MARANA TOWN COUNCIL
REGULAR COUNCIL MEETING
NOTICE AND AGENDA
11555 W. Civic Center Drive, Marana, Arizona 85653
Council Chambers, November 19, 2024, at or after 6:00 PM

Ed Honea, Mayor
Jon Post, Vice Mayor
Patrick Cavanaugh, Council Member
Patti Comerford, Council Member
Herb Kai, Council Member
John Officer, Council Member
Roxanne Ziegler, Council Member

Pursuant to A.R.S. §38-431.02, notice is hereby given to the members of the Marana Town Council and to the general public that the Town Council will hold a meeting open to the public on November 19, 2024, at or after 6:00 PM located in the Council Chambers of the Marana Municipal Complex, 11555 W. Civic Center Drive, Marana, Arizona.

ACTION MAY BE TAKEN BY THE COUNCIL ON ANY ITEM LISTED ON THIS AGENDA. Revisions to the agenda can occur up to 24 hours prior to the meeting. Revised agenda items appear in *italics*.

As a courtesy to others, please turn off or put in silent mode all electronic devices.

Meeting Times
Welcome to this Marana Town Council meeting. Regular Council meetings are usually held the first and third Tuesday of each month at 6:00 PM at the Marana Municipal Complex, although the date or time may change and additional meetings may be called at other times and/or places. Contact the Town Clerk or watch for posted agendas for other meetings. This agenda may be revised up to 24 hours prior to the meeting. In such a case a new agenda will be posted in place of this agenda.

Speaking at Meetings
If you are interested in speaking to the Council during the Call to the Public or Public Hearings, you must fill out a speaker card (located in the lobby outside the Council Chambers) and deliver it to the Town Clerk prior to the convening of the meeting.

All persons attending the Council meeting, whether speaking to the Council or not, are expected to observe the Council rules, as well as the rules of politeness, propriety, decorum and good conduct. Any person interfering with the meeting in any way, or acting rudely or loudly will be removed from the meeting and will not be allowed to return.

Accessibility
To better serve the citizens of Marana and others attending our meetings, the Council Chambers are wheelchair and handicapped accessible. Persons with a disability may request a reasonable accommodation, such as a sign language interpreter, by contacting the Town Clerk at (520) 382-1999. Requests should be made as early as possible to arrange the accommodation.

Agendas
Copies of the agenda are available the day of the meeting in the lobby outside the Council Chambers or online at www.maranaaz.gov under Agendas and Minutes. For questions about the Council meetings, special services or procedures, please contact the Town Clerk, at (520) 382-1999, Monday through Friday from 8:00 AM to 5:00 PM.

This Notice and Agenda Posted no later than 24 hours prior to the meeting, at the Marana Municipal Complex, 11555 W. Civic Center Drive, the Marana Operations Center, 5100 W. Ina Road, and at www.maranaaz.gov under Agendas and Minutes.

REGULAR COUNCIL MEETING

CALL TO ORDER AND ROLL CALL

PLEDGE OF ALLEGIANCE/INVOCATION/MOMENT OF SILENCE

APPROVAL OF AGENDA

CALL TO THE PUBLIC
At this time any member of the public is allowed to address the Town Council on any issue within the jurisdiction of the Town Council, except for items scheduled for a Public Hearing at this meeting. The speaker may have up to three minutes to speak. Any persons wishing to address the Council must complete a speaker card located outside the Council Chambers and deliver it to the Town Clerk prior to the commencement of the meeting. Individuals addressing a meeting at the Call to the Public will not be provided with electronic technology capabilities beyond the existing voice amplification and recording capabilities in the facilities. Pursuant to the Arizona Open Meeting Law, at the conclusion of Call to the Public, individual members of the Council may respond to criticism made by those who have addressed the Council, and may ask staff to review the matter, or may ask that the matter be placed on a future agenda.

PROCLAMATIONS

MAYOR AND COUNCIL REPORTS: SUMMARY OF CURRENT EVENTS

MANAGER'S REPORT: SUMMARY OF CURRENT EVENTS

PRESENTATIONS

CONSENT AGENDA

The Consent Agenda contains items requiring action by the Council which are generally routine items not requiring Council discussion. A single motion and affirmative vote will approve all items on the Consent Agenda, including any resolutions or ordinances. Prior to a motion to approve the Consent Agenda, any Council member may remove any item from the Consent Agenda and that item will be discussed and voted upon separately.

C1 Resolution No. 2024-101: Relating to Development; approving a Final Plat for Saguaro Reserve III at Dove Mountain, Lots 1-236, and Common Areas "A" (Private Streets) and "B" (Open Space / Drainage) located north of Dove Mountain Boulevard and east of Dove Reserve Drive within Sections 16 and 21, Township 11 South and Range 12 East (Scott S. Radden)

C2 Resolution No. 2024-102: Relating to Utilities; approving and authorizing the Mayor to sign an amendment to the Intergovernmental Agreement, effective December 1, 2024, between the Town of Marana and Pima County for provision of water consumption data and sewer user account billing services (Kim Baker)

C3 Relating to Procurement; approving a change order to the contract with Dibble & Associates in the amount of $106,795.15 for the Airport Control Tower, EA (AP031); authorizing the transfer of appropriations if necessary for the change order; and authorizing the Town Manager or designee to execute the necessary documents to effectuate the change order (Fausto Burruel)

C4 Approval of Study Session Summary Minutes of October 29, 2024, and approval of Regular Council Meeting Summary Minutes of November 6, 2024 (David L. Udall)

LIQUOR LICENSES

BOARDS, COMMISSIONS AND COMMITTEES

COUNCIL ACTION

A1 PUBLIC HEARING: Ordinance No. 2024.024: Relating to Development; approving a modification of a rezoning condition of Marana Ordinance No. 2021.016, which rezoned approximately 49 acres of land located approximately one-quarter mile south of Ina Road, west of Silverbell Road, to revise a provision of the ordinance that required all utilities outside of the Western Area Power Administration (WAPA) easement to be located underground (Austin J. Shreffler)

A2 Ordinance No. 2024.025: Relating to Land Development, adopting the Town of Marana Drainage Manual (Jason Angell)

Resolution No. 2024-103: Relating to Land Development, declaring as a public record filed with the Town Clerk the Town of Marana Drainage Manual adopted by Ordinance No. 2024.025 (Jason Angell)

ITEMS FOR DISCUSSION / POSSIBLE ACTION

D1 Resolution No. 2024-104: Relating to Development; adopting the amended Town of Marana Public Art Policy (Andrea De La Cruz)

D2 Relating to Economic Development; discussion and consideration of proposal from Marana Urban LLC in response to Town of Marana Request for Proposals (RFP) for Lease and Development of Town-Owned Property Located at Marana Main Street and Civic Center Drive and possible direction to staff to commence negotiations for a lease agreement (Terry S. Rozema)

EXECUTIVE SESSIONS

Pursuant to A.R.S. § 38-431.03, the Town Council may vote to go into executive session, which will not be open to the public, to discuss certain matters.

E1 Executive Session pursuant to A.R.S. §38-431.03 (A), Council may ask for discussion or consideration, or consultation with designated Town representatives, or consultation for legal advice with the Town Attorney, concerning any matter listed on this agenda for any of the reasons listed in A.R.S. §38-431.03 (A).

FUTURE AGENDA ITEMS

Notwithstanding the Mayor's discretion regarding the items to be placed on the agenda, if three or more Council members request that an item be placed on the agenda, it must be placed on the agenda for the second regular Town Council meeting after the date of the request, pursuant to Marana Town Code Section 2-4-2(B).

ADJOURNMENT

Council-Regular Meeting **C1**

Meeting Date: 11/19/2024

To: Mayor and Council

From: Scott Radden, Senior Planner

Date: November 19, 2024

Strategic Plan Focus Area:
Not Applicable

Subject: Resolution No. 2024-101: Relating to Development; approving a Final Plat for Saguaro Reserve III at Dove Mountain, Lots 1-236, and Common Areas "A" (Private Streets) and "B" (Open Space / Drainage) located north of Dove Mountain Boulevard and east of Dove Reserve Drive within Sections 16 and 21, Township 11 South and Range 12 East (Scott S. Radden)

Discussion:

Request
Baker and Associates Engineering, Inc. on behalf of the property owners, Pusch Ridge Christian Academy, Inc. and DM Phase IV Investment, LLC, is requesting approval of a final plat consisting of 236 residential lots, and Common Areas "A" (Private Streets) and "B" (Open Space/ Drainage) on approximately 81.9 acres within the Dove Mountain development.

Zoning
The zoning of the property is "F" Dove Mountain Specific Plan with a land use designation of Low-Density Residential (LDR). Under a “cluster option,” an average site area of 4,000 square feet per dwelling unit is permitted.

Land Use
The final plat proposes 236 residential lots, private streets and open space and drainage. A minimum lot size of 6,350 square feet and a maximum of 14,300 square feet is provided. The plat provides an average lot size of 7,533 square feet with a density of 2.87 residences per acre.

Access and Traffic Circulation
The subdivision is accessed from Dove Reserve Drive on the south side. There are three access points to the west, from Dove Mountain Reserve, and one access from the Saguaro Reserve II development on the north side. The subdivision proposes approximately 1.6 miles of new private streets.

Infrastructure and Utilities
Water service will be provided to the subdivision by Tucson Water. Wastewater service will be provided by Pima County Regional Wastewater. TRICO Electric and Southwest Gas will provide the electric and natural gas services.

Preliminary Plat
The Saguaro Reserve III at Dove Mountain Preliminary Plat(PRV2211-001) was approved by Town staff on November 13, 2023.

Staff Recommendation:

Staff has reviewed the request against the requirements of the Dove Mountain Specific Plan, the Marana Town Code, and the Marana General Plan. This Final Plat is in substantial conformance with all required development regulations, and staff recommends approval.

Suggested Motion:

I move to adopt Resolution No. 2024-101, approving a Final Plat for Saguaro Reserve III at Dove Mountain, Lots 1-236, and Common Areas "A" (Private Streets) and "B" (Open Space / Drainage).

Attachments

Resolution No. 2024-101
Final Plat
Location Map
Application

MARANA RESOLUTION NO. 2024-101

RELATING TO DEVELOPMENT; APPROVING A FINAL PLAT FOR SAGUARO RESERVE III AT DOVE MOUNTAIN, LOTS 1-236, AND COMMON AREAS "A" (PRIVATE STREETS) AND "B" (OPEN SPACE / DRAINAGE) LOCATED NORTH OF DOVE MOUNTAIN BOULEVARD AND EAST OF DOVE RESERVE DRIVE WITHIN SECTIONS 16 AND 21, TOWNSHIP 11 SOUTH AND RANGE 12 EAST

WHEREAS, on May 31, 1989, Town Council adopted Ordinance No. 89.22, approving the Dove Mountain Specific Plan (then known as the Tortolita Mountain Properties Specific Plan) which has been amended from time to time by ordinance; and

WHEREAS Town staff approved the preliminary plat for Saguaro Reserve III, Lots 1- 235, and Common Areas “A” (Private Streets) and “B” (Open Space/Drainage) on October 30, 2023; and,

WHEREAS Baker and Associates Engineering, Inc., representing the property owners, Pusch Ridge Christian Academy, Inc. and DM Phase IV Investments, LLC, has applied for approval of the final plat for Saguaro Reserve III at Dove Mountain, Lots 1-236, and Common Areas "A" (Private Streets) and "B" (Open Space / Drainage) located north of Dove Mountain Boulevard and east of Dove Reserve Drive; and

WHEREAS the Mayor and Town Council, at its November 19, 2024 meeting, determined that the final plat for Saguaro Reserve III at Dove Mountain, Lots 1-236 should be approved.

NOW, THEREFORE, BE IT RESOLVED BY THE MAYOR AND COUNCIL OF THE TOWN OF MARANA, ARIZONA that the final plat for Saguaro Reserve III at Dove Mountain, Lots 1-236 is hereby approved.

PASSED AND ADOPTED by the Mayor and Council of the Town of Marana, Arizona, this 19th day of November, 2024.

Mayor Ed Honea

ATTEST:

David L. Udall, Town Clerk

APPROVED AS TO FORM:

Jane Fairall, Town Attorney

DEDICATION

WE, THE UNDERSIGNED, HEREBY WARRANT THAT WE ARE ALL AND THE ONLY PARTIES HAVING ANY FEE TITLE INTEREST IN THE LAND SHOWN ON THIS PLAT, AND WE CONSENT TO THE SUBDIVISION OF THIS LAND IN THE MANNER SHOWN ON THIS PLAT.

UTILITY EASEMENTS, AS SHOWN ON THIS PLAT, ARE GRANTED TO THE TOWN OF MARANA, PIMA COUNTY, AND ALL PUBLIC AND PRIVATE UTILITY COMPANIES FOR THE PURPOSE OF INSTALLATION AND MAINTENANCE OF, AND ACCESS TO, PUBLIC AND PRIVATE UTILITIES AND PUBLIC SEWERS. SUCH UTILITY EASEMENTS ARE ALSO GRANTED TO THE DOVE MOUNTAIN COMMUNITY ASSOCIATION FOR PRIVATE ROADWAY MAINTENANCE AND INSTALLATION, AND MAINTENANCE OF STREET SIGNS.

NO VEHICULAR ACCESS EASEMENTS SHOWN ON THIS PLAT ARE GRANTED TO THE TOWN OF MARANA FOR THE PURPOSE OF ACCESS CONTROL TO ADJACENT COMMON AREAS.

WE, AND OUR SUCCESSORS AND ASSIGNS, HEREBY HOLD THE TOWN OF MARANA, ITS EMPLOYEES, OFFICERS, AND AGENTS, HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS FOR DAMAGES RELATED TO THE USE OF THESE LANDS NOW AND IN THE FUTURE BY REASON OF FLOODING, FLOWAGE, EROSION, OR DAMAGE CAUSED BY WATER, WHETHER SURFACE, FLOOD OR RAINFALL. NATURAL DRAINAGE SHALL NOT BE ALTERED, DISTURBED, OR OBSTRUCTED WITHOUT THE APPROVAL OF THE TOWN OF MARANA.

ALL COMMON AREAS, AS SHOWN ON THIS PLAT, ARE RESERVED FOR THE PRIVATE USE AND AND CONVENIENCE OF ALL OWNERS OF PROPERTY WITHIN THIS SUBDIVISION, THEIR GUESTS AND INVITEES. SUCH PRIVATE USE SHALL INCLUDE CONSTRUCTION OF COMMON AREA IMPROVEMENTS REQUIRED BY THE TOWN FOR THE SUBDIVISION.

ALL COMMON AREAS ARE GRANTED AS EASEMENTS TO THE TOWN OF MARANA, PIMA COUNTY, AND ALL PUBLIC AND PRIVATE UTILITY COMPANIES FOR THE PURPOSE OF ACCESS TO, INSTALLATION AND MAINTENANCE OF PUBLIC AND PRIVATE UTILITIES AND PUBLIC SEWERS.

