-Site Flows

Off-site storm water will be contained in the adjacent streets for the 100-year storm event. We have calculated that the existing 24-inch storm drain in Via Soleri and the 36-inch in Goldwater Boulevard have capacity for the 100-year storm event. The 36-inch storm drain in Marshall Way has capacity for approximately the 25-year storm event. Since the storm drain system in Via Soleri drains to the system in Marshall Way, we have assumed that storm water in excess of the 25-year event will backup within Via Soleri and overtop into Goldwater Boulevard at the northwest corner of our site. We have calculated the difference in discharge from the 25-year and 100-year storm event for the area (area N-A) to be approximately 4.3cfs. The ridge line on Via Soleri is at an elevation of 1277.87. We have calculated the anticipated high water elevation for this flow to be at an elevation of 1278.10. See appendix 2 for the Via Soleri to Goldwater weir calculation. Based on a 100 year high water elevation of 1278.09 we set the parking garage ridge elevation at 1279.10, this gives us one foot for freeboard .

As we stated the 36-inch in Marshall Way only has capacity for approximately the 25-year storm event. We have calculated the depth of runoff from the 100-year storm event that will not fit in the 36-inch storm drain from the Marshall Way tributary area (area N-B). The discharge in excess of the 25-year event is 7.19 CFS. This excess runoff will be contained within the roadway at a depth of approximately 0.19-0.25 feet draining towards the canal. Drainage calculations are included for the surrounding streets to show the capacity at the maximum high water before overtopping the curb. See Appendix 2 for Drainage Calculation and Appendix 5 for Existing Drainage Map.

1.1.4 FEMA Floodplain

The project site lies in a Federal Emergency Management Agency (FEMA) designated Flood Area Zone "X" (shaded) per FIRM Panel 04013C2160F, effective date September 30, 2005 (See Appendix 1).

The FIRM Panel defines a Zone "X" (shaded) designation as follows:

> *Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1-footor with drainage was less than 1 square mile; and areas protected by levees from 1% chance flood.*

1.2.0 PROPOSED DRAINAGE CONDITIONS

1.2.1 Proposed Site

The proposed multifamily project with retail will consist of 259 dwelling units, fitness center, pool, two levels of underground parking, landscape and hardscape and a retail building on approximately 3.35 net acres. The site will have one driveway entrance on Via Soleri.

1.2.2 Proposed Drainage

Based on the City of Scottsdale "Downtown Infrastructure Master Drainage Plan Volume 3 Drainage Sturdy" and two letters issued by the City of Scottsdale the site is not required to provide retention. See Appendix 7 for Retention Waiver Letters from 1987and 1988.

The site will consist of three main tributary areas. Tributary area "A" in the NW quadrant of the site will drain to two 12-inch storm drains on site that will discharge into the relocated catch basin in Via Soleri. The existing 18-inch portion of storm drain in Via Soleri will be replaced with a 24-inch storm drain. Tributary area "B", the retail portion, will drain to a 12-inch storm drain onsite that will discharge to the existing 36-inch pipe in Marshall Way. The connection will be made at an existing storm drain manhole in front of our site. Tributary area "C" is the south section of the site that is adjacent to the Arizona Canal. Storm water from this tributary area will be collected in an 18-inch storm drain onsite, which will discharge to the existing 36-inch pipe in Goldwater Boulevard. This connection will be made by constructing a new manhole on the existing 36-inch storm drain. At one point we thought that we would need to connect our site storm drain into the FCDMC 81 inch storm pipe that runs parallel to the Arizona Canal. Based on our final design it is not necessary to make this connection. The FCDMC will not need to review or permit the plans based on us not connecting to the 81-inch storm drain. Storm water in excess of the perimeter storm drain system will over flow into the streets or the south property line and drain to the Arizona Canal.

The elevation of the ridge into the garage has been set at an elevation of 1279.10. In event that the 24-inch storm drain was to back up the water would outfall from tributary area "A" to Goldwater Boulevard. We have calculated the anticipated high

water for the 100-year storm event in Via Soleri would be at an elevation of 1278.09 which gives us one foot of freeboard into the garage entrance. Drainage from the ramp into the garage will be collected in a trench drain. The trench drain and area drains in the garage will be routed through a sand and oil separator in the garage prior to being pumped to the storm drain system.

