Rawhide Wash Technical Support Report
City of Phoenix
Impact Fee Program

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1.0 Introduction

1.1 Purpose of Study

AECOM has been asked by the City of Phoenix Planning and Development Department to provide estimates of potential cost reductions associated with the removal of floodplain from a large area in the Northeast portion of the City. Currently this land, which is located largely in the Paradise Ridge and Desert Ridge areas, is subjected to flooding threats from the Rawhide Wash alluvial fan that extends southwest from the City of Scottsdale. The focus of the assignment is land that is currently designated by the Federal Emergency Management Agency (FEMA) as Flood Zone "AO" but could possibly be re-designated as "X" (Shaded), thereby reduce a variety of development and flood insurance restrictions, with the construction of major drainage projects. The projects are expected to be funded through a variety of sources that will include drainage impact fees paid by developers in the Paradise Ridge and adjacent areas. Since support for the projects, and the associated use of drainage impact fees, will in part depend on the cost/benefit aspect of the planned facilities, City staff requested that AECOM provide an analysis that would attempt to quantify the reduction of costs associated with site preparations and structure construction in areas where the "AO" designation was changed.

The future management of storm flows within the Rawhide Wash drainage corridor are currently being facilitated by projects led by the Flood Control District of Maricopa County (FCDMC). These include an ongoing design project for the channelization of a portion of the Rawhide Wash Reach located upstream and east of Scottsdale Road (FCD2018C015) and the development of a preliminary concept for an alignment for channelization alignment downstream of Scottsdale Road (FCD2018C011). Concept development developed as part of FCD2018C011 is preliminary in nature and subject to change based on the development of new land planning and environmental permitting efforts coupled with more detailed stormwater analysis and design. Ultimate implementation of drainage infrastructure both upstream and /or downstream of Scottsdale Road may provide an opportunity for application to the Federal Emergency Management Agency (FEMA) for a floodplain mapping revision.

A successful mapping revision could provide a variety of benefits, including reduced site improvement, residential and commercial construction, and flood insurance costs to potential developers and future property owners in the affected area. This assignment is focused on the identification and quantification of potentially-reduced costs that would be associated with changes in earthwork and drainage infrastructure requirements that would result from a transition from an "AO" zone to an "X" (Shaded) zone. These savings were estimated using very general assumptions about generic examples that might be representative of the types of development that are anticipated in the Paradise Ridge area. Three development model types were used for illustrative purposes:

- Medium Density Single-Family Detached Residential
- Attached Multifamily Residential
- Mixed Commercial

Reduced costs, or savings, were estimated by calculating the cost of developing sites in an "AO" zone, calculating the cost of developing sites in a revised "X" (Shaded) zone, and then finding the difference between the two.

1.2 Authority for Study

This preliminary and conceptual effort identified as **Rawhide Wash Technical Support – Impact Fee Program** is being performed on behalf of the City of Phoenix as part of **City of Phoenix Project Number 8591000000** under **Contract Number 148759**.

1.3 Project Location

The Area of Interest (AOI) is generally referred to as the Paradise Ridge Planning Area and is generally bound by Pinnacle Peak Road on the north side, the Central Arizona Project Canal (CAP) on the south side, Scottsdale Road on the east side, and the 64th Street Alignment on the west side, within the City of Phoenix (COP).

The AOI is characterized as predominately natural and undeveloped desert with existing commercial and residential land uses located south of the Loop 101 Freeway.

Figure 1 graphically illustrates the location of the AOI within Maricopa County. The locations of effective flood zones being considered is illustrated in **Figure 2**.