TITLE TO ALL COMMON AREAS SHALL BE VESTED IN THE DOVE MOUNTAIN COMMUNITY ASSOCIATION AS ESTABLISHED BY THE AMENDED AND RESTATED MASTER DECLARATION OF COVENANTS, CONDITIONS, RESTRICTIONS AND EASEMENTS RECORDED IN DOCKET 10660/1083 AND AS ESTABLISHED BY THE SUPPLEMENTARY DECLARATION OF COVENANTS, CONDITIONS, RESTRICTIONS AND EASEMENTS AS RECORDED IN SEQUENCE NO. _____ IN THE OFFICE OF THE PIMA COUNTY RECORDER. EACH AND EVERY LOT OWNER WITHIN THE SUBDIVISION SHALL BE A MEMBER OF THE ASSOCIATION, WHICH WILL ACCEPT ALL RESPONSIBILITY FOR THE CONTROL, MAINTENANCE, SAFETY AND LIABILITY OF ALL COMMON AREAS WITHIN THIS SUBDIVISION.

LANDMARK TITLE ASSURANCE AGENCY OF ARIZONA, L.L.C.

AN ARIZONA LIMITED LIABILITY COMPANY, AS TRUSTEE UNDER TRUST NOS. 18379-T AND 2108 AND NOT IN ITS CORPORATE CAPACITY.

_____
TRUST OFFICER

TRUST BENEFICIARY - TRUST NO. 18379-7

DM PHASE IV INVESTMENTS, L.L.C.
C/O COTTONWOOD PROPERTIES, INC.
3567 E. SUNRISE DRIVE, #219
TUCSON, AZ 85718

TRUST BENEFICIARY - TRUST NO. 2108

PUSCH RIDGE CHRISTIAN ACADEMY
C/O COTTONWOOD PROPERTIES, INC.
3567 E. SUNRISE DRIVE, #219
TUCSON, AZ 85718

ACKNOWLEDGMENT

STATE OF ARIZONA } S.S.
COUNTY OF PIMA

ON THIS, THE _____ DAY OF _____, 20__, BEFORE ME PERSONALLY APPEARED _____ WHO ACKNOWLEDGED HIMSELF/HERSELF TO BE THE TRUST OFFICER OF LANDMARK TITLE ASSURANCE AGENCY OF ARIZONA, L.L.C., AN ARIZONA LIMITED LIABILITY COMPANY, AS TRUSTEE UNDER TRUST NOS. 18379-T AND 2108, AND NOT IN ITS CORPORATE CAPACITY AND ACKNOWLEDGED THAT HE/SHE, AS THE TRUST OFFICER, BEING AUTHORIZED TO DO SO, EXECUTED THE FOREGOING INSTRUMENT FOR THE PURPOSE(S) THEREIN CONTAINED.

IN WITNESS WHEREOF: I HEREBY SET MY NAME AND OFFICIAL SEAL.

_____
NOTARY PUBLIC

ASSURANCES

ASSURANCE IN THE FORM OF THIRD PARTY TRUST AGREEMENTS FROM LANDMARK TITLE ASSURANCE AGENCY OF ARIZONA, L.L.C., TRUST NOS. 18379-T AND 2108, AS RECORDED IN SEQUENCE NUMBER _____ IN THE OFFICE OF THE RECORDER OF PIMA COUNTY, ARIZONA HAVE BEEN PROVIDED TO GUARANTEE INSTALLATION OF REQUIRED STREET, SEWER, ELECTRIC, GAS, AND WATER UTILITIES, DRAINAGE, FLOOD CONTROL AND OTHER SUBDIVISION IMPROVEMENTS MEETING ESTABLISHED MINIMUM STANDARDS OF DESIGN AND CONSTRUCTION.

BY: _____ _____
TOWN OF MARANA DATE

GENERAL NOTES

1. THE GROSS AREA OF THIS SUBDIVISION IS 3,568,509 SF, OR 81.9 ACRES.
2. THE TOTAL NUMBER OF LOTS IS 236.
3. THE TOTAL AREA OF COMMON AREA "A" (PRIVATE STREETS) IS 366,969 SF.
   THE TOTAL AREA OF COMMON AREA "B" (OPEN SPACE/DRAINAGE) IS 1,423,508 SF.
4. TOTAL MILES OF NEW PUBLIC STREETS IS 0.0 MILES.
   TOTAL MILES OF NEW PRIVATE STREETS IS 1.58 MILES.
5. THE APPROVED ZONING FOR THIS PROJECT IS "F" DOVE MOUNTAIN SPECIFIC PLAN AND THE LAND USE DESIGNATION IS "LDR" IN ACCORDANCE WITH THE DOVE MOUNTAIN SPECIFIC PLAN AND WILL REMAIN.
6. AVERAGE ALLOWABLE LOT SIZE IS 4,000 SF (PER THE DOVE MOUNTAIN SPECIFIC PLAN "LDR" DESIGNATION, CLUSTER OPTION).
   MINIMUM PROVIDED LOT SIZE IS 6,350 SF.
   AVERAGE LOT SIZE IS 7,533 SF.
   MAXIMUM LOT SIZE PROVIDED IS 14,300 SF (LOT #221 - NOT A RESTRICTION).
   MAXIMUM ALLOWABLE BUILDING HEIGHT IS 35' FOR "LDR."
7. THIS PROJECT SHALL COMPLY WITH THE CONDITIONS SET FORTH IN THE DOVE MOUNTAIN SPECIFIC PLAN APPROVED IN MAY, 1989 (ORDINANCE NO. 89.22), AND AS AMENDED BY MARANA ORDINANCE FROM TIME TO TIME.
8. THERE WILL BE 2 PARKING SPACES PROVIDED FOR EACH LOT ON-SITE, AS WELL AS 2 ADDITIONAL GUEST PARKING SPACES.
9. THE BUILDING SETBACKS ARE AS FOLLOWS:
   FRONT: 20 FEET REAR: 15 FEET
   SIDE: 5 FEET CORNER: 20 FEET
10. THE GROSS DENSITY FOR THIS PROJECT IS 2.87 RAC.
11. NO FURTHER LOT SPLITTING SHALL BE DONE WITHOUT THE WRITTEN APPROVAL OF THE TOWN OF MARANA.
12. APPROVAL OF THIS PLAT DOES NOT AFFIRM, CERTIFY OR APPROVE ANY LAND DIVISION THAT MAY BE CONTRARY TO STATE LAW, NOR DOES IT CERTIFY THE EXISTENCE OF, OR COMPLIANCE WITH, ANY DEED RESTRICTIONS OR EASEMENTS.
13. OBJECTS AND MATERIALS WITHIN THE SIGHT-VISIBILITY TRIANGLES SHALL BE PLACED SO AS NOT TO INTERFERE WITH A VISIBILITY PLANE DESCRIBED BY TWO HORIZONTAL LINES LOCATED 30 INCHES AND 72 INCHES ABOVE THE FINISHED GRADE OF THE ROADWAY SURFACE AND SHALL CONFORM TO SECTION 4.8 OF THE TOWN OF MARANA SUBDIVISION STANDARDS.
14. THE PROFESSIONAL ENGINEER OF RECORD SHALL CERTIFY AS TO THE FORM, LINE AND FUNCTION OF ALL PUBLIC AND PRIVATE ROADWAYS AND DRAINAGE STRUCTURES BEFORE THE RELEASE OF ASSURANCES.
15. THE AREA BETWEEN 100-YEAR FLOOD LIMITS REPRESENTS AN AREA THAT MAY BE SUBJECT TO FLOODING FROM A 100-YEAR FREQUENCY FLOOD AND ALL LAND IN THIS AREA WILL BE RESTRICTED TO USES THAT ARE COMPATIBLE WITH THE FLOODPLAIN MANAGEMENT AS APPROVED BY THE FLOODPLAIN ADMINISTRATOR.
16. ALL NEW AND EXISTING UTILITIES EXCEPT ELECTRICAL TRANSMISSION LINES CARRYING 48 KV OR GREATER, AND THOSE LINES WHICH CAN BE SHOWN TO EXIST IN CURRENT OR FUTURE ELECTRICAL TRANSMISSION CORRIDORS, WITHIN OR CONTIGUOUS TO THE SITE, SHALL BE PLACED UNDERGROUND.
17. THIS SUBDIVISION IS LOCATED WITHIN THE CITY OF TUCSON SERVICE AREA, WHICH HAS BEEN DESIGNATED AS HAVING AN ASSURED WATER SUPPLY UNDER A.R.S. SECTION 45-576.
18. INSTALLATION OF ITEMS SUCH AS LANDSCAPING, IRRIGATION, SIGNAGE, MONUMENTS, WALLS AND DRAINAGE IMPROVEMENTS IN THE PUBLIC RIGHTS-OF-WAY SHALL REQUIRE A PERPETUAL LICENSE AGREEMENT FOR INSTALLATION, MAINTENANCE AND INDEMNIFICATION. THE LICENSE SHALL BE EXECUTED AND APPROVED BY THE TOWN OF MARANA PRIOR TO APPROVAL OF THE CLOSEOUT PACKAGE FOR THIS PROJECT.

BASIS OF BEARING

BASIS OF BEARING: NORTH 00°00'49" EAST, ACCORDING TO SEQUENCE NUMBER 20081880587, PIMA COUNTY, ARIZONA BETWEEN MONUMENTS FOUND ON THE WEST LINE OF THE SOUTHWEST QUARTER OF SECTION 16, AS SHOWN.

RECORDING DATA

STATE OF ARIZONA } S.S. FEE _____
COUNTY OF PIMA SEQUENCE NO. _____

THIS INSTRUMENT WAS FILED FOR RECORD AT THE REQUEST OF BAKER AND ASSOCIATES ENGINEERING, INC., ON THIS _____ DAY OF _____, 20___, AT _____M. IN SEQUENCE NO. _____ THEREOF.

_____ _____
GABRIELLA CAZARES-KELLY, PIMA COUNTY RECORDER DATE
DEPUTY COUNTY RECORDER

CERTIFICATIONS

I HEREBY CERTIFY THAT THE BOUNDARY SURVEY AS SHOWN ON THIS PLAT WAS PERFORMED UNDER MY DIRECTION AND THAT ALL EXISTING OR PROPOSED SURVEY MONUMENTS AND MARKERS SHOWN ARE CORRECTLY DESCRIBED.

BRIAN J. LIVERNOIS, R.L.S.
ON POINT SURVEYING, PLLC
REGISTERED LAND SURVEYOR NO. 58324
STATE OF ARIZONA

I HEREBY CERTIFY THAT THE INTERIOR SUBDIVISION GEOMETRY FOR THIS PLAT WAS REVIEWED AND SHOWN UNDER MY SUPERVISION.

WILLIAM H. BAKER, JR.
BAKER & ASSOCIATES ENGINEERING, INC.
REGISTERED LAND SURVEYOR NO. 16784
STATE OF ARIZONA

I HEREBY CERTIFY THAT THE FLOODPRONE LIMITS AND EROSION HAZARD SETBACKS WERE REVIEWED AND SHOWN UNDER MY SUPERVISION.

LARRY K. ROBERTS
ARROYO ENGINEERING, L.L.C.
REGISTERED ENGINEER NO. 25331
STATE OF ARIZONA

TOWN OF MARANA APPROVALS

BY: _____ P.E. _____
MARANA TOWN ENGINEER/DEVELOPMENT ENGINEER DATE

BY: _____ _____
MARANA PLANNING MANAGER DATE

PIMA COUNTY WASTEWATER APPROVAL

BY: _____ _____
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT DATE

CITY OF TUCSON ASSURED WATER SUPPLY

THE UNDERSIGNED CERTIFIES THAT IT IS DESIGNATED AS HAVING AN ASSURED WATER SUPPLY AND WILL PROVIDE WATER SERVICE TO THIS SUBDIVISION.

BY: _____
ITS: _____
CITY OF TUCSON WATER DEPARTMENT DATE

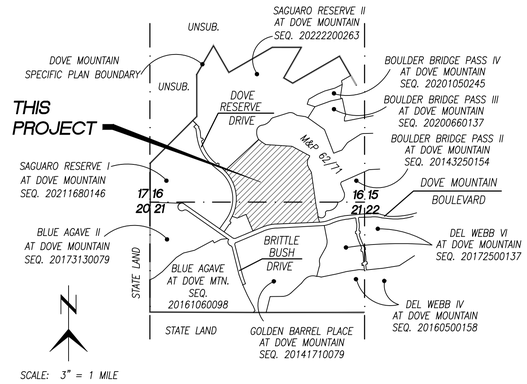
MARANA TOWN COUNCIL CERTIFICATION

I, _____, CLERK OF THE TOWN OF MARANA, HEREBY CERTIFY THAT THIS PLAT WAS APPROVED BY THE TOWN COUNCIL OF THE TOWN OF MARANA ON THE _____ DAY OF _____, 20____.

BY: _____ _____
CLERK OF THE TOWN OF MARANA DATE

SHEET INDEX

SHEET #1	COVER SHEET, NOTES
SHEET #2	SHEET/KEY MAP, BASIS OF BEARING TIE
SHEET #3 - #12	FINAL PLAT SHEETS
SHEET #13	CURVE AND LINE TABLES



SCALE: 3" = 1 MILE

LOCATION PLAN

SECTIONS 16 AND 21, T11S, R12E,
G&SRB&M, TOWN OF MARANA, PIMA COUNTY, ARIZONA

LEGEND

▲	FOUND 2" BRASS SURVEY MONUMENT PER TOM STD. DTL. M-103B
△	SET 2" BRASS SURVEY MONUMENT PER TOM STD. DTL. M-103B
●	SET PROPERTY CORNER TAGGED "RLS 58324"
OR	1/2" REBAR TO BE SET BY A REGISTERED LAND SURVEYOR
	CALCULATED POINT (NOTHING FOUND OR SET)
	SUBDIVISION BOUNDARY
C5	CURVE DATA (SEE TABLE, SHEET 13)
L10	LINE DATA (SEE TABLE, SHEET 13)
(NEW PRIVATE STREET)	NEW PRIVATE RIGHT-OF-WAY DEDICATED BY THIS PLAT
	NEW RIGHT-OF-WAY LINE
	EXISTING RIGHT-OF-WAY LINE
	SECTIONLINE
	STREET CENTERLINE
	EASEMENT LINE AS SHOWN (SEE ALSO "EASEMENT KEYNOTES," SHEETS #3 - #12)
	DEVELOPED 100 YEAR FLOODPRONE LINE ("F.P.L.")
	DEVELOPED EROSION SETBACK LINE ("E.S.L.")
(1)	KEYNOTE FOR EROSION SETBACK LINE ("E.S.L.") COINCIDENT WITH LOTLINE (BEGINNING AT TERMINUS OF E.S.L. LINE/LIMIT)
(R)	RADIAL
P/L	BOUNDARY/PROPERTY LINE

ADMINISTRATIVE ADDRESS

14500 N. DOVE RESERVE DRIVE, MARANA, AZ 85658

FINAL PLAT for

SAGUARO RESERVE III AT DOVE MOUNTAIN, LOTS 1-236, AND COMMON AREAS "A" (PRIVATE STREETS) AND "B" (OPEN SPACE/DRAINAGE)