Roof drain discharge and deck drains will be sized by the Plumbing Engineer in accordance with the International Plumbing Code. The sump pump discharge rate will also be provided by the Plumbing Engineer at final design.

The finish floor elevation is controlled by the retail portion of the site. We have designed the site to be ADA accessible to the existing curb grades along Marshall Way. The finish floor is above the anticipated high water elevation for the 100-year storm event. For the residential portion of the site the finish floor is over 12-inches above the anticipated high water elevation for the 100-year storm event and a minimum of 18-inches above the adjacent outfall elevation. See Appendix 2 for Drainage Calculations and Appendix 6 for Proposed Drainage Map and Grading and Drainage Plan.

2.0 SECTION 2 - METHOD OF ANALYSIS

2.1.0 HYDROLOGY

2.1.1 Retention

According to letters issued by the City of Scottsdale in 1987 and 1988 the site is not required to provide retention. See appendix 7 for a copy of the letters. At the time the site was fully developed as a retail site and the site was anticipated to be fully developed in the future. Based on the current method for calculating the in-lieu fee we have compared the historic runoff coefficient, when the site was a retail development, to the proposed development. We used an aerial overlay from December 3, 1996 that was provided by The Flood Control District of Maricopa County. The site remained fully developed after 1996 however the 1996 aerial was the clearest available. The weighted runoff calculations are provided in Appendix 4. Since the historic development has a higher runoff coefficient then the proposed development no in-lieu fee is required.

2.1.2 Storm Drain

The capacity of the exiting storm drain systems and roadways were calculated using Haestad Methods FlowMaster v7.0. The anticipated peak flows from the 100-year storm event were calculated using the Rational Method within the Drainage Design Management System Software created by the Flood Control District of Maricopa County. The Rational Method is defined as follows:

$Q_{100} = CIA$

Q_{100} = Peak Flow in cubic feet for the selected storm reoccurrence interval

C = Runoff Coefficient (worst case of 0.95 used for calculating flows)

I = (Peak Intensity for 100-year per NOAA Atlas 14, Volume 1, Version 5

A = Drainage Area in acres

Catch basins, curb openings and scuppers will be sized for the anticipated peak discharge from the 100-year storm event using the weir and orifice equation in Haestad Methods, Inc., FlowMaster v7.0. The inlet capacity will be calculated using a headwater elevation set a maximum 0.50-foot above the inlet rim to assure capacity is achieved with a ponding depth of 0.50-feet or less. The inlet capacity will also be calculated with a clogging factor of 50%. See appendix 2 for proposed storm drain calculations.

3.0 SECTION 3 - CONCLUSIONS

Based on our understanding of the applicable City of Scottsdale requirements and design standards associated with drainage, it can be concluded that:

- This onsite drainage report is prepared in accordance with the recommendations and design parameters within the City of Scottsdale requirements.
- The proposed conditions of the site do not increase the storm water discharge condition from the historic site.
- The residential finish floor elevations are designed to a minimum of 12-inches above the anticipated 100-year high water elevations and the retail building is set above the anticipated 100-year high water elevation.
- The garage is protected from the 100-year storm event by setting the break over elevation 12-inches above the anticipated 100-year high water elevation.

Flood Control District of Maricopa County
Drainage Design Management System
RATIONAL METHOD SUMMARY - ALL
Project Reference: K12117