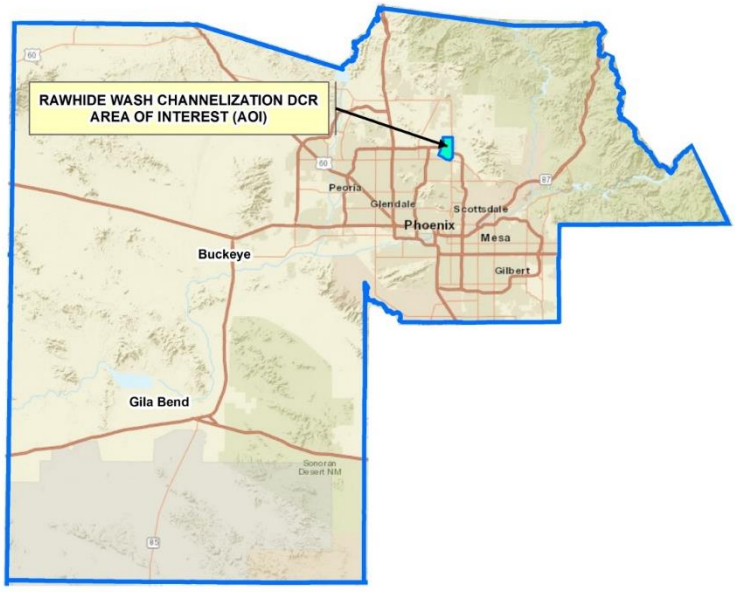

Figure 1: Project Location Map

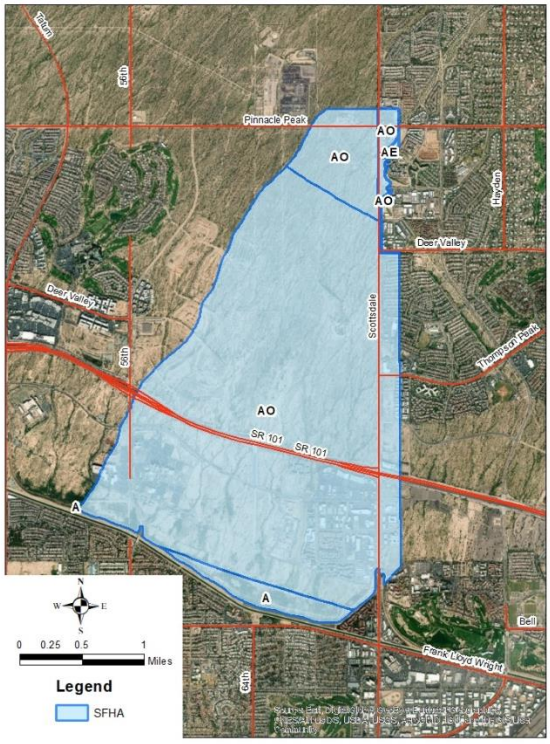

Figure 2: Location of Flood Zone "AO" Within the AOI

1.4 Methodology

A series of Preliminary Estimates of Development Cost Reductions (**Costs**) are estimated herein for infrastructure elements pertinent to land development and drainage design for area within FEMA Flood Zones “X” (Shaded) and “AO”. Flood Zone designations are further defined in Section 2.0.

The following assumptions were made regarding the development of the **Costs** presented herein.

- The information presented herein is considered preliminary and conceptual in nature and subject to change based on more detailed information.
- This information excludes bridges and culverts that may be required as part of transportation improvements
- Preliminary estimates of development cost reductions presented herein are based on a unit acre basis unless otherwise noted
- Right-of-Way costs are excluded from estimates
- Issues associated with Clean Water Act (CWA) Section 404 jurisdictional area and any associated permitting requirements are not considered

2.0 FEMA Floodplain Designation

The Federal Emergency Management Agency (FEMA) indicates that the subject area is encompassed by effective Flood Insurance Rate Map (FIRM) Panels and subsequent map revision updates, each identified as a Letter of Map Revision (LOMR), summarized in **Table 1**.

Table 1: Effective FEMA FIRM Panel Summary

Community No	FIRM Panel ID(1)	DATE	SUBSEQUENT UPDATES (LOMR)
040037 040051 045012	04013C1305L	10/16/2013	
040037 040051 045012	04013C1310L	10/16/2013	Update based on LOMR 15-09-1857P Dated 6/10/2016 Update based on LOMR 17-09-0074P Dated 8/25/2017
040051	04013C1315L	10/16/2013	
040037 040051 045012	04013C1320L	10/16/2013	Update based on LOMR 15-09-1857P Dated 6/10/2016 Update based on LOMR 17-09-0074P Dated 8/25/2017

Notes:

1. FEMA FIRM Panel IDs and information indicated are identified based on information available on FEMA's Map Service Center online resource.

Flood Zones "X" (Shaded), "A", and "AO" are each defined by FEMA and the FIRM Panel as follows:

Flood Zone "X" (Shaded): *Other Flood Areas; Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.*

Flood Zone "A": *Special Flood Hazard Areas (SFHAs) subject to inundation by the 1% annual chance flood; No base flood elevations determined.*

Flood Zone "AO": *Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.*

An application to the COP and FEMA for a LOMR based on and subsequent to successful construction of major drainage project improvements including channelization and conveyance of the Rawhide Wash 100-year flow would result in removal of a portion of the SFHA designation from with reclassification to a Flood Zone “X” (Shaded).

3.0 Technical Support Approach

The following sections outline the approach and assumptions for development of preliminary estimates of development cost reductions.

3.1 Development Considerations within Effective / Revised Floodplain

Much of the Paradise Ridge area is encumbered by an effective Flood Zone "AO" with an associated depth of 1 foot. Drainage design criteria prescribed by the COP *Storm Water Policies and Standards* (Phoenix, 2013) would require that finished floor elevations be a minimum of 1-foot about the adjacent floodplain elevation which would be the flood depth associated with the effective flood zone. This would require a minimum of 2 feet of elevation above adjacent grade within the effective Flood Zone "AO" within the Paradise Ridge area.

Implementation of regional drainage infrastructure (i.e., below grade open channel) to intercept and convey flows within Rawhide Wash from Scottsdale Road to the Loop 101 alignment is expected to provide an opportunity for application to FEMA for a floodplain mapping revision. This application may facilitate revision of some portion of the effective flood zone "AO" to "X" (Shaded) (with the exception of the residual conveyance corridor). While finished floors would require elevation above adjacent top of curbing, an approved floodplain mapping revision from "AO" to "X" (Shaded) would reduce the need to elevate finished floor elevations above adjacent grade by 2-feet. The COP criteria for design of finished floor elevations outside of FEMA flood zones is summarized below.

- 14-inches above the lowest adjacent top of curb elevation or the lowest drainage outfall
- 6-inches above the highest adjacent top of curb elevation or the adjacent roadway crown, perpendicular to the property

Both effective Flood Zone "AO" (Depth=1ft) and "X" (Shaded) are considered herein for the purposes of this exercise.