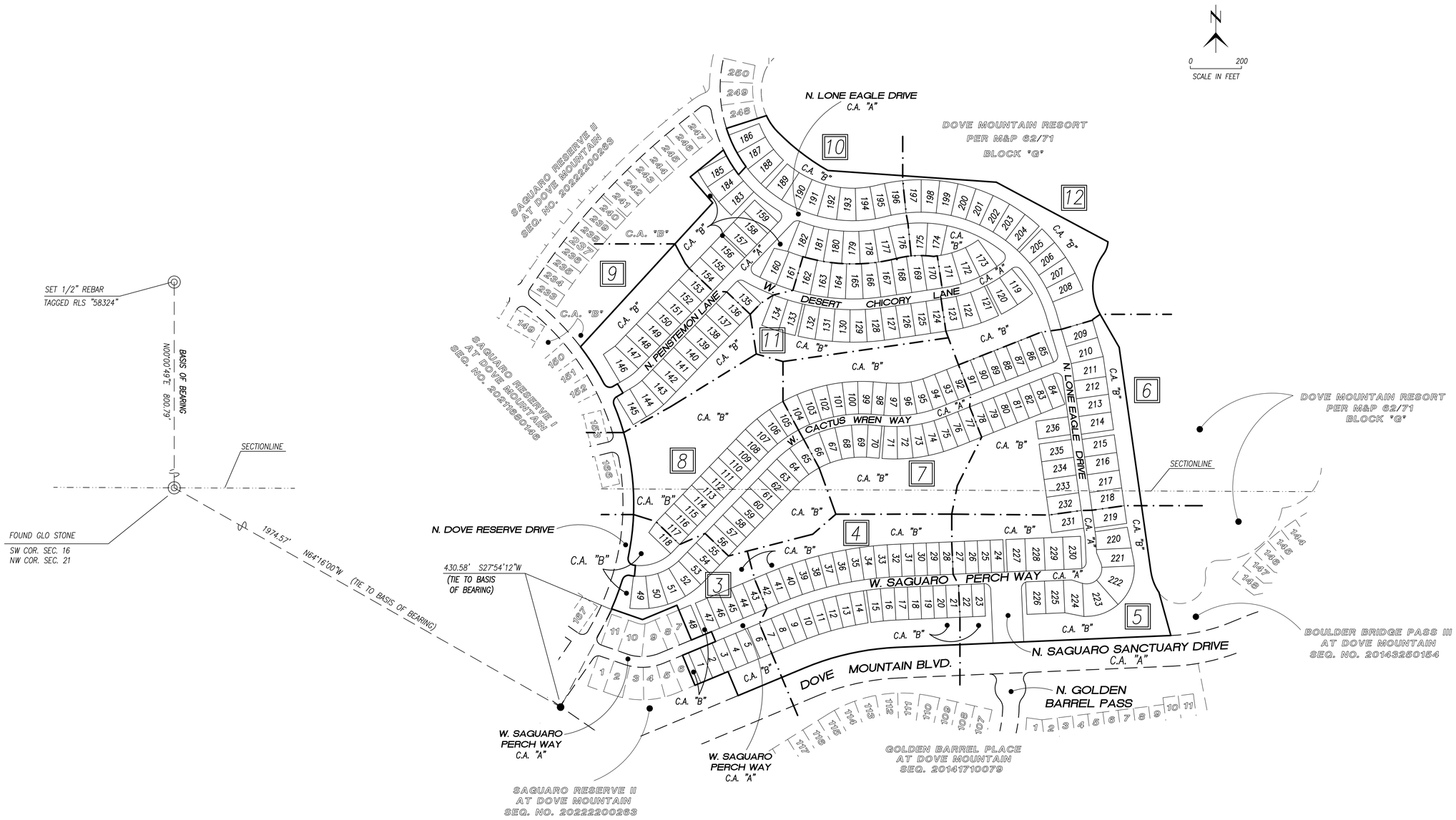
BEING A SUBDIVISION OF A PORTION OF BLOCK "1" OF SAGUARO RESERVE I, SEQ. #20211680146, BLOCKS "1" - "4" OF SAGUARO RESERVE II, SEQ. #20222200263, AND A PORTION OF SECTIONS 16 AND 21, T11S, R12E, G&SRM, TOWN OF MARANA, PIMA COUNTY, ARIZONA

Baker & Associates Engineering, Inc.
3561 E. Sunrise Drive, Suite #225 Tucson, Arizona 85718 (520) 318-1950 Fax (520) 318-1930

#PRV2403-001 REF.: #PRV2211-001; REF.: PRV2109-005; PRV2102-004; PRV1803-002 JOB #2447.4 DATE: OCTOBER 17, 2024 SHEET 1 OF 13

SEQUENCE #_____

SEQUENCE #



SEQUENCE #

SHEET/KEY MAP/ BASIS OF BEARING TIE

1 — PAGE #

— · — · — SHEET/KEY MAP MATCHLINE

FOR INTERIOR GEOMETRY ONLY

REGISTERED LAND SURVEYOR
36784
WILLIAM H. BAKER JR.
ARIZONA U.S.A.

FINAL PLAT for

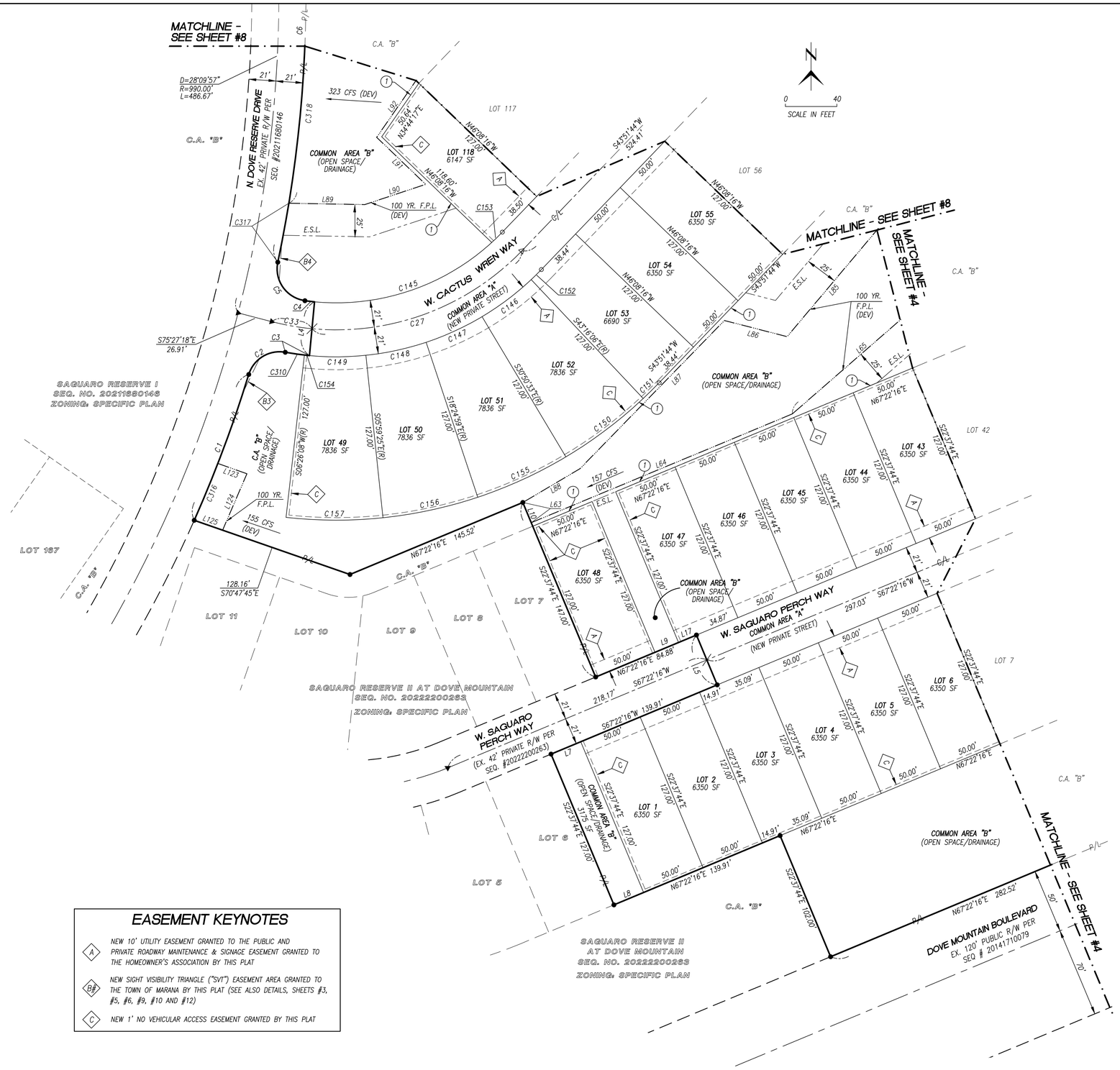
SAGUARO RESERVE III AT DOVE MOUNTAIN, LOTS 1-236, AND COMMON AREAS "A" (PRIVATE STREETS) AND "B" (OPEN SPACE/DRAINAGE)

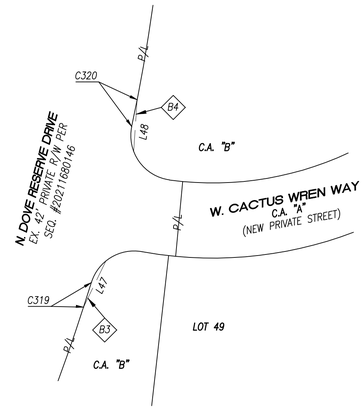
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Baker & Associates Engineering, Inc.
3561 E. Sunrise Drive, Suite #225 Tucson, Arizona 85718 (520) 318-1950 Fax (520) 318-1930

#PRV2403-001 REF.: #PRV2211-001; REF.: PRV2109-005; PRV2102-004; PRV1803-002 JOB #2447.4 DATE: OCTOBER 17, 2024 SHEET 2 OF 13

SEQUENCE #_____





SIGHT VISIBILITY TRIANGLE ("SVT") - B3 AND B4

DETAIL - COMMON AREA "B" (NEAR LOTS 49 AND 118)

EASEMENT KEYNOTES

- (A) *NEW 10' UTILITY EASEMENT GRANTED TO THE PUBLIC AND PRIVATE ROADWAY MAINTENANCE & SIGNAGE EASEMENT GRANTED TO THE HOMEOWNER'S ASSOCIATION BY THIS PLAT*
- (B#) *NEW SIGHT VISIBILITY TRIANGLE ("SVT") EASEMENT AREA GRANTED TO THE TOWN OF MARANA BY THIS PLAT (SEE ALSO DETAILS, SHEETS #3, #5, #6, #9, #10 AND #12)*
- (C) *NEW 1' NO VEHICULAR ACCESS EASEMENT GRANTED BY THIS PLAT*

FOR INTERIOR GEOMETRY ONLY

REGISTERED LAND SURVEYOR 36784 WILLIAM M. BAKER, JR. ARIZONA, U.S.A.

FINAL PLAT for

SAGUARO RESERVE III AT DOVE MOUNTAIN, LOTS 1-236, AND COMMON AREAS "A" (PRIVATE STREETS) AND "B" (OPEN SPACE/DRAINAGE)

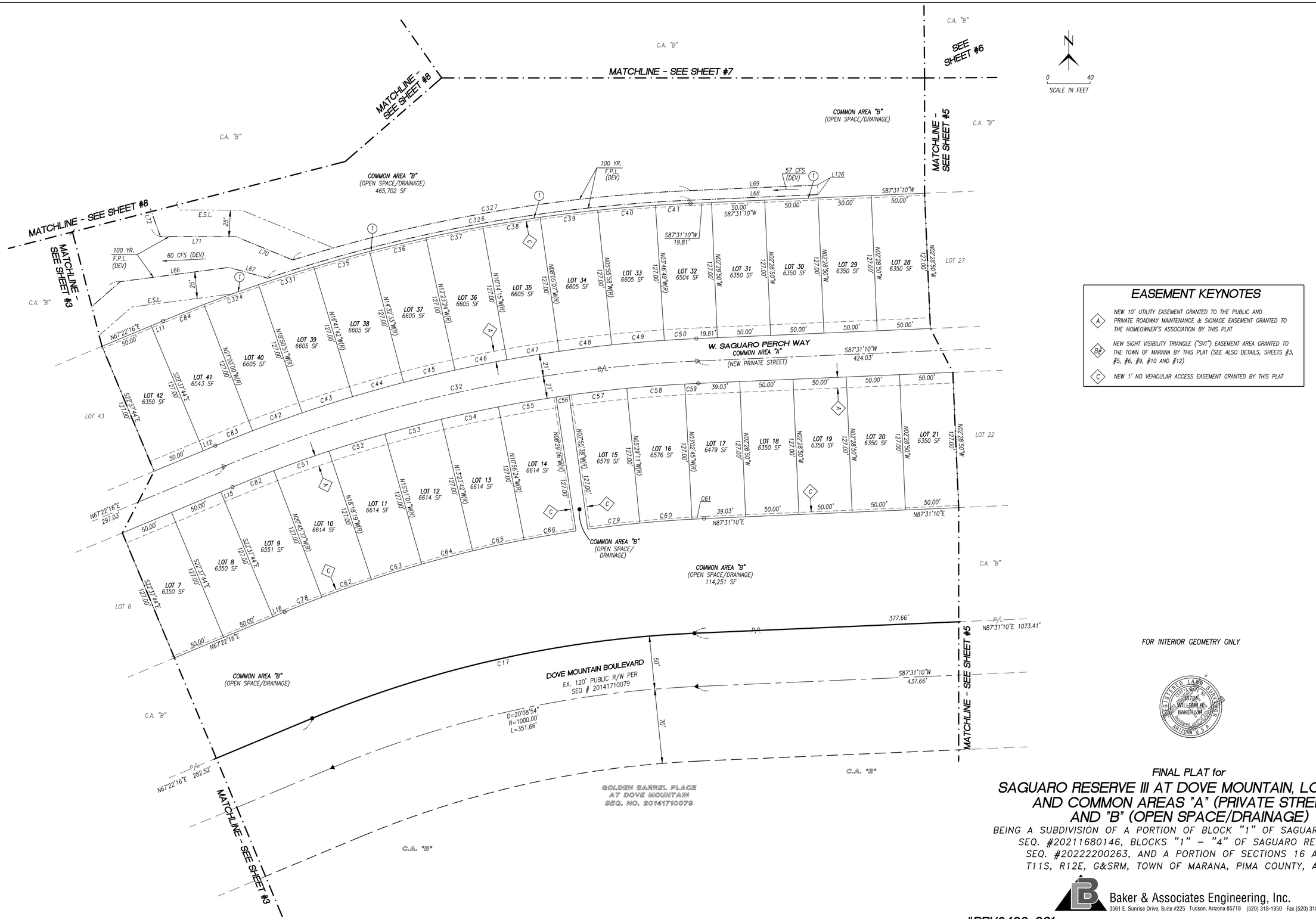
BEING A SUBDIVISION OF A PORTION OF BLOCK "1" OF SAGUARO RESERVE I, SEQ. #20211680146, BLOCKS "1" - "4" OF SAGUARO RESERVE II, SEQ. #20222200263, AND A PORTION OF SECTIONS 16 AND 21, T11S, R12E, G&SRM, TOWN OF MARANA, PIMA COUNTY, ARIZONA

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#PRV2403-001 REF.: #PRV2211-001; REF.: PRV2109-005; PRV2102-004; PRV1803-002 JOB #2447.4 DATE: OCTOBER 17, 2024 SHEET 3 OF 13

SEQUENCE #_____

SEQUENCE #_____



EASEMENT KEYNOTES

- (A) NEW 10' UTILITY EASEMENT GRANTED TO THE PUBLIC AND PRIVATE ROADWAY MAINTENANCE & SIGNAGE EASEMENT GRANTED TO THE HOMEOWNER'S ASSOCIATION BY THIS PLAT
- (B) NEW SIGHT VISIBILITY TRIANGLE ("SVT") EASEMENT AREA GRANTED TO THE TOWN OF MARANA BY THIS PLAT (SEE ALSO DETAILS, SHEETS #3, #5, #6, #9, #10 AND #12)
- (C) NEW 1' NO VEHICULAR ACCESS EASEMENT GRANTED BY THIS PLAT

FOR INTERIOR GEOMETRY ONLY

REGISTERED LAND SURVEYOR
WILLIAM E. BAKER JR.
ARIZONA U.S.A.