11/5/2012

Type ID	Conveyance Length (ft)	Conveyance Velocity (ft/sec)	Conveyance Tpipe (min)	Combine		Return Period (Years) 2	5	10	25	50	100
Maior Basin ID: 01											
Sub Basin	-	-	-	-	Q (cfs)	5.7	8.3	10.3	14.0	16.1	18.2
X-A					CA (ac)	2.87	2.87	2.87	3.18	3.21	3.21
					Tc (min)	11.1	9.6	8.9	8.2	7.8	7.4
					i (in/hr)	1.99	2.89	3.58	4.40	5.03	5.67
Sub Basin	-	-	-	-	Q (cfs)	10.5	15.6	19.7	28.0	33.4	38.5
X-B					CA (ac)	7.45	7.45	7.45	8.24	8.33	8.33
					Tc (min)	24.5	21.0	19.3	17.5	16.4	15.6
					i (in/hr)	1.41	2.10	2.64	3.40	4.01	4.62
Combine	-	-	-	2	Q (cfs)	11.9	18.4	23.1	31.5	39.9	42.7
X-AB					CA (ac)	10.32	10.32	10.32	11.42	11.54	11.54
					Tc (min)	-	-	-	-	-	-
					i (in/hr)	-	-	-	-	-	-
Sub Basin	-	-	-	-	Q (cfs)	5.2	7.6	9.5	13.4	15.7	17.7
N-A					CA (ac)	2.79	2.79	2.79	3.08	3.12	3.12
					Tc (min)	14.3	12.3	11.3	10.3	7.8	7.4
					i (in/hr)	1.86	2.73	3.41	4.35	5.03	5.67
Sub Basin	-	-	-	-	Q (cfs)	10.4	15.5	19.6	27.9	33.2	38.3
N-B					CA (ac)	7.41	7.41	7.41	8.20	8.28	8.28
					Tc (min)	24.5	21.1	19.3	17.5	16.4	15.6
					i (in/hr)	1.41	2.09	2.64	3.40	4.01	4.62
Combine	-	-	-	2	Q (cfs)	13.2	19.7	25.0	34.9	39.5	42.4
N-AB					CA (ac)	10.20	10.20	10.20	11.28	11.40	11.40
					Tc (min)	-	-	-	-	-	-
					i (in/hr)	-	-	-	-	-	-