3.2 Land Use Planning Considerations

While land planning efforts have been developed in the area previously, it is AECOM's understanding that the ASLD will seek to develop a new comprehensive land plan in the future for the Paradise Ridge Area. The development of preliminary estimates of development cost reductions on a per-acre basis for each of these flood zone conditions, allows for assumptions in the absence of a final land plan. Preliminary estimates of development cost reductions were therefore developed on a per-acre basis, based on a series of conceptual land uses. These include the following:

- Single Family Residential (Detached)
- Multi-Family Residential
- Retail and Office

The location of these general land use categories within the Zone "AO" is identified in **Figure 3**. Drainage infrastructure aspects for each of these conceptual land uses are discussed in further detail in the following sections.

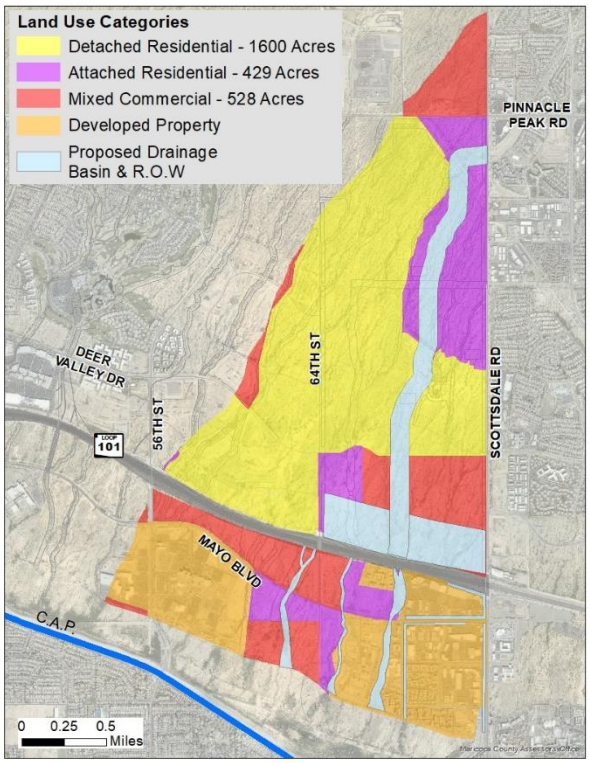

Figure 3 – Location of General Land Use Categories

3.3 Drainage Infrastructure Considerations

The primary drainage infrastructure aspects for which associated Costs were identified include the following:

- Storm water storage
- Storm drain improvements
- Earthwork

Each of these elements represents potential for significant impact to construction cost depending on storm water storage volume requirements and flood zone determination assumed at the time of construction. For each land use considered, conceptual assumptions for hydrology, street conveyance capacity, and storm water storage were made.

3.3.1 Stormwater Storage

For purposes of this exercise, a flood zone "X" (Shaded) and first flush event storm water storage volume requirements were assumed to result from the implementation of future regional infrastructure for the channelization of Rawhide Wash west of Scottsdale Road. The maintenance of the effective flood zone "AO" (Depth=1ft) and typical COP 100-year, 2-hour storm water storage volume requirements were assumed to result from no implementation of regional infrastructure for the channelization of Rawhide Wash.

Storm water runoff (first flush or 100-year, 2-hour retention volume) is estimated based on the following equation.

$$\boldsymbol{V} = \frac{\boldsymbol{P}}{\mathbf{12}} \cdot \boldsymbol{A} \cdot \boldsymbol{C}$$

Where:

$\boldsymbol{V}$ = Calculated volume in acre − feet
$\boldsymbol{P}$ = Rainfall depth in inches ($P_{100yr,2hr}$ or P = 0.04 ft for first flush)
$\boldsymbol{A}$ = Area of project site in acres
$\boldsymbol{C}$ = Runoff coefficient (C = 1.0 for first flush volume)

First flush volume is defined per COP criteria as runoff volume resulting from 0.5-inches of direct runoff. For the land uses considered, the following runoff coefficients were used which are based on COP *Storm*

Water Policies and Standards (Phoenix, 2013) and the FCDMC's *Drainage Design Manual for Maricopa County, Hydrology* (FCDMC, 2013).

Table 2 – Runoff Coefficients

Land Use Considered	Classification	Runoff Coefficient
Single Family (Detached)	Medium Density Residential	C_{100}=0.80
Multi-Family (Attached)	Multi-Family Residential	C_{100}=0.94
Mixed Commercial	Commercial	C_{100}=0.95

Runoff volumes for both first flush ($V_{First\ Flush}$) and retention ($V_{100yr\text{-}2hr}$) for conceptual 1-acre project sites are summarized below in **Table 3**.

Table 3 – Unit Area Runoff Volumes

Event	Land Use Considered	P [inches]	A [2] [acres]	C [3]	V [4] [acre-feet]
First Flush	MDR	0.50	1	1.00	0.042
	MFR	0.50	1	1.00	0.042
	Commercial	0.50	1	1.00	0.042
Retention [1]	MDR	2.323	1	0.80	0.16
	MFR	2.323	1	0.94	0.18
	Commercial	2.323	1	0.95	0.18

Notes:

1. Event reflects the 100-year, 2-hour event.
2. Estimate based on conceptual 1-acre project site.
3. Runoff coefficient for first flush event based on value of 1 due to 0.50 inches of direct runoff. Coefficients for 100-year, 2-hour event based on values presented in the COP and FCDMC's *Drainage Design Manual for Maricopa County, Hydrology*.
4. Runoff volume indicated is estimated based on the use of V=(P/12) (A)(C).