SEQUENCE #

FINAL PLAT for

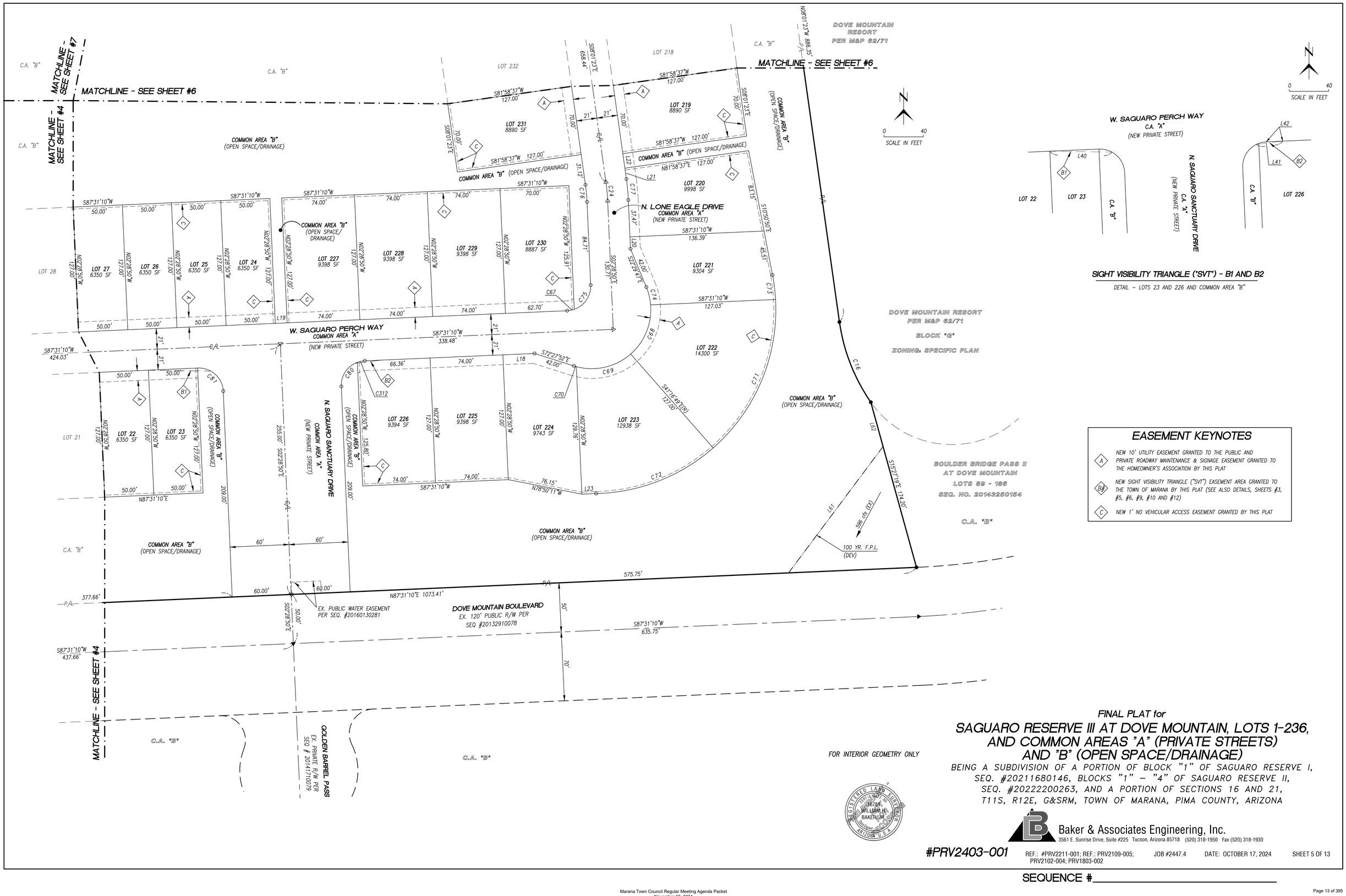
SAGUARO RESERVE III AT DOVE MOUNTAIN, LOTS 1-236, AND COMMON AREAS "A" (PRIVATE STREETS) AND "B" (OPEN SPACE/DRAINAGE)

BEING A SUBDIVISION OF A PORTION OF BLOCK "1" OF SAGUARO RESERVE I, SEQ. #20211680146, BLOCKS "1" – "4" OF SAGUARO RESERVE II, SEQ. #20222200263, AND A PORTION OF SECTIONS 16 AND 21, T11S, R12E, G&SRM, TOWN OF MARANA, PIMA COUNTY, ARIZONA

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#PRV2403-001 REF.: #PRV2211-001; REF.: PRV2109-005; PRV2102-004; PRV1803-002 JOB #2447.4 DATE: OCTOBER 17, 2024 SHEET 4 OF 13

SEQUENCE #_____



SIGHT VISIBILITY TRIANGLE ("SVT") - B1 AND B2

DETAIL - LOTS 23 AND 226 AND COMMON AREA "B"

EASEMENT KEYNOTES

- (A) NEW 10' UTILITY EASEMENT GRANTED TO THE PUBLIC AND PRIVATE ROADWAY MAINTENANCE & SIGNAGE EASEMENT GRANTED TO THE HOMEOWNER'S ASSOCIATION BY THIS PLAT
- (B#) NEW SIGHT VISIBILITY TRIANGLE ("SVT") EASEMENT AREA GRANTED TO THE TOWN OF MARANA BY THIS PLAT (SEE ALSO DETAILS, SHEETS #3, #5, #6, #9, #10 AND #12)
- (C) NEW 1' NO VEHICULAR ACCESS EASEMENT GRANTED BY THIS PLAT

FOR INTERIOR GEOMETRY ONLY

REGISTERED LAND SURVEYOR 16784 WILLIAM H. BAKER, JR. ARIZONA U.S.A.

FINAL PLAT for

SAGUARO RESERVE III AT DOVE MOUNTAIN, LOTS 1-236, AND COMMON AREAS "A" (PRIVATE STREETS) AND "B" (OPEN SPACE/DRAINAGE)

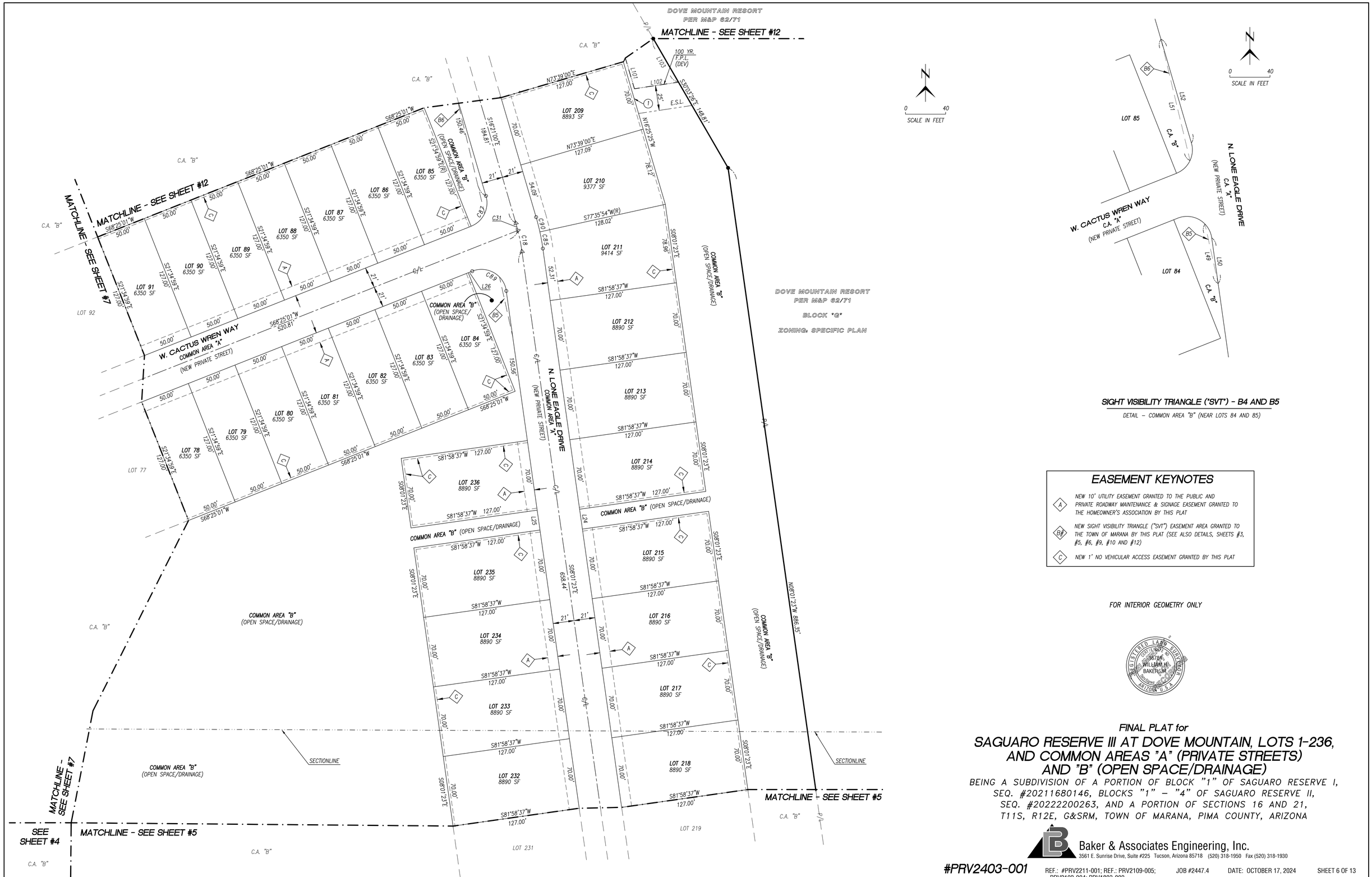
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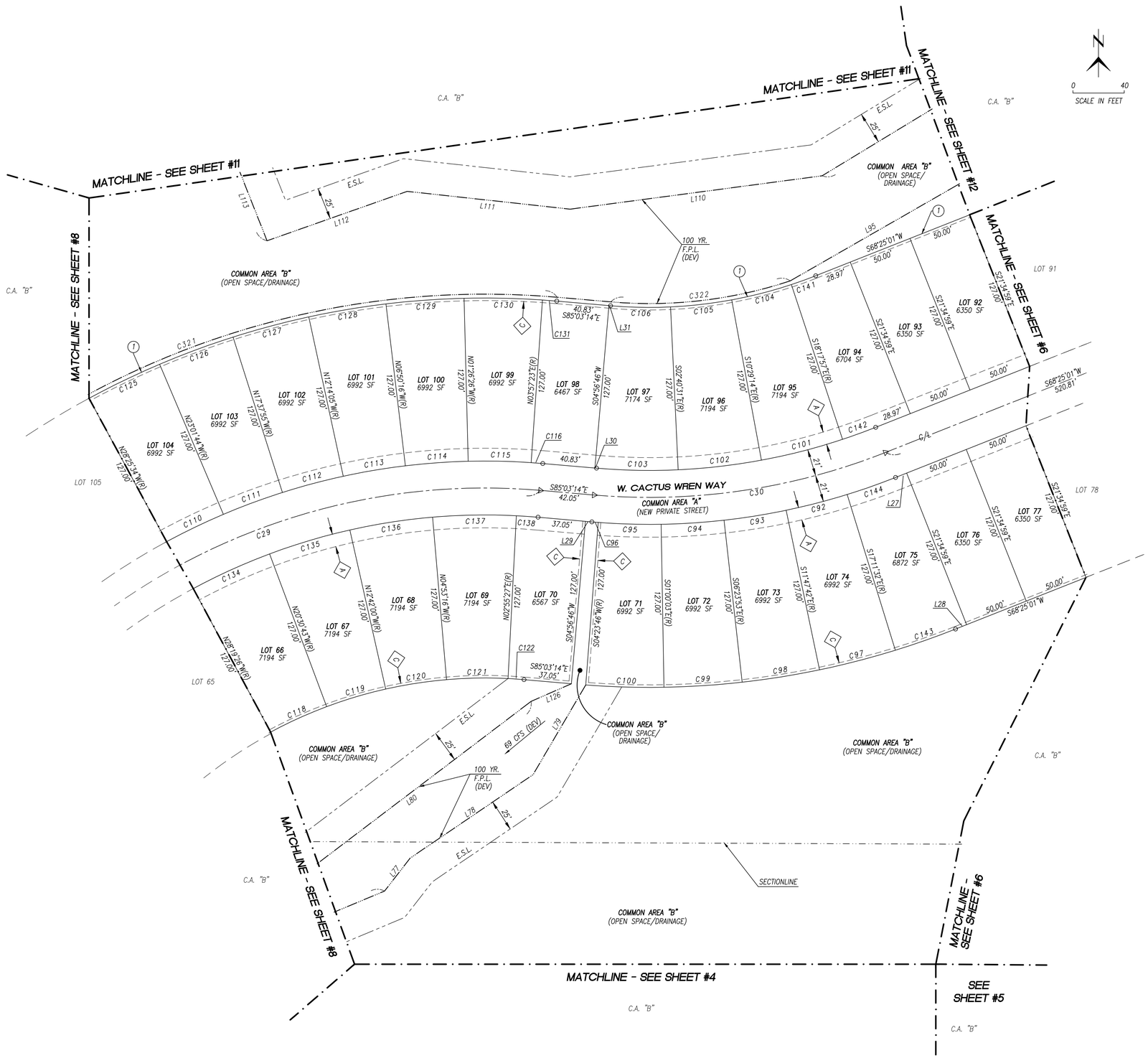
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SEQUENCE #_____