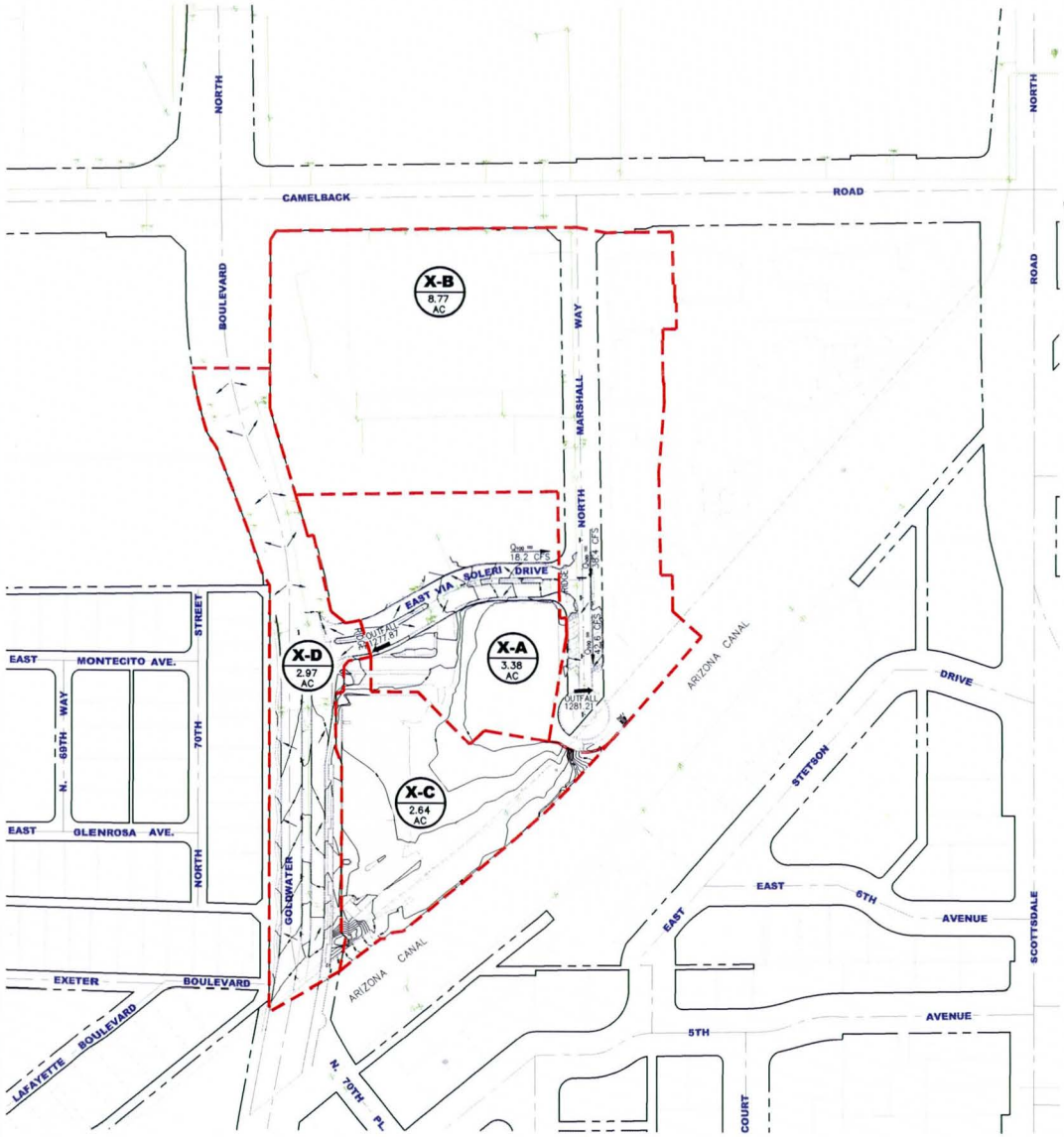
* First Pipe

Flood Control District of Maricopa County
Drainage Design Management System
SUB BASINS
Project Reference: K12117

11/5/2012

ID	Sub Basin Data							Sub Basin Hydrology Summary					
	Area (acres)	Length (ft)	USGE	DSGE	Slope (ft/mi)	Kb		2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
Major Basin ID: 01													
X-A	3.4	570	1,283.00	1,281.00	18.5	0.037	Q (cfs)	5.7	8.3	10.3	14.0	16.1	18.2
							C	0.85	0.85	0.85	0.94	0.95	0.95
							CA (ac)	2.87	2.87	2.87	3.18	3.21	3.21
							Tc (min)	11*	10*	9*	8*	8*	7*
							i (in/hr)	1.99	2.89	3.58	4.40	5.03	5.67
X-B	8.8	1,360	1,284.00	1,281.00	11.6	0.034	Q (cfs)	10.5	15.6	19.7	28.0	33.4	38.5
							C	0.85	0.85	0.85	0.94	0.95	0.95
							CA (ac)	7.45	7.45	7.45	8.24	8.33	8.33
							Tc (min)	25	21	19	18	16	16
							i (in/hr)	1.41	2.10	2.64	3.40	4.01	4.62
X-D	3.0	600	1,285.00	1,278.00	61.6	0.037	Q (cfs)	5.5	7.5	9.0	12.3	14.2	16.0
							C	0.85	0.85	0.85	0.94	0.95	0.95
							CA (ac)	2.52	2.52	2.52	2.79	2.82	2.82
							Tc (min)	11*	10*	9*	8*	8*	7*
							i (in/hr)	2.19	2.98	3.58	4.40	5.03	5.67
N-A	3.1	500	1,282.00	1,281.00	10.6	0.037	Q (cfs)	5.2	7.6	9.5	13.4	15.7	17.7
							C	0.85	0.85	0.85	0.94	0.95	0.95
							CA (ac)	2.79	2.79	2.79	3.08	3.12	3.12
							Tc (min)	14	12	11	10	8*	7*
							i (in/hr)	1.86	2.73	3.41	4.35	5.03	5.67
N-B	8.7	1,360	1,284.00	1,281.00	11.6	0.034	Q (cfs)	10.4	15.5	19.6	27.9	33.2	38.3
							C	0.85	0.85	0.85	0.94	0.95	0.95
							CA (ac)	7.41	7.41	7.41	8.20	8.28	8.28
							Tc (min)	25	21	19	18	16	16
							i (in/hr)	1.41	2.09	2.64	3.40	4.01	4.62

* Non default value



1 inch = 100 ft.

STORM WATER DISCHARGE CALCULATION

RATIONAL METHOD.
SEE ATTCHED CALCULATIONS USING THE FLOOD CONTROL DISTICT OF MARICOPA COUNTY DDMS SOFTWARE

Q = CIA
C = 0.95 – WORST CASE RUNOFF COEFFICIENT USED FOR CALCULATING STORM WATER DISCHARGE
I = PEAK INTENSITY FOR 100–YEAR PER NOAA ATLAS 14, VOLUME 1, VERSION 5
A = AREA IN ACRES

602-263-1100
1-800-STAKE-IT
(8:00 MIRIZON CONTY)