These runoff volumes were associated with the regional infrastructure implementation/no implementation scenarios summarized below in **Table 4**.

Table 4 – Storm Water Storage Volumes

Event	Flood Zone	Land Use Considered	V [yd^3]	V [acre-feet]
First Flush	Zone "X"	MDR	70	0.042
	Zone "X"	MFR	70	0.042
	Zone "X"	Commercial	70	0.042
Retention [1]	Zone "AO"	MDR	250	0.16
	Zone "AO"	MFR	300	0.18
	Zone "AO"	Commercial	300	0.18

A common industry practice with regard to storm water storage in commercial land development encompasses underground storage. Utilization of this means of storm water accommodation was corroborated by engineering professionals with experience in the vicinity of the subject area. Underground storm water storage can reduce the surface area required to accommodate runoff volume. Underground storm water storage is commonly facilitated with the use of large diameter (e.g., 10-foot) corrugated steel tanks and evacuation by means of drywells. The conceptual implementation of underground stormwater storage was considered for use herein as part of commercial land use.

3.3.2 Street Flow Capacity and Storm Drain Improvements

Conceptual storm drain improvements based on implementation / no implementation of regional drainage infrastructure were considered for purposes of this exercise. For a scenario encompassing implementation of regional infrastructure, storm drain improvements were assumed to be incorporated on the basis of street flow conveyance capacity and when estimated street flow conveyance was exceeded. Street flow capacity was estimated based on local street cross-section "H" as identified in 2015 City of Phoenix Supplemental Standard Details for Public Works Construction (COP, 2015), which is illustrated below in **Figure 4**.

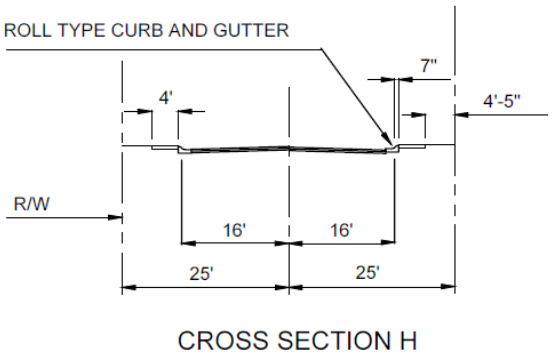

Figure 4 – COP Local Cross-Section H

Street flow capacity was estimated based on the use of Bentley Systems, Inc.'s FlowMaster V8i program in conjunction with the criteria identified below. Longitudinal gutter slope = 0.0025 ft/ft

- Manning's roughness coefficient = 0.015
- Normal crown cross-slope = 0.02 ft/ft
- Maximum flow depth = 8-inches

The half-street flow capacity at a depth of 8-inches is estimated to be approximately 24 cfs. Conceptual storm drain improvements were therefore considered where estimated full-street flow capacity [(2)(24)

= 48cfs] is expected to be exceeded. For purposes of this exercise, and for the implementation of regional drainage infrastructure, the maximum lateral distance from the regional drainage corridor considered for which storm water from local land development projects beyond the first flush event magnitude could drain toward the regional corridor was assumed as one-half mile (2,640 feet).

A preliminary estimate of the tributary size based on assumed land use and the maximum street flow capacity was made based on rational methodology and the equation shown below.

$$Q = C \cdot i \cdot A$$

Where:

$\boldsymbol{Q}$ = Peak flow (cfs)

$\boldsymbol{C}$ = Runoff coefficient

$\boldsymbol{i}$ = Rainfall intensity (inches per hour)

$\boldsymbol{A}$ = Area of project site in acres

Runoff coefficients identified previously were maintained for these estimates. Rainfall intensity was estimated based on an assumed minimum time of concentration of ten (10) minutes coupled with a rainfall-intensity-duration frequency relationship published by FCDMC for all estimates.

Table 5 – Conceptual Project Site Tributary Sizes

Land Use	Q [ft^3/sec]	C	i [2] [in/hour]	A [1] [acres]
MDR	48	0.80	6.0	10
MFR	48	0.94	6.0	8.5
Commercial	48	0.95	6.0	8.4

Notes:

1. Area [A] indicated is estimated as follows: [A=[Q/[(C)(i)]]
2. Rainfall intensity is based on a minimum T_c of 10 minutes coupled with FCDMC's intensity-duration-frequency relationship.

Preliminary conveyance capacities for storm drain conduits were estimated with the use of Bentley Systems, Inc.'s FlowMaster V8i program in conjunction with the criteria identified below and are summarized in **Table 6**.

- Reinforced concrete pipe (RCP)
- Pipe slope = 0.0030 ft/ft
- Manning's roughness coefficient = 0.015
- Pipe flowing full condition

Table 6 – Conceptual Storm Drain Capacity

Pipe Diameter [inches]	$Q_{CAPACITY}$ [ft^3/sec]
18	5
24	11
30	19
36	32
42	48
48	74

Conceptual storm drain sizes were estimated by using the general tributary sizes and associated flow rates for each land use, in comparison to assumed storm drain capacities identified in **Table 5**. Additional appurtenances consisting of storm drain inlets, manholes, and outlet headwalls were also identified.