SEQUENCE #


DOVE MOUNTAIN RESORT
PER M&P 62/71
MATCHLINE - SEE SHEET #12
C.A. "B"
100 YR. F.P.L. (DEV)
L101
L102
S80°03'26"E 149.81'
25' E.S.L.
N73°39'00"E 127.00'
LOT 209 8893 SF
70.00'
N16°25'25"W 78.12'
LOT 210 9377 SF
N73°39'00"E 127.09'
S77°35'54"W(R) 128.02'
LOT 211 9414 SF
S08°01'23"E 78.96'
S81°58'37"W 127.00'
LOT 212 8890 SF
LOT 213 8890 SF
LOT 214 8890 SF
S08°01'23"E 658.44'
N08°01'23"W 896.35'
COMMON AREA "B" (OPEN SPACE/DRAINAGE)
N. LONE EAGLE DRIVE
COMMON AREA "A"
(NEW PRIVATE STREET)
DOVE MOUNTAIN RESORT
PER M&P 62/71
BLOCK "G"
ZONING: SPECIFIC PLAN
0 40
SCALE IN FEET
B6
B5
L52
L51
L49
L50
LOT 85
LOT 84
C.A. "B"
C.A. "A"
W. CACTUS WREN WAY
(NEW PRIVATE STREET)
N. LONE EAGLE DRIVE
(NEW PRIVATE STREET)
SIGHT VISIBILITY TRIANGLE ("SVT") - B4 AND B5
DETAIL - COMMON AREA "B" (NEAR LOTS 84 AND 85)
MATCHLINE - SEE SHEET #12
MATCHLINE - SEE SHEET #7
S68°25'01"W 520.81'
W. CACTUS WREN WAY
COMMON AREA "A"
(NEW PRIVATE STREET)
LOT 91 6350 SF
LOT 90 6350 SF
LOT 89 6350 SF
LOT 88 6350 SF
LOT 87 6350 SF
LOT 86 6350 SF
LOT 85 6350 SF
LOT 84 6350 SF
LOT 83 6350 SF
LOT 82 6350 SF
LOT 81 6350 SF
LOT 80 6350 SF
LOT 79 6350 SF
LOT 78 6350 SF
LOT 92
LOT 77
S21°34'59"E 127.00'
50.00'
C/L
21'
C85
C86
C87
C89
C90
C91
C31
C18
L26
L25
L24
150.46'
S16°21'00"E 184.81'
COMMON AREA "B" (OPEN SPACE/DRAINAGE)
S21°34'59"E(R) 127.00'
150.56'
52.37'
54.09'
COMMON AREA "B" (OPEN SPACE/DRAINAGE)
S81°58'37"W 127.00'
LOT 236 8890 SF
LOT 235 8890 SF
LOT 234 8890 SF
LOT 233 8890 SF
LOT 232 8890 SF
LOT 231
LOT 215 8890 SF
LOT 216 8890 SF
LOT 217 8890 SF
LOT 218 8890 SF
LOT 219
COMMON AREA "B" (OPEN SPACE/DRAINAGE)
COMMON AREA "B" (OPEN SPACE/DRAINAGE)
COMMON AREA "B" (OPEN SPACE/DRAINAGE)
SECTIONLINE
SECTIONLINE
MATCHLINE - SEE SHEET #7
MATCHLINE - SEE SHEET #5
MATCHLINE - SEE SHEET #5
SEE SHEET #4
C.A. "B"
C.A. "B"
C.A. "B"



SEQUENCE #_____

EASEMENT KEYNOTES

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- (C) NEW 1' NO VEHICULAR ACCESS EASEMENT GRANTED BY THIS PLAT

FOR INTERIOR GEOMETRY ONLY

REGISTERED LAND SURVEYOR 36784 WILLIAM H. BAKER, JR. ARIZONA, U.S.A.

FINAL PLAT for
SAGUARO RESERVE III AT DOVE MOUNTAIN, LOTS 1-236, AND COMMON AREAS "A" (PRIVATE STREETS) AND "B" (OPEN SPACE/DRAINAGE)

BEING A SUBDIVISION OF A PORTION OF BLOCK "1" OF SAGUARO RESERVE I, SEQ. #20211680146, BLOCKS "1" – "4" OF SAGUARO RESERVE II, SEQ. #20222200263, AND A PORTION OF SECTIONS 16 AND 21, T11S, R12E, G&SRM, TOWN OF MARANA, PIMA COUNTY, ARIZONA

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SEQUENCE #_____

SEQUENCE #

MATCHLINE - SEE SHEET #9

MATCHLINE - SEE SHEET #11

MATCHLINE - SEE SHEET #7

MATCHLINE - SEE SHEET #3

C.A. "B"

COMMON AREA "B"
(OPEN SPACE/DRAINAGE)
448,261 SF

COMMON AREA "B"
(OPEN SPACE/
DRAINAGE)

COMMON AREA "B"
(OPEN SPACE/DRAINAGE)

COMMON AREA "B"
(OPEN SPACE/
DRAINAGE)

COMMON AREA "B"
(OPEN SPACE/DRAINAGE)

W. CACTUS WREN WAY
COMMON AREA "A"
(NEW PRIVATE STREET)

N. DOVE RESERVE DRIVE

BELOPERON LANE

SAGUARO RESERVE I
SEQ. NO. 20211680146

SAGUARO RESERVE I
SEQ. NO. 20211680146
ZONING SPECIFIC PLAN

EX. 42' PRIVATE R/W PER
SEQ. #20211680146

LOT 153

LOT 156

LOT 118

LOT 55

LOT 104

LOT 66

LOT 105 6992 SF

LOT 106 6992 SF

LOT 107 6992 SF

LOT 108 6530 SF

LOT 109 6350 SF

LOT 110 6350 SF

LOT 111 6350 SF

LOT 112 6350 SF

LOT 113 6350 SF

LOT 114 6350 SF

LOT 115 6350 SF

LOT 116 6350 SF

LOT 117 6350 SF

LOT 65 7194 SF

LOT 64 7194 SF

LOT 63 6585 SF

LOT 62 6350 SF

LOT 61 6350 SF

LOT 60 6350 SF

LOT 59 6350 SF

LOT 58 6350 SF

LOT 57 6350 SF

LOT 56 6350 SF

SECTIONLINE

100 YR. F.P.L. (DEV)

E.S.L.

25'

21'

50.00'

C/L

D=26°09'57"
R=990.00'
L=486.67'

0 40
SCALE IN FEET

EASEMENT KEYNOTES

- (A) NEW 10' UTILITY EASEMENT GRANTED TO THE PUBLIC AND PRIVATE ROADWAY MAINTENANCE & SIGNAGE EASEMENT GRANTED TO THE HOMEOWNER'S ASSOCIATION BY THIS PLAT
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- (C) NEW 1' NO VEHICULAR ACCESS EASEMENT GRANTED BY THIS PLAT

FOR INTERIOR GEOMETRY ONLY

REGISTERED LAND SURVEYOR
16764
WILLIAM M. BAKER, JR.
ARIZONA U.S.A.

FINAL PLAT for

SAGUARO RESERVE III AT DOVE MOUNTAIN, LOTS 1-236, AND COMMON AREAS "A" (PRIVATE STREETS) AND "B" (OPEN SPACE/DRAINAGE)

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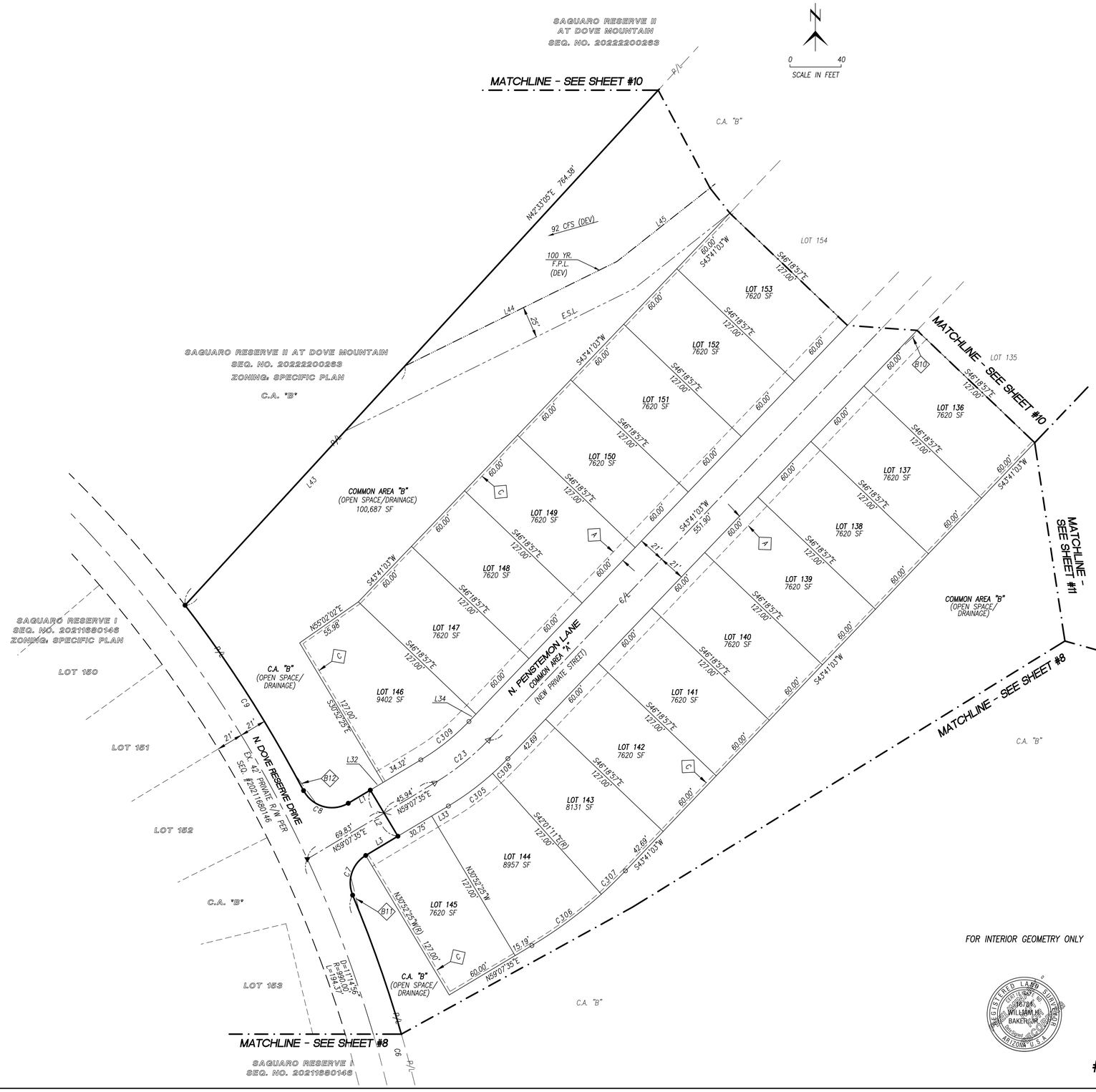
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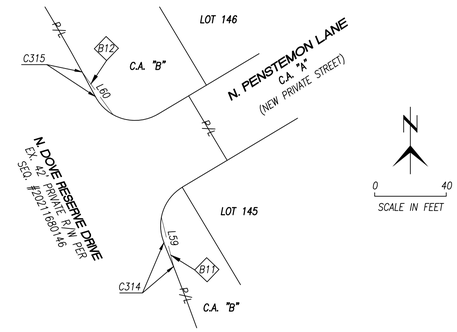
JOB #2447.4

DATE: OCTOBER 17, 2024

SHEET 8 OF 13

SEQUENCE #_____





SIGHT VISIBILITY TRIANGLE ("SVT") - B11 AND B12

DETAIL - COMMON AREA "B" (NEAR LOTS 145 AND 146)

EASEMENT KEYNOTES

- (A) NEW 10' UTILITY EASEMENT GRANTED TO THE PUBLIC AND PRIVATE ROADWAY MAINTENANCE & SIGNAGE EASEMENT GRANTED TO THE HOMEOWNER'S ASSOCIATION BY THIS PLAT
- (B#) NEW SIGHT VISIBILITY TRIANGLE ("SVT") EASEMENT AREA GRANTED TO THE TOWN OF MARANA BY THIS PLAT (SEE ALSO DETAILS, SHEETS #3, #5, #6, #9, #10 AND #12)
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FINAL PLAT for

SAGUARO RESERVE III AT DOVE MOUNTAIN, LOTS 1-236, AND COMMON AREAS "A" (PRIVATE STREETS) AND "B" (OPEN SPACE/DRAINAGE)

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#PRV2403-001

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JOB #2447.4 DATE: OCTOBER 17, 2024 SHEET 9 OF 13

SEQUENCE #

SEQUENCE #

SEQUENCE #

N. QUAIL BRUSH PASS
EX. 42' PRIVATE R/W PER SEQ. #20222200263

SAGUARO RESERVE II AT DOVE MOUNTAIN
SEQ. NO. 20222200263
ZONING: SPECIFIC PLAN

LOT 248

LOT 247

LOT 246

LOT 245

LOT 244

C.A. "B"

N. LONE EAGLE DRIVE
EX. 42' PRIVATE R/W PER SEQ. #20222200263

COMMON AREA "B" (OPEN SPACE/DRAINAGE)

S72°15'36"W 164.10'

S69°12'13"W(R) 127.00'

LOT 186 8535 SF

S60°44'58"W(R) 127.00'

LOT 187 8535 SF

S52°17'42"W(R) 127.00'

LOT 188 8535 SF

S45°50'26"W(R) 127.00'

LOT 189 8535 SF

S40°55'01"W(R) 127.00'

LOT 190 8535 SF

S32°27'46"W(R) 127.00'

LOT 191 8535 SF

S24°00'31"W(R) 127.00'

LOT 192 8535 SF

S15°33'15"W(R) 127.00'

LOT 193 8535 SF

S07°06'00"W(R) 127.00'

LOT 194 8535 SF

S01°21'15"E(R) 127.00'

LOT 195 7633 SF

S09°48'30"E(R) 127.00'

LOT 196 8344 SF

N11°53'33"W(R) 127.00'

LOT 197

N05°49'57"W(R) 127.00'

COMMON AREA "B" (OPEN SPACE/DRAINAGE)

N86°00'58"W 659.66'

C.A. "B"

DOVE MOUNTAIN RESORT
PER M&P 62/71
BLOCK "G"
ZONING: SPECIFIC PLAN

DOVE MOUNTAIN RESORT
PER M&P 62/71

MATCHLINE - SEE SHEET #12

COMMON AREA "B" (OPEN SPACE/DRAINAGE)

N59°54'38"E 167.30'

S61°45'15"W(R) 127.00'

LOT 185 8337 SF

S55°43'51"W(R) 127.00'

LOT 184 8337 SF

S49°42'27"W(R) 127.00'

LOT 183 8337 SF

S43°41'03"W(R) 127.00'

N40°56'46"W 134.01'

SAGUARO RESERVE II AT DOVE MOUNTAIN
SEQ. NO. 20222200263
ZONING: SPECIFIC PLAN

C.A. "B"

COMMON AREA "B" (OPEN SPACE/DRAINAGE)

S43°41'03"W 60.00'

S46°18'57"E 127.00'

LOT 159 7620 SF

LOT 158 7620 SF

LOT 157 7620 SF

LOT 156 7620 SF

LOT 155 7620 SF

LOT 154 7620 SF

LOT 153

N. LONE EAGLE DRIVE COMMON AREA "A" (NEW PRIVATE STREET)

N. PENSTEMON LANE COMMON AREA "A" (NEW PRIVATE STREET)

COMMON AREA "B" (OPEN SPACE/DRAINAGE)

S76°39'43"E 54.29'

LOT 182 8337 SF

LOT 181 8337 SF

LOT 180 8337 SF

LOT 179 8337 SF

LOT 178 8337 SF

LOT 177 8290 SF

LOT 176 8547 SF

LOT 175

MATCHLINE - SEE SHEET #12

C.A. "B" (OPEN SPACE/DRAINAGE)

LOT 160 8477 SF

LOT 161 8724 SF

LOT 162

LOT 163

LOT 164

LOT 165

LOT 166

LOT 167

LOT 168

LOT 169

W. DESERT CHICORY LANE COMMON AREA "A" (NEW PRIVATE STREET)

COMMON AREA "B" (OPEN SPACE/DRAINAGE)

LOT 135 7617 SF

LOT 136

C.A. "B"

LOT 134

MATCHLINE - SEE SHEET #9

MATCHLINE - SEE SHEET #11

N42°33'05"E 764.38'

100 YR. F.P.L. (DEV)

0 40
SCALE IN FEET

SIGHT VISIBILITY TRIANGLE ("SVT") - B9 AND B10

DETAIL – LOTS 135 AND 136 AND COMMON AREA "B" (NEAR LOT 160)

N. PENSTEMON LANE C.A. "A" (NEW PRIVATE STREET)

W. DESERT CHICORY LANE C.A. "A" (NEW PRIVATE STREET)

C.A. "B"

LOT 160

LOT 135

LOT 136

EASEMENT KEYNOTES

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- (C) NEW 1' NO VEHICULAR ACCESS EASEMENT GRANTED BY THIS PLAT

FOR INTERIOR GEOMETRY ONLY

REGISTERED LAND SURVEYOR 16784 WILLIAM H. BAKER JR. ARIZONA U.S.A.