REVISIONS

BROADSTONE WATERFRONT

EXISTING DRAINAGE MAP

KLAND
CIVIL ENGINEERS
CIVIL ENGINEERING
LAND DEVELOPMENT SERVICES
LAND SURVEYING
7227 N. 16th St. Suite 217
Phoenix, Arizona 85020
PHONE: (480) 344-0480
FAX: (480) 393-8825
www.klandeng.com

ENGINEER: L. KLAND
DESIGNER: C. HADERLY
CAD TECH: C. HADERLY

PRELIMINARY
NOT
FOR
CONSTRUCTION
OR RECORDING

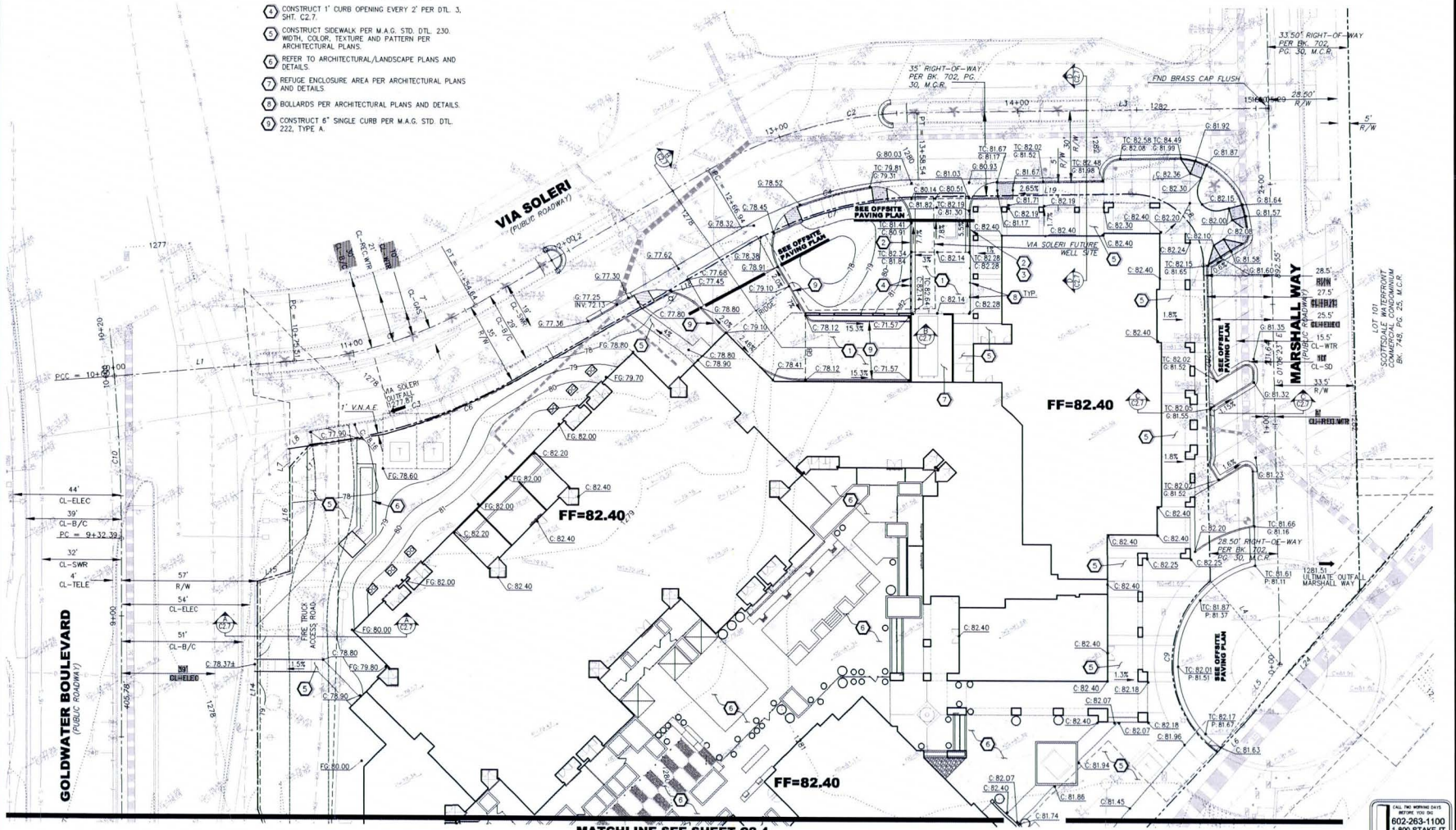
Project No.
K12117

11-06-12

Sheet No.
XDM
OF 1

CONSTRUCTION NOTES(ONSITE)