More significant storm drain quantities were identified for a scenario incorporating regional drainage infrastructure. Conceptual storm drain quantities were more limited for a scenario that did not incorporate regional drainage infrastructure.

3.3.2 Earthwork

Conceptual earthwork estimates were considered based on implementation / no implementation of regional drainage infrastructure. Earthwork estimates for a master planned community of this nature would be expected to encompass a larger scale mass grading exercise, ideally with an assumed intent to achieve a balance between cut and fill material placement.

Assumptions associated with conceptual earthwork estimates presented herein include the fill placement depths summarized below in **Table 7**. For a scenario encompassing implementation of regional drainage infrastructure, a general balance between cut and fill earthwork quantities with a general depth of 0.5 feet was assumed. For scenarios encompassing no implementation of regional drainage infrastructure, the placement of fill material to a depth of one (1) foot above the effective Zone AO (Depth-1 foot) per City of Phoenix requirements was assumed (total fill placement depth $\geq$ 2 feet).

A typical industry standard stepped lot and building pad condition was assumed for single and multiple family residential land use. Development criteria for mixed commercial land use typically includes provision of a uniform building pad and floor elevation to avoid a differential in the ground floor level that would require steps and/or ramps. These stepped conditions were reflected in the fill placement depths used in the conceptual earthwork volume estimates. Furthermore, mixed commercial land uses can encompass coffee, drug, grocery, and department store establishments that may range in size from 2,000

to 250,000 square feet in area, respectively. Larger establishments can be expected to encompass an entire assumed unit acre area thus requiring the larger estimate of fill placement depth.

Table 7 – Conceptual Earthwork Volume Estimates

Land Use	Q [ft^3/sec]	Dimensions [ft] (1)			Earthwork Volume [yd^3] (2)(3)
		W [ft]	L [ft]	D [ft]	
Implementation	MDR	209	209	0.5	1,000
	MFR	209	209	0.5	1,000
	Commercial	209	209	0.5	1,000
No Implementation	MDR	209	209	2.5	4,000
	MFR	209	209	2.6	4,200
	Commercial	209	209	4.1	6,600

Notes:

1. Dimensions are based on 1-acre property and depth of fill (D) and land use assumptions mentioned.
2. Volume indicated is conceptual in nature and subject to change based on more detailed information.
3. A value of 10% of the volume indicated for the No Regional Infrastructure Implementation scenario is assumed for cut earthwork

4.0 Preliminary Estimates of Development Cost Reductions

Management of storm water can encompass numerous elements for flow interception, conveyance, storage volume, flood peak attenuation, elevation, and quality. For the purposes of this exercise, the conceptual estimates for development cost reduction have been based primarily on the more significant elements mentioned previously which include the following:

- Storm water storage
- Storm drain improvements
- Earthwork

For the purposes of this exercise, many assumptions have been made in regard to estimation of the quantities used for determining preliminary costs for the significant elements which have been discussed in detail in the preceding sections. Key assumptions made with regard to the general approach to this exercise are summarized as follows:

- Estimates are made based on a unit acreage basis
- Estimates are made based on **Implementation / No Implementation** of regional drainage infrastructure
- **Implementation** of regional drainage infrastructure is assumed to imply reduction of the extent of the FEMA Flood Zone "AO" Special Flood Hazard Area delineation
- **Implementation** of regional drainage infrastructure is assumed to provide reduced storm water storage requirements and an opportunity for use as a storm water outfall
- **No Implementation** of regional drainage infrastructure is assumed to require adjacent land development to provide sufficient elevation above the effective FEMA water surface elevation coupled with typical storm water storage requirements
- **No implementation** of regional drainage infrastructure is assumed to imply no change in FEMA's effective Flood Zone "AO" Special Flood Hazard Area delineation
- A maximum of three (3) land use classifications have been considered; (Detached Residential, Attached Residential, and Mixed Commercial)

Review of the preliminary estimates of development costs indicates that construction of regional drainage improvements and subsequent revision to and reduction of the Flood Zone "AO" delineation could reduce costs associated with land development for the land use categories considered herein. A conceptual summary of the reduction in development (stormwater-oriented) & grading costs is included below in **Table 8**. These estimates of total cost reduction have been based on a one-acre unit basis and extrapolated based on total acreage for each identified land use category. Reduction in cost however is not expected to be linear in nature and could be more or less than the estimates indicated.

Table 8 – Conceptual Development and Grading Cost Savings Comparison [(1)]

Land Use	Development Cost per Acre [(1)] [$]		Estimated Cost Savings per Acre [$]	Estimated Number of Acres [(4)]	Estimated Reduction in Development & Grading Costs [(1)]
	Implementation [(2)]	No Implementation [(3)]			
Detached Residential	$43,000	$103,000	$60,000	1,600	$96,000,000
Attached Residential	$48,000	$112,000	$64,000	429	$27,456,000
Mixed Commercial	$105,000	$214,000	$109,000	528	$57,552,000
Total Reduction in Development & Grading Costs – NE Phoenix Drainage Area [(1)]					**$181,008,000[(5)]**

Notes:

1. Costs indicated are limited to significant elements associated with stormwater management and earthwork only. Other elements associated with land development not reflected herein are expected to contribute to development costs.
2. Based on Implementation of Regional Drainage Infrastructure.
3. Based on NO Implementation of Regional Drainage Infrastructure.
4. Acreage provided is based on information provided by the City of Phoenix.
5. Estimates indicated have been based on a one-acre unit basis, extrapolated based on total acreage identified by the City of Phoenix for each land use category. Actual estimates may be more or less than those indicated.