FINAL PLAT for
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JOB #2447.4

DATE: OCTOBER 17, 2024

SEQUENCE #



EASEMENT KEYNOTES

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- (C) NEW 1' NO VEHICULAR ACCESS EASEMENT GRANTED BY THIS PLAT

FOR INTERIOR GEOMETRY ONLY

REGISTERED LAND SURVEYOR 36724 WILLIAM H. BAKER, JR. ARIZONA U.S.A.

FINAL PLAT for

SAGUARO RESERVE III AT DOVE MOUNTAIN, LOTS 1-236, AND COMMON AREAS "A" (PRIVATE STREETS) AND "B" (OPEN SPACE/DRAINAGE)

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#PRV2403-001 REF.: #PRV2211-001; REF.: PRV2109-005; PRV2102-004; PRV1803-002 JOB #2447.4 DATE: OCTOBER 17, 2024 SHEET 11 OF 13

SEQUENCE #

SEQUENCE #

EASEMENT KEYNOTES

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- (C) NEW 1' NO VEHICULAR ACCESS EASEMENT GRANTED BY THIS PLAT

DOVE MOUNTAIN RESORT PER M&P 62/71

DOVE MOUNTAIN RESORT PER M&P 62/71 BLOCK "G" ZONING: SPECIFIC PLAN

MATCHLINE - SEE SHEET #10

MATCHLINE - SEE SHEET #11

MATCHLINE - SEE SHEET #7

MATCHLINE - SEE SHEET #6

N86°00'58"W 659.66'

S61°54'12"E 494.78'

COMMON AREA "B" (OPEN SPACE/DRAINAGE)

COMMON AREA "B" (OPEN SPACE/DRAINAGE) 266,627 SF

N LONE EAGLE DRIVE COMMON AREA "A" (NEW PRIVATE STREET)

W. DESERT CHICORY LANE COMMON AREA "A" (NEW PRIVATE STREET)

LOT 196 | LOT 197 8344 SF | LOT 198 8344 SF | LOT 199 8344 SF | LOT 200 8344 SF | LOT 201 8344 SF | LOT 202 8344 SF | LOT 203 8344 SF | LOT 204 8344 SF | LOT 205 8344 SF | LOT 206 8344 SF | LOT 207 8344 SF | LOT 208 8344 SF

LOT 176 | LOT 175 8547 SF | LOT 174 8431 SF | COMMON AREA "B" (OPEN SPACE/DRAINAGE) 14,753 SF | LOT 173 8636 SF

LOT 170 | LOT 171 8491 SF | LOT 172 8636 SF | COMMON AREA "B" (OPEN SPACE/DRAINAGE) | LOT 119 8392 SF | LOT 120 8392 SF | COMMON AREA "B" (OPEN SPACE/DRAINAGE)

LOT 124 | LOT 123 8149 SF | LOT 122 8392 SF | LOT 121 8392 SF | COMMON AREA "B" (OPEN SPACE/DRAINAGE)

COMMON AREA "B" (OPEN SPACE/DRAINAGE)

LOT 209 | LOT 85 | LOT 86 | LOT 87 | LOT 88 | LOT 89 | LOT 90 | LOT 91 | LOT 92

100 YR. F.P.L. (DEV)

275 CFS (DEV)

278 CFS (DEV)

E.S.L. 25'

C.A. "B"

N81°30'41"E 237.90'

S16°21'00"E 184.81'

150.46'

0 40 SCALE IN FEET

SIGHT VISIBILITY TRIANGLE ("SVT") - B7 AND B8

DETAIL - COMMON AREA "B" (NEAR LOTS 119 AND 173)

FOR INTERIOR GEOMETRY ONLY

REGISTERED LAND SURVEYOR 36784 WILLIAM H. BAKER JR Revised 10-17-24 ARIZONA U.S.A.

SEQUENCE #

FINAL PLAT for
SAGUARO RESERVE III AT DOVE MOUNTAIN, LOTS 1-236, AND COMMON AREAS "A" (PRIVATE STREETS) AND "B" (OPEN SPACE/DRAINAGE)

BEING A SUBDIVISION OF A PORTION OF BLOCK "1" OF SAGUARO RESERVE I, SEQ. #20211680146, BLOCKS "1" – "4" OF SAGUARO RESERVE II, SEQ. #20222200263, AND A PORTION OF SECTIONS 16 AND 21, T11S, R12E, G&SRM, TOWN OF MARANA, PIMA COUNTY, ARIZONA

Baker & Associates Engineering, Inc.
3561 E. Sunrise Drive, Suite #225 Tucson, Arizona 85718 (520) 318-1950 Fax (520) 318-1930

#PRV2403-001 REF.: #PRV2211-001; REF.: PRV2109-005; PRV2102-004; PRV1803-002 JOB #2447.4 DATE: OCTOBER 17, 2024 SHEET 12 OF 13

SEQUENCE #_____

NUMBER	DELTA ANGLE	RADIUS	ARC LENGTH
C1	06°51'52"	1011.00	121.12
C2	83°16'22"	25.00	36.33
C3	04°54'40"	221.00	18.94
C4	02°24'36"	179.00	7.53
C5	94°07'01"	25.00	41.07
C6	34°30'56"	1011.00	609.04
C7	81°42'01"	25.00	35.65
C8	93°11'03"	25.00	40.66
C9	09°45'03"	1011.00	172.06
C10	11°35'34"	561.00	113.51
C11	18°35'50"	519.00	168.46
C12	19°54'38"	225.00	78.19
C13	15°47'38"	900.00	248.09
C14	32°59'02"	90.00	51.81
C15	66°31'40"	215.00	249.64
C16	26°37'57"	190.00	88.32
C17	20°08'54"	1050.00	369.24
C18	06°08'13"	200.00	21.42
C19	29°03'53"	535.00	271.39
C20	28°01'09"	540.00	264.07
C21	36°26'37"	500.00	318.03
C22	07°48'21"	200.00	27.25
C23	15°26'32"	200.00	53.90
C24	05°32'33"	200.00	19.35
C25	40°22'23"	846.00	596.13
C26	39°25'10"	540.00	371.52
C27	51°33'09"	200.00	179.95
C28	58°47'55"	535.00	549.03
C29	51°05'02"	500.00	445.79
C30	26°31'45"	500.00	231.51
C31	02°11'24"	200.00	7.64
C32	20°08'54"	1300.00	457.15
C33	09°07'49"	200.00	31.87
C34	33°51'02"	540.00	319.03
C35	02°09'09"	1448.00	54.40
C36	02°09'09"	1448.00	54.40
C37	02°09'09"	1448.00	54.40
C38	02°09'09"	1448.00	54.40
C39	02°09'09"	1448.00	54.40
C40	02°09'09"	1448.00	54.40
C41	01°17'59"	1448.00	32.85
C42	02°09'09"	1321.00	49.63
C43	02°09'09"	1321.00	49.63
C44	02°09'09"	1321.00	49.63
C45	02°09'09"	1321.00	49.63
C46	02°09'09"	1321.00	49.63
C47	02°09'09"	1321.00	49.63
C48	02°09'09"	1321.00	49.63
C49	02°09'09"	1321.00	49.63
C50	01°17'59"	1321.00	29.97
C51	02°27'18"	1279.00	54.80
C52	02°27'18"	1279.00	54.80
C53	02°27'18"	1279.00	54.80
C54	02°27'18"	1279.00	54.80
C55	02°27'18"	1279.00	54.80
C56	00°33'28"	1279.00	12.45
C57	02°26'27"	1279.00	54.48
C58	02°26'27"	1279.00	54.48
C59	00°33'55"	1279.00	12.62
C60	02°26'27"	1152.00	49.07
C61	00°33'55"	1152.00	11.37
C62	02°27'18"	1152.00	49.36
C63	02°27'18"	1152.00	49.36
C64	02°27'18"	1152.00	49.36
C65	02°27'18"	1152.00	49.36
C66	02°27'18"	1152.00	49.36
C67	16°58'44"	25.00	7.41
C68	53°20'23"	60.00	55.86
C69	56°22'30"	60.00	59.04
C70	02°26'27"	60.00	2.56
C71	51°53'12"	187.00	169.35
C72	39°56'29"	187.00	130.36
C73	07°40'49"	187.00	25.07
C74	17°52'35"	60.00	18.72
C75	73°01'16"	25.00	31.86
C76	05°32'33"	179.00	17.32
C77	05°32'33"	221.00	21.38
C78	01°52'07"	1152.00	37.57
C79	02°26'27"	1152.00	49.07
C80	72°12'21"	25.00	31.51
C81	90°00'00"	25.00	39.27
C82	01°52'07"	1279.00	41.71
C83	01°37'44"	1321.00	37.55
C84	01°37'44"	1448.00	41.17
C85	04°22'43"	221.00	16.89
C86	05°19'39"	556.00	51.70
C87	84°46'01"	25.00	36.99
C88	23°57'31"	514.00	214.93
C89	103°33'36"	25.00	45.19
C90	03°56'54"	221.00	15.23
C91	89°37'32"	25.00	39.11
C92	05°23'49"	521.00	49.08
C93	05°23'49"	521.00	49.08
C94	05°23'49"	521.00	49.08
C95	05°23'49"	521.00	49.08
C96	00°32'59"	521.00	5.00
C97	05°23'49"	648.00	61.04
C98	05°23'49"	648.00	61.04
C99	05°23'49"	648.00	61.04
C100	05°23'49"	648.00	61.04

NUMBER	DELTA ANGLE	RADIUS	ARC LENGTH
C101	07°48'43"	479.00	65.31
C102	07°48'43"	479.00	65.31
C103	07°37'16"	479.00	63.71
C104	07°48'43"	352.00	47.99
C105	07°48'43"	352.00	47.99
C106	07°37'16"	352.00	46.82
C107	05°23'49"	521.00	49.08
C108	05°23'49"	521.00	49.08
C109	05°23'49"	521.00	49.08
C110	05°23'49"	521.00	49.08
C111	05°23'49"	521.00	49.08
C112	05°23'49"	521.00	49.08
C113	05°23'49"	521.00	49.08
C114	05°23'49"	521.00	49.08
C115	05°23'49"	521.00	49.08
C116	00°59'23"	521.00	9.00
C117	07°48'43"	352.00	47.99
C118	07°48'43"	352.00	47.99
C119	07°48'43"	352.00	47.99
C120	07°48'43"	352.00	47.99
C121	07°48'43"	352.00	47.99
C122	02°01'19"	352.00	12.42
C123	05°23'49"	648.00	61.04
C124	05°23'49"	648.00	61.04
C125	05°23'49"	648.00	61.04
C126	05°23'49"	648.00	61.04
C127	05°23'49"	648.00	61.04
C128	05°23'49"	648.00	61.04
C129	05°23'49"	648.00	61.04
C130	05°23'49"	648.00	61.04
C131	00°59'23"	648.00	11.19
C132	07°48'43"	479.00	65.31
C133	07°48'43"	479.00	65.31
C134	07°48'43"	479.00	65.31
C135	07°48'43"	479.00	65.31
C136	07°48'43"	479.00	65.31
C137	07°48'43"	479.00	65.31
C138	02°01'19"	479.00	16.90
C139	02°11'24"	479.00	18.31
C140	01°31'14"	521.00	13.83
C141	03°17'02"	352.00	20.17
C142	03°17'02"	479.00	27.45
C143	04°23'27"	648.00	49.66
C144	04°23'27"	521.00	39.93
C145	47°52'11"	179.00	149.55
C146	12°25'34"	221.00	47.93
C147	12°25'34"	221.00	47.93
C148	12°25'34"	221.00	47.93
C149	11°24'18"	221.00	43.99
C150	12°25'34"	348.00	75.47
C151	02°52'10"	348.00	17.43
C152	02°52'10"	221.00	11.07
C153	03°40'58"	179.00	11.51
C154	01°01'16"	221.00	3.94
C155	12°25'34"	348.00	75.47
C156	12°25'34"	348.00	75.47
C157	12°25'34"	348.00	75.47
C158	02°11'24"	352.00	13.45
C159	07°48'43"	352.00	47.99
C160	01°31'14"	648.00	17.20
C161	05°23'49"	648.00	61.04
C162	06°28'39"	521.00	58.90
C163	06°28'39"	521.00	58.90
C164	01°05'32"	521.00	9.93
C165	06°28'39"	521.00	58.90
C166	06°28'39"	521.00	58.90
C167	04°26'34"	521.00	40.40
C168	04°26'34"	648.00	50.25
C169	06°28'39"	648.00	73.26
C170	06°28'39"	648.00	73.26
C171	06°28'39"	648.00	73.26
C172	06°28'39"	648.00	73.26
C173	06°04'36"	556.00	58.97
C174	06°04'36"	683.00	72.44
C175	06°04'36"	556.00	58.97
C176	06°04'36"	683.00	72.44
C177	06°04'36"	556.00	58.97
C178	06°04'36"	683.00	72.44
C179	04°49'23"	825.00	69.45
C180	04°49'23"	825.00	69.45
C181	04°49'23"	825.00	69.45
C182	04°49'23"	825.00	69.45
C183	04°49'23"	825.00	69.45
C184	04°49'23"	825.00	69.45
C185	04°49'23"	825.00	69.45
C186	01°38'42"	825.00	23.69
C187	03°55'14"	867.00	59.33
C188	03°55'14"	867.00	59.33
C189	03°55'14"	867.00	59.33
C190	03°55'14"	867.00	59.33
C191	03°55'14"	867.00	59.33
C192	00°39'39"	867.00	10.00
C193	03°55'14"	867.00	59.33
C194	03°55'14"	867.00	59.33
C195	08°29'11"	867.00	128.41
C196	58°39'20"	25.00	25.59
C197	03°55'14"	994.00	68.02
C198	03°55'14"	994.00	68.02
C199	03°55'14"	994.00	68.02
C200	03°55'14"	994.00	68.02