1. CONSTRUCT 7" PCCP PAVEMENT OVER 4" A.B.C. PER SOILS ENGINEERS' RECOMMENDATION.
2. CONSTRUCT CURB AND GUTTER PER M.A.G. STD. DTL. 220. TYPE A.
3. CONSTRUCT CURB TRANSITION FROM FLUSH CURB TO VERTICAL CURB. SEE PLAN FOR ELEVATIONS.
4. CONSTRUCT 1' CURB OPENING EVERY 2' PER DTL. 3, SHT. C2.7.
5. CONSTRUCT SIDEWALK PER M.A.G. STD. DTL. 230. WIDTH, COLOR, TEXTURE AND PATTERN PER ARCHITECTURAL PLANS.
6. REFER TO ARCHITECTURAL/LANDSCAPE PLANS AND DETAILS.
7. REFUGE ENCLOSURE AREA PER ARCHITECTURAL PLANS AND DETAILS.
8. BOLLARDS PER ARCHITECTURAL PLANS AND DETAILS.
9. CONSTRUCT 6" SINGLE CURB PER M.A.G. STD. DTL. 222, TYPE A.



CALL TWO WORKING DAYS BEFORE YOU DIG
602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

REVISIONS

BROADSTONE WATERFRONT

GRADING AND DRAINAGE PLAN

KLAND CIVIL ENGINEERS
CIVIL ENGINEERING
LAND DEVELOPMENT SERVICES
LAND SURVEYING
7227 N. 16th St. Suite 217
Phoenix, Arizona 85020
PHONE: (480) 344-0480
FAX: (480) 393-8825
www.klandeng.com

ENGINEER: L. KLAND
DESIGNER: L. KLAND
CAD TECH: D. WAGONER

Registered Professional Engineer (Civil)
CERTIFICATE NO. 31695
LESLIE J. KLAND
ARIZONA U.S.A.
Expires 06/30/15

Project No.
K12117

11-06-12

Sheet No.
C2.3
OF 13

PROJECT NO. 3772-12, CASE NO. 35-DR-2012

MATCHLINE SEE SHEET C2.3

GOLDWATER BOULEVARD (PUBLIC ROADWAY)

FIRE TRUCK ACCESS ROAD

PRIVATE IRRIGATION LINE EASEMENT

FF=82.40

ARIZONA CANAL

AGREEMENT OF EASEMENT & LICENSE

EASEMENT AGREEMENT FOR FLOOD CONTROL PURPOSES

PT = 5+26.61

PC 4+24

1 inch = 20 ft.

CONSTRUCTION NOTES(ONSITE)

5. CONSTRUCT SIDEWALK PER M.A.G. STD. DTL. 230. WIDTH, COLOR, TEXTURE AND PATTERN PER ARCHITECTURAL PLANS.
6. REFER TO ARCHITECTURAL/LANDSCAPE PLANS AND DETAILS.

CALL TWO WORKING DAYS BEFORE YOU DIG
602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

REVISIONS

BROADSTONE WATERFRONT

GRADING AND DRAINAGE PLAN

KLAND CIVIL ENGINEERS

CIVIL ENGINEERING
LAND DEVELOPMENT SERVICES
LAND SURVEYING

7227 N. 16th St. Suite 217
Phoenix, Arizona 85020
PHONE: (480) 344-0480
FAX: (480) 393-8825
www.klandeng.com

ENGINEER: L. KLAND
DESIGNER: L. KLAND
CAD TECH: D. WAGONER

Registered Professional Engineer (Civil)
CERTIFICATE NO. 31695
LESLIE J. KLAND
Date Signed 11-05-12
ARIZONA U.S.A.
Expires 09/30/15

Project No. K12117

11-05-12

Sheet No. C2.4 OF 13

PROJECT NO. 3772-12, CASE NO. 35-DR-2012

December 8, 1987

Mr. William R. Kendall
Collar, Williams and White Engineering
2702 North 44th Street, Suite 100A
Phoenix, Arizona 85008

Dear Mr. Kendall:

This letter is to notify you that the City of Scottsdale will not require Scottsdale Fashion Square redevelopment (104-Z-85 and 59-Z-87) to provide any new onsite retention or detention facilities.