Details associated with development of the Preliminary Estimates of Development Cost Reductions for each land use condition mentioned previously is included in **Appendix A**. The unit costs indicated for storm drain improvements have been based in part on documents available from the COP.

Earthwork unit costs which are expected to represent a significant component of the development cost, have been assumed based on an import condition at $12 per cubic yard for the purposes of this exercise. The construction of a regional drainage infrastructure solution to the conveyance of Rawhide Wash peak flows may however result in a lowered unit cost based on generation of fill material with reduced haul distances.

The assumptions and design elements included herein as well as in the attachments are preliminary and conceptual in nature. Other factors or considerations including but not limited to a revised land plan, revised 404 permitting, and channelization analysis and design not identified or considered in the estimates will be required as part of a future design.

5.0 References

1. City of Phoenix, *Storm Water Policies and Standards*, December 2013.
2. Flood Control District of Maricopa County, *Drainage Design Manual for Maricopa County, Hydrology*, August 15, 2013.
3. Bentley Systems, Inc., *FlowMaster V8i Program*, 2009.

Appendix A

Preliminary Estimates of Development Cost Reduction

RAWHIDE WASH TECHNICAL SUPPORT CITY OF PHOENIX
IMPACT FEE PROGRAM (8591000000)
12/23/2019

DETACHED RESIDENTIAL

FEMA FLOODZONE "X" (Shaded)[1]

ELEMENT[2][5]	DESCRIPTION	QTY	UNIT	UNIT COST	ACREAGE CONSIDERED [6]	TOTAL COST (per acre) [(QTYxUC)/Acreage]
Earthwork (FILL)	Grading	1,000	YD^3	$12	1	$12,000
Earthwork (CUT)	Grading	1,000	YD^3	$12	1	$429
Stormwater Storage[4]	First Flush Volume	70	YD^3	$12	1	$840
Stormdrain[3]	36-in RCP	550	LF	$165	28	$3,259
Stormdrain[3]	42-in RCP	550	LF	$185	28	$3,654
Stormdrain[3]	48-in RCP	550	LF	$200	28	$3,950
Stormdrain Manholes	Manhole at 400-ft Spacing	4	EA	$4,200	28	$603
Stormdrain Inlets	Curb Opening Inlets	8	EA	$5,000	28	$1,436
Stormdrain Outfall	Outfall into regional corridor	1	EA	$3,300	28	$118
SubTotal						$26,288
Design (10%)						$2,628.83
Permitting (2%)						$525.77
Construction Surveying and Layout (2%)						$525.77
Mobilization (3%)						$788.65
Construction Administration (6%)						$1,577.30
Contingency (40%)						$10,515.33
Total						$43,000

NOTES:

1. Element mentioned is based on assumed Flood Zone "X" (Shaded) resulting from approved map revision applications.
2. Cost elements indicated are based on a per acre basis and are considered PRELIMINARY and conceptual in nature and subject to change based on more detailed information.
3. Cost indicated is based on assumed implementation of storm drain to convey storm water to a proposed regional corridor designed and implemented separately.
4. Stormwater storage is assumed to be first flush volume quantity equivalent to 0.5 inches of direct runoff per City of Phoenix criteria.
5. Flood Insurance requirements estimated separately and not reflected here may be reduced as a result of a successful floodplain mapping revision.
6. Elements including conceptual stormdrain improvements have been developed based on a per acre basis. Stormdrain improvements have been developed based on a larger area and converted into a unit acre basis.
7. This information excludes bridges and culverts that may be required as part of transportation improvements.

FEMA FLOODZONE "AO"[1]

ELEMENT[2]	DESCRIPTION	QTY	UNIT	UNIT COST	ACREAGE CONSIDERED [8]	TOTAL (per acre)
Earthwork (FILL)[3]	Elevation above AO Depth	4,000	YD^3	$12	1	$48,000
Earthwork (CUT)[4]	Elevation above AO Depth	400	YD^3	$12	1	$4,800
Stormwater Storage[7]	100-yr, 2-hr Runoff Volume	250	YD^3	$12	1	$3,000
Stormdrain[5]	24-in RGRCP	50	LF	$115	5.6	$1,027
Stormdrain Inlets[6]	Curb Opening Inlet	2	EA	$5,000	5.6	$1,786
Stormdrain Manholes		1	EA	$4,200	5.6	$750
Stormdrain Outfall		1	EA	$3,300	5.6	$589
Drywells	Stormwater Storage Bleed-Off	1	EA	$18,000	5.6	$3,214
SubTotal						$63,166
Design (10%)						$6,316.6
Permitting (2%)						$1,263.3
Construction Surveying and Layout (2%)						$1,263.3
Mobilization (3%)						$1,895.0
Construction Administration (6%)						$3,790.0
Contingency (40%)						$25,266.4
Total						$103,000

NOTES:

1. Element mentioned is based on effective Flood Zone "AO" with 1-ft Depth.
2. Cost elements indicated are based on a per acre basis and are considered PRELIMINARY and conceptual in nature and subject to change based on more detailed information.
3. Earthwork (FILL) element indicated is based on a minimum of 1-foot elevation above the Floodzone AO depth. Depth of 2.5-ft throughout 1-acre parcel to account for stepped pad grading.
4. Earthwork (CUT) element indicated is an assumed value of 10% of Earthwork (FILL).
5. Cost indicated is based on assumed implementation of storm drain to convey storm water to a proposed regional corridor designed and implemented separately.
6. Inlets (set of 2) associated with conceptual stormdrain system.
7. Stormwater storage is assumed to be COP Standard 100-yr, 2-hr runofff volume quantity.
8. Elements including conceptual stormdrain improvements have been developed based on a per acre basis. Stormdrain improvements have been developed based on a larger area and converted into a unit acre basis.
9. This information excludes bridges and culverts that may be required as part of transportation improvements.

RAWHIDE WASH TECHNICAL SUPPORT CITY OF PHOENIX
IMPACT FEE PROGRAM (8591000000)
12/23/2019

ATTACHED RESIDENTIAL

FEMA FLOODZONE "X" (Shaded)[1]

ELEMENT[2][5]	DESCRIPTION	QTY	UNIT	UNIT COST	ACREAGE CONSIDERED [6]	TOTAL COST (per acre) [(QTYxUC)/Acreage]
Earthwork (FILL)	Grading	1,000	YD^3	$12	1	$12,000
Earthwork (CUT)	Grading	1,000	YD^3	$12	1	$429
Stormwater Storage[4]	First Flush Volume	70	YD^3	$12	1	$840
Stormdrain[3]	36-in RGRCP	450	LF	$165	26	$2,856
Stormdrain[3]	42-in RGRCP	450	LF	$185	26	$3,202
Stormdrain[3]	48-in RGRCP	900	LF	$200	26	$6,923
Stormdrain Manholes	Manhole at 400-ft Spacing	5	EA	$4,200	26	$808
Stormdrain Inlets	Curb Opening Inlets	10	EA	$5,000	26	$1,923
Stormdrain Outfall	Outfall into regional corridor	1	EA	$3,300	26	$127
SubTotal						$29,107
Design (10%)						$2,910.70
Permitting (2%)						$582.14
Construction Surveying and Layout (2%)						$582.14
Mobilization (3%)						$873.21
Construction Administration (6%)						$1,746.42
Contingency (40%)						$11,642.81
Total						$48,000

NOTES:

1. Element mentioned is based on assumed Flood Zone "X" (Shaded) resulting from approved map revision applications.
2. Cost elements indicated are based on a per acre basis and are considered PRELIMINARY and conceptual in nature and subject to change based on more detailed information.
3. Cost indicated is based on assumed implementation of storm drain to convey storm water to a proposed regional corridor designed and implemented separately.
4. Stormwater storage is assumed to be first flush volume quantity equivalent to 0.5 inches of direct runoff per City of Phoenix criteria.
5. Flood Insurance requirements estimated separately and not reflected here may be reduced as a result of a successful floodplain mapping revision.
6. Elements including conceptual stormdrain improvements have been developed based on a per acre basis. Stormdrain improvements have been developed based on a larger area and converted into a unit acre basis.
7. This information excludes bridges and culverts that may be required as part of transportation improvements.

FEMA FLOODZONE "AO"[1]

ELEMENT[2]	DESCRIPTION	QTY	UNIT	UNIT COST	ACREAGE CONSIDERED [8]	TOTAL COST (per acre) [(QTYxUC)/Acreage]
Earthwork (FILL)[3]	Elevation above AO Depth	4,200	YD^3	$12	1	$50,400
Earthwork (CUT)[4]	Elevation above AO Depth	420	YD^3	$12	1	$5,040
Stormwater Storage[7]	100-yr, 2-hr Runoff Volume	300	YD^3	$12	1	$3,600
Stormdrain[5]	24-in RGRCP	50	LF	$115	4.3	$1,337
Stormdrain Inlets[6]	Curb Opening Inlet	2	EA	$5,000	4.3	$2,326
Stormdrain Manholes		1	EA	$4,200	4.3	$977
Stormdrain Outfall		1	EA	$3,300	4.3	$767
Drywells	Stormwater Storage Bleed-Off	1	EA	$18,000	4.3	$4,186
SubTotal						$68,633
Design (10%)						$6,863.3
Permitting (2%)						$1,372.7
Construction Surveying and Layout (2%)						$1,372.7
Mobilization (3%)						$2,059.0
Construction Administration (6%)						$4,118.0
Contingency (40%)						$27,453.2
Total						$112,000

NOTES:

1. Element mentioned is based on effective Flood Zone "AO" with 1-ft Depth.
2. Cost elements indicated are based on a per acre basis and are considered PRELIMINARY and conceptual in nature and subject to change based on more detailed information.
3. Earthwork (FILL) element indicated is based on a minimum of 1-foot elevation above the Floodzone AO depth. Depth of 2.9-ft throughout 1-acre parcel to account for stepped pad grading.
4. Earthwork (CUT) element indicated is an assumed value of 10% of Earthwork (FILL).
5. Cost indicated is based on assumed implementation of storm drain to convey storm water to a proposed regional corridor designed and implemented separately.
6. Inlets (set of 2) associated with conceptual stormdrain system.
7. Stormwater storage is assumed to be COP Standard 100-yr, 2-hr runofff volume quantity.
8. Elements including conceptual stormdrain improvements have been developed based on a per acre basis. Stormdrain improvements have been developed based on a larger area and converted into a unit acre basis.
9. This information excludes bridges and culverts that may be required as part of transportation improvements.