NUMBER	DELTA ANGLE	RADIUS	ARC LENGTH
C201	03°55'14"	994.00	68.02
C202	03°55'14"	994.00	68.02
C203	01°22'08"	994.00	23.75
C204	03°55'14"	994.00	68.02
C205	01°22'08"	867.00	20.71
C206	105°53'15"	25.00	46.20
C207	00°52'47"	825.00	12.67
C208	27°09'01"	514.00	243.57
C209	09°22'39"	352.00	57.61
C210	07°04'52"	352.00	43.50
C211	09°22'39"	352.00	57.61
C212	03°28'33"	479.00	29.06
C213	102°25'09"	25.00	44.69
C214	09°22'39"	479.00	78.40
C215	09°22'39"	479.00	78.40
C216	08°01'56"	479.00	67.15
C217	06°04'36"	556.00	58.97
C218	06°04'36"	556.00	58.97
C219	06°04'36"	683.00	72.44
C220	06°04'36"	683.00	72.44
C221	06°04'36"	683.00	72.44
C222	06°04'36"	683.00	72.44
C223	06°04'36"	556.00	58.97
C224	06°04'36"	556.00	58.97
C225	06°04'36"	556.00	58.97
C226	06°04'36"	683.00	72.44
C227	06°04'36"	683.00	72.44
C228	06°04'36"	683.00	72.44
C229	06°04'36"	683.00	72.44
C230	06°04'36"	683.00	72.44
C231	06°04'36"	556.00	58.97
C232	06°04'36"	556.00	58.97
C233	06°04'36"	556.00	58.97
C234	06°04'36"	556.00	58.97
C235	06°04'36"	556.00	58.97
C236	08°27'15"	519.00	76.58
C237	08°27'15"	392.00	57.84
C238	04°24'17"	392.00	30.14
C239	04°24'17"	519.00	39.90
C240	02°19'15"	556.00	22.52
C241	02°19'15"	683.00	27.66
C242	08°33'34"	514.00	76.79
C243	08°33'34"	514.00	76.79
C244	08°33'34"	514.00	76.79
C245	05°50'07"	561.00	57.14
C246	00°12'46"	514.00	1.91
C247	06°01'24"	561.00	58.98
C248	06°01'24"	561.00	58.98
C249	06°01'24"	561.00	58.98
C250	06°01'24"	561.00	58.98
C251	06°01'24"	561.00	58.98
C252	68°03'17"	25.00	29.69
C253	08°27'15"	519.00	76.58
C254	08°27'15"	519.00	76.58
C255	08°27'15"	519.00	76.58
C256	08°27'15"	392.00	57.84
C257	08°27'15"	392.00	57.84
C258	08°27'15"	392.00	57.84
C259	08°27'15"	519.00	76.58
C260	08°27'15"	392.00	57.84
C261	08°27'15"	392.00	57.84
C262	08°27'15"	519.00	76.58
C263	02°55'25"	519.00	26.48
C264	102°31'00"	25.00	44.73
C265	12°31'00"	561.00	122.55
C266	06°01'24"	561.00	58.98
C267	06°01'24"	688.00	72.33
C268	03°06'50"	561.00	30.49
C269	06°01'24"	688.00	72.33
C270	06°01'24"	561.00	58.98
C271	06°01'24"	688.00	72.33
C272	08°27'16"	519.00	76.58
C273	08°27'16"	392.00	57.84
C274	01°22'05"	519.00	12.39
C275	07°05'11"	519.00	64.19
C276	08°27'16"	392.00	57.84
C277	08°27'16"	519.00	76.58
C278	08°27'16"	392.00	57.84
C279	03°03'22"	519.00	27.68
C280	08°55'22"	387.00	60.27
C281	06°58'10"	387.00	47.08
C282	04°59'15"	688.00	59.89
C283	04°49'23"	688.00	57.91
C284	04°49'23"	688.00	57.91
C285	04°49'23"	688.00	57.91
C286	04°49'23"	688.00	57.91
C287	04°49'23"	688.00	57.91
C288	04°49'23"	688.00	57.91
C289	00°24'37"	688.00	4.93
C290	08°33'34"	387.00	57.81
C291	08°33'34"	387.00	57.81
C292	04°35'23"	387.00	31.00
C293	06°01'24"	688.00	72.33
C294	06°01'24"	688.00	72.33
C295	06°01'24"	688.00	72.33
C296	06°01'24"	688.00	72.33
C297	06°01'24"	688.00	72.33
C298	02°39'36"	561.00	26.04
C299	00°57'04"	352.00	5.84
C300	05°50'07"	688.00	70.07

CURVE TABLE

NUMBER	DELTA ANGLE	RADIUS	ARC LENGTH
C301	00°12'46"	387.00	1.44
C302	02°54'34"	561.00	28.49
C303	01°37'00"	688.00	19.41
C304	06°01'45"	387.00	40.72
C305	11°08'46"	221.00	42.99
C306	11°08'46"	348.00	67.70
C307	04°17'46"	348.00	26.09
C308	04°17'46"	221.00	16.57
C309	15°26'32"	179.00	48.24
C310	03°53'24"	221.00	15.00
C311	17°07'56"	25.00	7.48
C312	17°47'39"	25.00	7.76
C313	18°38'43"	514.00	167.27
C314	00°48'49"	1011.00	14.36
C315	00°53'03"	1011.00	15.60
C316	02°42'48"	1011.00	47.88
C317	02°38'37"	1011.00	46.65
C318	08°54'46"	1011.00	157.27
C319	00°48'55"	1011.00	14.38
C320	00°51'52"	1011.00	15.25
C321	51°05'02"	651.00	580.42
C322	23°14'43"	349.00	141.59
C323	06°13'08"	514.00	55.79
C324	02°09'09"	1448.00	54.40
C325	10°23'18"	215.00	38.98
C326	15°57'48"	1451.00	404.27
C327	14°52'39"	1460.00	379.11
C328	13°26'38"	514.00	120.60
C329	06°04'36"	683.00	72.44
C330	01°13'09"	556.00	11.83
C331	02°09'09"	1448.00	54.40

NUMBER	DIRECTION	DISTANCE
L1	S59°07'35"W	20.00'
L2	S30°52'25"E	42.00'
L3	N59°07'35"E	29.25'
L4	S05°24'53"W	42.00'
L5	N22°37'44"W	42.00'
L6	S42°33'05"W	42.74'
L7	S67°22'16"W	25.00'
L8	S67°22'16"W	25.00'
L9	S67°22'16"W	19.75'
L10	N22°37'44"W	20.00'
L11	N67°22'16"E	12.16'
L12	S67°22'16"W	12.16'
L13	S81°30'41"W	18.85'
L14	N81°30'41"E	18.85'
L15	N67°22'16"E	11.94'
L16	N67°22'16"E	11.94'
L17	S67°22'16"W	15.13'
L18	S87°31'10"W	32.12'
L19	S87°31'10"W	12.00'
L20	S02°28'50"E	12.24'
L21	S08°01'23"E	11.24'
L22	S08°01'23"E	14.89'
L23	S87°31'10"W	14.39'
L24	S08°01'23"E	20.00'
L25	S08°01'23"E	20.00'
L26	S68°25'01"W	4.25'
L27	S68°25'01"W	9.32'
L28	S68°25'01"W	9.32'
L29	S85°03'14"E	5.00'
L30	S85°03'14"E	1.22'
L31	S85°03'14"E	1.22'
L32	N59°07'35"E	11.61'
L33	N59°07'35"E	15.19'
L34	S43°41'03"W	7.95'
L35	S43°41'03"W	10.00'
L36	S43°41'03"W	10.00'
L37	N81°30'41"E	14.11'
L38	N81°30'41"E	8.61'
L39	N81°30'41"E	8.61'
L40	N89°11'48"W	63.05'
L41	S83°00'20"W	26.81'
L42	N87°31'10"E	16.68'
L43	S42°33'05"W	253.65'
L44	S63°44'23"W	184.71'
L45	S51°42'54"W	92.65'
L46	N51°40'04"E	178.23'
L47	S25°48'09"W	28.67'
L48	N03°49'41"E	29.10'
L49	S12°29'39"E	60.59'
L50	S08°01'23"E	45.79'
L51	N13°36'39"W	124.35'
L52	N16°21'00"W	113.52'
L53	S37°38'47"E	137.69'
L54	N56°54'47"W	184.09'
L55	N39°14'47"E	57.64'
L56	S43°41'03"W	43.22'
L57	S47°05'57"W	96.36'
L58	S43°41'03"W	27.61'
L59	S13°48'43"E	28.66'
L60	N35°49'26"W	29.56'
L61	S36°45'41"W	160.40'
L62	N15°27'19"W	46.72'
L63	S22°37'44"E	17.00'
L64	N67°22'16"E	219.75'
L65	S48°57'07"W	146.69'
L66	N82°32'15"E	102.81'
L67	N74°26'40"W	37.72'
L68	N87°31'10"E	119.81'
L69	N87°31'10"E	119.81'
L70	N67°36'24"W	57.24'

NUMBER	DIRECTION	DISTANCE
L71	N89°50'33"W	71.28'
L72	N19°43'22"W	40.08'
L73	N44°05'03"E	107.44'
L74	N79°32'03"E	69.24'
L75	S58°59'08"W	78.78'
L76	S67°20'43"W	97.96'
L77	S37°53'52"W	32.60'
L78	N55°49'22"E	115.65'
L79	S30°26'01"W	81.06'
L80	S52°48'09"W	249.47'
L81	N83°13'32"W	109.60'
L82	S46°27'20"W	64.73'
L83	N25°21'23"E	23.49'
L84	S39°20'55"W	188.13'
L85	S40°06'10"W	108.34'
L86	S75°33'42"E	50.32'
L87	S44°14'20"W	160.71'
L88	S59°19'57"W	51.74'
L89	S88°58'26"E	58.94'
L90	S71°36'55"W	49.91'
L91	N46°08'16"W	52.80'
L92	S34°44'17"W	53.44'
L93	N43°51'44"E	486.15'
L94	N85°03'14"W	42.05'
L95	N60°09'42"E	151.04'
L96	S87°57'24"E	109.62'
L97	N68°25'01"E	111.43'
L98	S16°21'00"E	42.73'
L99	N61°14'56"E	173.71'
L100	N73°39'00"E	127.00'
L101	N16°25'25"W	31.95'
L102	S81°26'56"W	44.41'
L103	S30°03'26"E	50.10'
L104	S69°39'49"E	107.02'
L105	S68°19'21"W	73.02'
L106	N30°54'55"E	97.58'
L107	N58°09'18"E	39.96'
L108	S73°56'20"E	132.55'
L109	S58°44'17"W	268.53'
L110	S82°27'38"W	197.91'
L111	N83°46'07"W	127.75'
L112	S70°34'29"W	115.78'
L113	S21°33'25"E	74.92'
L114	N74°07'53"W	46.90'
L115	S83°17'44"W	94.23'
L116	S32°21'38"W	183.42'
L117	S42°36'21"W	203.38'
L118	S70°16'56"E	89.67'
L119	S54°51'20"W	49.37'
L120	S03°27'37"W	97.19'
L121	S43°03'59"W	276.94'
L122	N66°20'48"E	34.29'
L123	S70°21'34"E	23.94'
L124	S23°17'19"W	47.73'
L125	N70°47'45"W	23.34'
L126	N02°28'50"W	9.00'

LINE TABLE

FOR INTERIOR GEOMETRY ONLY

REGISTERED LAND SURVEYOR 16784 WILLIAM H. BAKER, JR. ARIZONA U.S.A.

FINAL PLAT for

SAGUARO RESERVE III AT DOVE MOUNTAIN, LOTS 1-236, AND COMMON AREAS "A" (PRIVATE STREETS) AND "B" (OPEN SPACE/DRAINAGE)

BEING A SUBDIVISION OF A PORTION OF BLOCK "1" OF SAGUARO RESERVE I, SEQ. #20211680146, BLOCKS "1" – "4" OF SAGUARO RESERVE II, SEQ. #20222200263, AND A PORTION OF SECTIONS 16 AND 21, T11S, R12E, G&SRM, TOWN OF MARANA, PIMA COUNTY, ARIZONA

Baker & Associates Engineering, Inc.
3561 E. Sunrise Drive, Suite #225 Tucson, Arizona 85718 (520) 318-1950 Fax (520) 318-1930