It is our understanding that the existing onsite catch basin and storm drain network which conveys stormwater runoff to the underground storm sewers in Camelback and Scottsdale Roads, will remain intact. These guidelines conform to the master drainage report for Scottsdale Fashion Square, approved by the City on August 18, 1986.

Sincerely,

John Farmwalt
Project Review Director

cc: John Saltzer, Project Review Manager
Dick Cowl, Planning and Zoning Manager
Randy Grant, Project Review Manager

jf/rm

RECEIVED
DEC 16 1987
C.W.W. b

May 27, 1988

Mr. William R. Kendall
Collar, Williams and White Engineering
2702 N. 44th Street, Suite 205-B
Phoenix, Arizona 85008

RE: MASTER DRAINAGE PLAN SCOTTSDALE FASHION SQUARE DEVELOPMENT
(104-Z-85 AND 59-Z-87)

Dear Mr. Kendall:

This letter is to notify all interested parties of the City of Scottsdale's acceptance of the referenced revised Master Drainage Plan dated 9/15/87 and accompanying text dated 5/10/88.

Further, this letter is to advise potential future development, not included in this plan but using this plan as a basis for design, of the current drainage policies and ordinances.

First, the City of Scottsdale Downtown Infrastructure Master Plan, Volume 3, Drainage Study, dated December 1986, is the guide for development of the area.

The Scottsdale Fashion Square Master Drainage Plan indicates adherence to the Downtown Plan by noting on the drawing a "Future Storm Drainage Line (By Others)" to be placed in 70th Place, and notes the 30 inch to 42 inch existing storm drain in Scottsdale Road that may require an increase in size at some future date.

Secondly, as a result of change in policy, development within the Downtown Master Plan area is not required to provide retention or detention facilities as shown on the City of Scottsdale letter dated 12/8/87. The storage requirement is not necessary if development contributes to the Infrastructure Plan by constructing the storm sewer system.

Last, City Council Ordinance No. 1993 amended Title 37 of the City Code, the Floodplain and Drainage Ordinance, which directly affects future development in the Fashion Square area. Quoted from Title 37 of the City Code, Division 1, Regulations, Section 37-42 (12)(a.), "As a minimum, all development will make provisions to store runoff from rainfall events up to, and including, the 100-year 2-hour duration event"; and, "If storage is waived, the development shall be required to contribute to the cost of drainage works on the basis of runoff contribution".

Because parts of the Fashion Square project are in a Special Flood Hazard Area, a "FEMA A" Zone, it is necessary to inform all concerned that "FEMA" has indicated that at sometime in the near future, management of the "A" Zone will require dedicated flowage easements over the affected area. This requirement will be similar to the City Code requirements in the Environmentally Sensitive Land Areas Section 37-42 (14)(b.).

It is advised that the current A Zone shown on the attachment be transferred to the Master Plan and, after construction, "as-built" certifications, as to elevations and locations, should be included with the Master Plans so that a "Letter of Map Amendment" can be made to FEMA if easements are required at a future date.

Again, these changes are not applicable to the development as shown on the referenced plan, but serve as a guide for future development within adjacent areas.

It is suggested that this communication be included in the text of the referenced plan for future use.

Sincerely,

William Erickson
Drainage Planner and Floodplain Administrator

WE/tm

Broadstone 18-inch SD (FOR INFORMATION ONLY)

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Normal Depth	1.50	ft
Diameter	1.50	ft
Discharge	7.43	ft^3/s

Results

Discharge	7.43	ft^3/s
Normal Depth	1.50	ft
Flow Area	1.77	ft^2
Wetted Perimeter	4.71	ft
Hydraulic Radius	0.38	ft
Top Width	0.00	ft
Critical Depth	1.06	ft
Percent Full	100.0	%
Critical Slope	0.00703	ft/ft
Velocity	4.20	ft/s
Velocity Head	0.27	ft
Specific Energy	1.77	ft
Froude Number	0.00	
Maximum Discharge	7.99	ft^3/s
Discharge Full	7.43	ft^3/s
Slope Full	0.00500	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%

Broadstone 18-inch SD (FOR INFORMATION ONLY)

GVF Output Data

Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.50	ft
Critical Depth	1.06	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00703	ft/ft

Messages

Notes

For information only.
This capacity is a check of a pipe design by KLAND Civil Engineers.