RAWHIDE WASH TECHNICAL SUPPORT CITY OF PHOENIX
IMPACT FEE PROGRAM (8591000000)
12/23/2019

RETAIL / OFFICE

FEMA FLOODZONE "X" (Shaded)[1]

ELEMENT[2][5]	DESCRIPTION	QTY	UNIT	UNIT COST	ACREAGE CONSIDERED [6]	TOTAL COST (per acre) [(QTYxUC)/Acreage]
Earthwork (FILL)	Grading	3,800	YD^3	$12	1	$45,600
Earthwork (CUT)	Grading	3,800	YD^3	$12	1	$1,629
Stormwater Storage[4]	First Flush Volume	70	YD^3	$12	1	$840
Stormdrain[3]	36-in RGRCP	450	LF	$165	26	$2,856
Stormdrain[3]	42-in RGRCP	450	LF	$185	26	$3,202
Stormdrain[3]	48-in RGRCP	900	LF	$200	26	$6,923
Stormdrain Manholes	Manhole at 400-ft Spacing	5	EA	$4,200	26	$808
Stormdrain Inlets	Curb Opening Inlets	10	EA	$5,000	26	$1,923
Stormdrain Outfall	Outfall into regional corridor	1	EA	$3,300	26	$127
SubTotal						$63,907
Design (10%)						$6,390.70
Permitting (2%)						$1,278.14
Construction Surveying and Layout (2%)						$1,278.14
Mobilization (3%)						$1,917.21
Construction Administration (6%)						$3,834.42
Contingency (40%)						$25,562.81
Total						$105,000

NOTES:

1. Element mentioned is based on assumed Flood Zone "X" (Shaded) resulting from approved map revision applications.
2. Cost elements indicated are based on a per acre basis and are considered PRELIMINARY and conceptual in nature and subject to change based on more detailed information.
3. Cost indicated is based on assumed implementation of storm drain to convey storm water to a proposed regional corridor designed and implemented separately.
4. Stormwater storage is assumed to be first flush volume quantity equivalent to 0.5 inches of direct runoff per City of Phoenix criteria.
5. Flood Insurance requirements estimated separately and not reflected here may be reduced as a result of a successful floodplain mapping revision.
6. Elements including conceptual stormdrain improvements have been developed based on a per acre basis. Stormdrain improvements have been developed based on a larger area and converted into a unit acre basis.
7. This information excludes bridges and culverts that may be required as part of transportation improvements.

FEMA FLOODZONE "AO"[1]

ELEMENT[2]	DESCRIPTION	QTY	UNIT	UNIT COST	ACREAGE CONSIDERED [8]	TOTAL COST (per acre) [(QTYxUC)/Acreage]
Earthwork (FILL)[3]	Elevation above AO Depth[9]	6,600	YD^3	$12	1	$79,200
Earthwork (CUT)[4]	Elevation above AO Depth	660	YD^3	$12	1	$7,920
Underground Storage[7]	100-yr, 2-hr Runoff Volume	110	LF	$300	1	$33,000
Stormdrain[5]	24-in RGRCP	100	LF	$115	4.3	$2,674
Stormdrain Inlets[6]	Local storm drain system	2	EA	$5,000	4.3	$2,326
Stormdrain Manholes	Local storm drain system	1	EA	$4,200	4.3	$977
Stormdrain Outfall	Local storm drain system	1	EA	$3,300	4.3	$767
Drywells	Stormwater Storage Bleed-Off	1	EA	$18,000	4.3	$4,186
SubTotal						$131,050
Design (10%)						$13,105.0
Permitting (2%)						$2,621.0
Construction Surveying and Layout (2%)						$2,621.0
Mobilization (3%)						$3,931.5
Construction Administration (6%)						$7,863.0
Contingency (40%)						$52,420.1
Total						$214,000

NOTES:

1. Element mentioned is based on effective Flood Zone "AO" with 1-ft Depth.
2. Cost elements indicated are based on a per acre basis and are considered PRELIMINARY and conceptual in nature and subject to change based on more detailed information.
3. Earthwork (FILL) element indicated is based on a minimum of 1-foot elevation above the Floodzone AO depth. Depth of 4.1-ft throughout 1-acre parcel to account for pad grading.
4. Earthwork (CUT) element indicated is an assumed value of 10% of Earthwork (FILL).
5. Cost indicated is based on assumed implementation of storm drain to convey storm water to a proposed regional corridor designed and implemented separately.
6. Inlets (set of 2) associated with conceptual stormdrain system.
7. Stormwater storage is assumed to be COP Standard 100-yr, 2-hr runofff volume quantity.
8. Elements including conceptual stormdrain improvements have been developed based on a per acre basis. Stormdrain improvements have been developed based on a larger area and converted into a unit acre basis.
9. Earthwork associated with retail land use is assumed to reflect a non-stepped building which will require additional fill material within a flood zone "AO".
10. This information excludes bridges and culverts that may be required as part of transportation improvements.