#PRV2403-001

REF.: #PRV2211-001; REF.: PRV2109-005; PRV2102-004; PRV1803-002

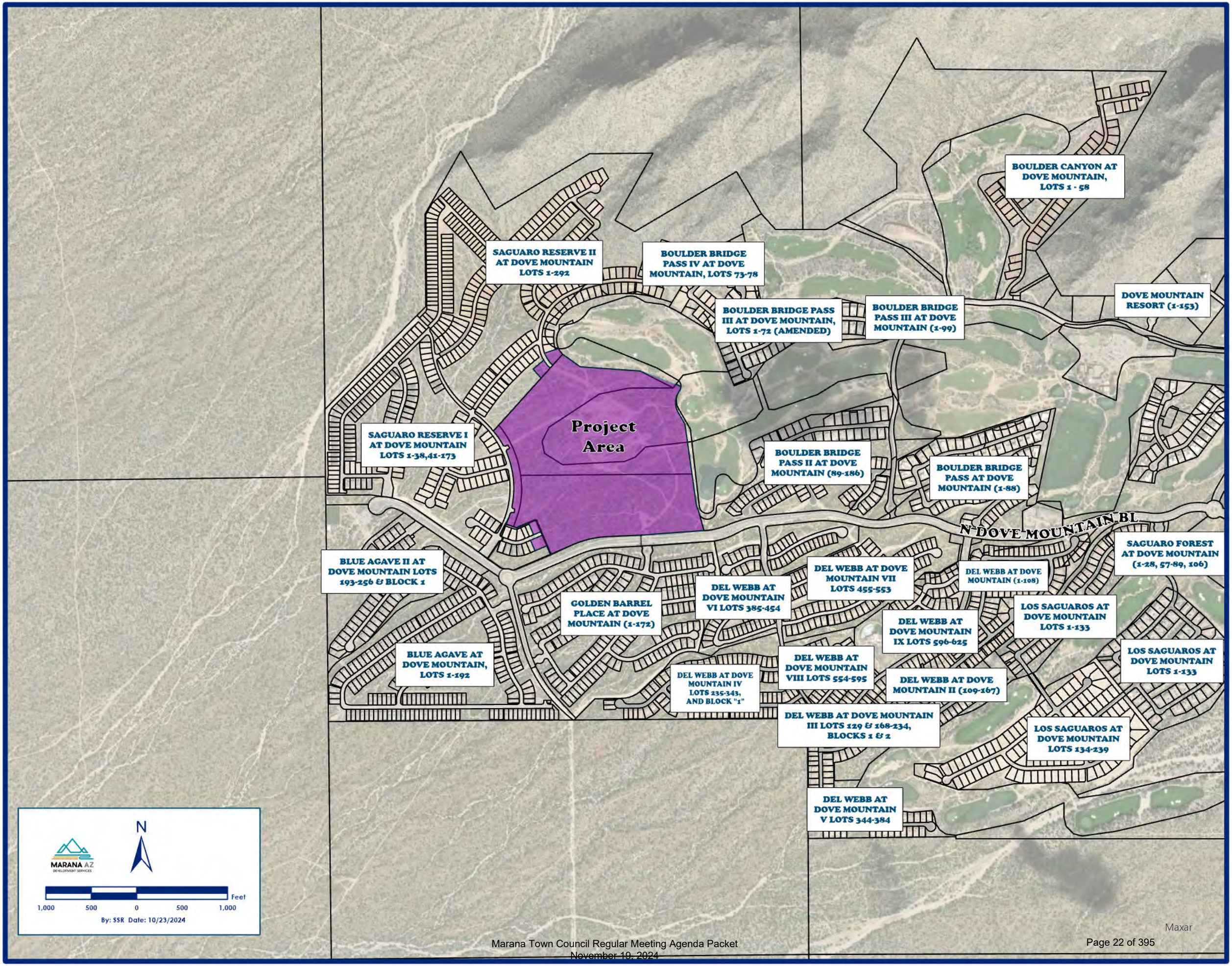
JOB #2447.4

DATE: OCTOBER 17, 2024

SHEET 13 OF 13

SEQUENCE #

SEQUENCE #


SAGUARO RESERVE II AT DOVE MOUNTAIN LOTS 1-292
BOULDER BRIDGE PASS IV AT DOVE MOUNTAIN, LOTS 73-78
BOULDER CANYON AT DOVE MOUNTAIN, LOTS 1 - 58
BOULDER BRIDGE PASS III AT DOVE MOUNTAIN, LOTS 1-72 (AMENDED)
BOULDER BRIDGE PASS III AT DOVE MOUNTAIN (1-99)
DOVE MOUNTAIN RESORT (1-153)
Project Area
SAGUARO RESERVE I AT DOVE MOUNTAIN LOTS 1-38,41-173
BOULDER BRIDGE PASS II AT DOVE MOUNTAIN (89-186)
BOULDER BRIDGE PASS AT DOVE MOUNTAIN (1-88)
N DOVE MOUNTAIN BL
SAGUARO FOREST AT DOVE MOUNTAIN (1-28, 57-89, 106)
BLUE AGAVE II AT DOVE MOUNTAIN LOTS 193-256 & BLOCK 1
DEL WEBB AT DOVE MOUNTAIN VII LOTS 455-553
DEL WEBB AT DOVE MOUNTAIN (1-108)
GOLDEN BARREL PLACE AT DOVE MOUNTAIN (1-172)
DEL WEBB AT DOVE MOUNTAIN VI LOTS 385-454
LOS SAGUAROS AT DOVE MOUNTAIN LOTS 1-133
DEL WEBB AT DOVE MOUNTAIN IX LOTS 596-625
BLUE AGAVE AT DOVE MOUNTAIN, LOTS 1-192
DEL WEBB AT DOVE MOUNTAIN VIII LOTS 554-595
LOS SAGUAROS AT DOVE MOUNTAIN LOTS 1-133
DEL WEBB AT DOVE MOUNTAIN IV LOTS 235-343, AND BLOCK "1"
DEL WEBB AT DOVE MOUNTAIN II (109-167)
DEL WEBB AT DOVE MOUNTAIN III LOTS 129 & 168-234, BLOCKS 1 & 2
LOS SAGUAROS AT DOVE MOUNTAIN LOTS 134-239
DEL WEBB AT DOVE MOUNTAIN V LOTS 344-384
N
MARANA AZ
DEVELOPMENT SERVICES
Feet
1,000 500 0 500 1,000
By: SSR Date: 10/23/2024
Maxar

MARANA AZ

Development Services / maranaplanning@maranaAZ.gov
11555 West Civic Center Drive / Marana, AZ 85653
Ph (520) 382-2600 / Fax (520) 382-2641 / maranaAZ.gov

PROJECT APPLICATION

APPLICATION TYPE

☐ Annexation	☐ Development Plan	☐ Development Plan Package	☐ General Plan Amendment
☐ Rezone	☐ Minor Land Division	☐ Significant Land Use Change	☐ Conditional Use Permit
☐ Specific Plan	☐ Landscape Plan	☐ Native Plant Plan/Exception	☐ SWPP
☐ Variance	☐ Hydraulic Model	☐ Sewer Capacity Assurance	☐ Sign Program
☒ Plat	☐ Improvement Plan	☐ Report (Type): _____	☐ Other: _____

PROJECT INFORMATION

Project Name: Saguaro Reserve III at Dove Mountain	
Description of Project: Single Family Residential Subdivision	Number of Lots: 235
Parcel No.(s): Portion of 218-22-002U, -002T, -002J, -1760, -183K, -183L	Gross Area (Acres): 81.9
Project Address: 15000 N. Dove Mountain Blvd., Marana, AZ 85658	
Ref. Project No.: PRV2109-005, PRV2102-004, PRV1803-002	

CONTACT INFORMATION

Owner: Landmark Title Trust 18379	Contact Name: c/o Cottonwood Prop./Bill Hallinan		
Address: 3567 E. Sunrise, Suite 219	City: Tucson	State: AZ	Zip: 85718
Email: bhallinan@cottonwoodproperties.com	Phone No.: (520) 299-8424		
Applicant: Baker & Assoc. Engineering	Contact Name: Marty Magelli		
Address: 3561 E. Sunrise, Suite 225	City: Tucson	State: AZ	Zip: 85718
Email: marty@baetucson.com	Phone No.: (520) 318-1950		
Consultant/Engineer: Baker & Assoc. Engineering	Contact Name: Marty Magelli		
Address: 3561 E. Sunrise, Suite 225	City: Tucson	State: AZ	Zip: 85718
Email: marty@baetucson.com	Phone No.: (520) 318-1950		

OWNER/APPLICANT AUTHORIZATION

I hereby certify that the information set forth in this application are true and correct to the best of my knowledge and that I am either the owner of the property or that I have been authorized in writing by the owner to file this application. (If applicant is not the owner, attach written authorization from the owner.)

William Hallinan		3/14/24
Applicant Name (PRINT)	Signature	Date

FOR OFFICIAL USE ONLY

Project No._____ **Date Received**_____

Revision Date 03/29/2019

Council-Regular Meeting **C2**

Meeting Date: 11/19/2024

To: Mayor and Council

From: Kimberly Baker, Financial Manager

Date: November 19, 2024

Strategic Plan Focus Area:
Not Applicable

Subject: Resolution No. 2024-102: Relating to Utilities; approving and authorizing the Mayor to sign an amendment to the Intergovernmental Agreement, effective December 1, 2024, between the Town of Marana and Pima County for provision of water consumption data and sewer user account billing services (Kim Baker)

Discussion:

On November 17, 2020, the Town Council approved Resolution No. 2020-121, authorizing the Town to enter into an intergovernmental agreement (IGA) with Pima County for the provision of water consumption data and sewer user account billing services. Based on this IGA between Pima County and the Town of Marana, the Marana Water Department processes billing for Pima County Regional Wastewater Reclamation Department (RWRD) customers each month and transfers appropriate data and revenues to RWRD. For this service, the Town collected $1.59 per month per customer account processed without exceeding $65,000.00 (the Maximum Yearly Limit) annually. The IGA has a two-year term with up to four optional one-year extensions following the initial term. Amendment number one under this IGA, effective on December 1, 2022, established a revised user fee of $1.86 per month per customer account processed, and the Maximum Yearly Limit increased to $85,000.00 annually. Amendment number two under this IGA, effective December 1, 2023, established a revised user fee of $2.08 per month per customer account processed, and the Maximum Yearly Limit increased to $100,000.00 annually.

The 2023 amendment to the original agreement expires on November 30, 2024. Marana Water Department staff has negotiated a new billing rate for the upcoming year.

Pursuant to the proposed new amendment, which is attached as Exhibit A to the resolution accompanying these agenda materials, the rate will increase from $2.08 to $2.09 per month per customer account processed, and the Maximum Yearly Limit will increase from $100,000 to $102,000.00 annually. Under the proposed amendment, the IGA will be extended through November 30, 2025.

Financial Impact:

The revenue resulting from the amendment is included in the Water Department's revenue forecasting on an annual basis and helps toward the recovery of costs associated with the administration of the IGA terms.

Staff Recommendation:

Staff recommends adoption of Resolution No. 2024-102, approving and authorizing the Mayor to sign an amendment to the intergovernmental agreement, effective December 1, 2024, between the Town of Marana and Pima County for provision of water consumption data and sewer user account billing services.

Suggested Motion:

I move to adopt Resolution No. 2024-102, approving and authorizing the Mayor to sign an amendment to the Intergovernmental Agreement, effective December 1, 2024, between the Town of Marana and Pima County for provision of water consumption data and sewer user account billing services.

Attachments

Resolution No. 2024-102

Exhibit A to Resolution - IGA

MARANA RESOLUTION NO. 2024-102

RELATING TO UTILITIES; APPROVING AND AUTHORIZING THE MAYOR TO SIGN AN AMENDMENT TO THE INTERGOVERNMENTAL AGREEMENT, EFFECTIVE DECEMBER 1, 2024, BETWEEN THE TOWN OF MARANA AND PIMA COUNTY FOR PROVISION OF WATER CONSUMPTION DATA AND SEWER USER ACCOUNT BILLING SERVICES

WHEREAS Pima County operates and maintains a public sanitary sewerage system and is the designated public sewer system provider for the eastern and southern portions of the Town of Marana; and

WHEREAS the Town of Marana is the potable water provider for a portion of the area that receives sewer service from Pima County; and

WHEREAS on November 17, 2020, the Town Council approved Resolution No. 2020-121 authorizing the Town to enter into an intergovernmental agreement with Pima County, effective December 1, 2020 (the "IGA"), for the provision of water consumption data and sewer user account billing services; and

WHEREAS the IGA is effective for a two-year period with up to four optional, one-year extensions; and

WHEREAS the Town and the County exercised the first one-year extension, effective December 1, 2022, and amended the IGA to increase the monthly billing rate for the provision of water consumption data and sewer user account billing services; and

WHEREAS the Town and the County exercised the second one-year extension, effective December 1, 2023, and amended the IGA to increase the monthly billing rate for the provision of water consumption data and sewer user account billing services; and

WHEREAS the Town and the County are now desirous to exercise the third extension and amend the agreement to further increase the monthly billing rate for the provision of water consumption data and sewer user account billing services; and

WHEREAS the Mayor and Town Council find that entering into such an amendment is in the best interests of the Town and its citizens.

NOW, THEREFORE, BE IT RESOLVED BY THE MAYOR AND COUNCIL OF THE TOWN OF MARANA, ARIZONA, AS FOLLOWS:

SECTION 1. The amendment to the intergovernmental agreement between the Town of Marana and Pima County for provision of water consumption data and sewer user account billing services, substantially in the same form attached to and incorporated by this reference in this resolution as Exhibit A, is hereby approved and the Mayor is hereby authorized and directed to sign it for and on behalf of the Town of Marana.

SECTION 2. The Town's Manager and staff are hereby directed and authorized to undertake all other and further tasks required or beneficial to carry out the terms, obligations, and objectives of the intergovernmental agreement, as amended.

PASSED AND ADOPTED BY THE MAYOR AND COUNCIL OF THE TOWN OF MARANA, ARIZONA, this 19th day of November, 2024.

_____
Mayor Ed Honea

ATTEST:

_____
David L. Udall, Town Clerk

APPROVED AS TO FORM:

_____
Jane Fairall, Town Attorney

Pima County Department of Regional Wastewater Reclamation

Project: Billing and Collection Services

Contractor: Town of Marana

Contract No.: CT-WW-21-224

Contract Amendment No.: 3

Orig. Contract Term:	12/01/2020 – 11/30/2022	**Orig. Amount:**	$130,000.00
Termination Date Prior Amendment:	11/30/2024	**Prior Amendments Amount:**	$185,000.00
Termination Date This Amendment:	11/30/2025	**This Amendment Amount:**	$102,000.00
		Revised Total Amount:	$417,000.00

INTERGOVERNMENTAL AGREEMENT AMENDMENT

WHEREAS, Pima County ("County") and the Town of Marana ("Town") entered into an Intergovernmental Agreement ("IGA") on December 1, 2020 for services as referenced above; and

WHEREAS, County and Town, pursuant to Section 4, have agreed to extend the term of the IGA for the third of four one-year renewal periods, and

WHEREAS, County and Town have agreed to increase the total contract amount to allow County payment to Town for the continued provision of sewer billing and collection services to County during the extended term of the IGA.

NOW, THEREFORE, it is agreed as follows:

1) **Maximum Payment Amount.** Section 3 of the IGA is amended as follows:

   a) The County and Town agree to increase the monthly administration and billing fee, set forth in Section 3(a) and most recently amended in the Second Amendment, from $2.08 to $2.09 per customer per month for the purpose of reimbursing Town for the cost of billing and collection services.

   b) The maximum amount County will spend under this IGA, as set forth in Section 3(b), is increased by $102,000.00. County's total payments to Town under this IGA, including any sales taxes, will not exceed $417,000.00.

2) **Term.** County is exercising the third extension option to renew the contract for one additional year commencing on December 1, 2024, and terminating on November 30, 2025. If the commencement date is before the Effective Date of this amendment, the parties will, for all purposes, deem the amendment to have been in effect as of the commencement date.

3. **Counterparts.** This Agreement may be executed in counterparts, each of which when fully executed and delivered will constitute a duplicate original. All counterparts together shall constitute a single agreement.

All other provisions of the Contract not specifically changed by this Amendment remain in effect and are binding upon the parties.

PIMA COUNTY

Adelita S. Grijalva
Chair, Board of Supervisors

Date

ATTEST

Melissa Manriquez
Clerk of the Board

Date

Approval as to Content for PCRWRD

Jackson Jenkins, Director, RWRD

TOWN OF MARANA

Ed Honea
Mayor, Town of Marana

Date

ATTEST

David Udall
Town Clerk

Date

Approved as to Content for F&RMD

Director, F&RMD

Intergovernmental Agreement Determination

The foregoing Intergovernmental Agreement Amendment between Pima County and the Town of Marana has been reviewed by the undersigned, each of whom has determined that it is in proper form and is within the powers an authority granted under the laws of the State of Arizona to the party he or she represents:

PIMA COUNTY:

Bobby Yu, Deputy County Attorney

TOWN OF MARANA:

Jane Fairall, Town Attorney

Council-Regular Meeting **C3**

Meeting Date: 11/19/2024

To: Mayor and Council

Submitted For: Fausto Burruel, Public Works Director

From: Dan Grossman, CIP Process Analyst

Date: November 19, 2024

Strategic Plan Focus Area:
Not Applicable

Subject: Relating to Procurement; approving a change order to the contract with Dibble & Associates in the amount of $106,795.15 for the Airport Control Tower, EA (AP031); authorizing the transfer of appropriations if necessary for the change order; and authorizing the Town Manager or designee to execute the necessary documents to effectuate the change order (Fausto Burruel)

Discussion:

Marana Town Code Section 3-4-7(B)(3) provides that Town Council approval is necessary for change orders that individually or cumulatively exceed the amounts set forth in section 3-4-8(A)(3) of the town code.

The budget for fiscal year 2024-2025 was adopted on June 18, 2024, and included the Town's 5 year CIP program. The Airport Control Tower, Environmental Assessment (AP031) was properly included within the Town of Marana's FY2025 Capital Improvement Plan.

Effective April 11, 2023, the Town entered into an agreement with Dibble & Associates to prepare the necessary Planning and Environmental Documentation for a new Airport Traffic Control Tower at the Marana Regional Airport for $220,669.20.

Dibble & Associates has requested a change order, in the amount of $106,795.15 due to the following additional requirements and delays from the FAA:

- Staff changes at the FAA and protracted review periods of draft documents.

- The FAA Reauthorization Act of 2024 which requires additional environmental provisions that need to be considered in the final Environmental Assessment.
- Additional unforeseen consultation with the National Park Service related to potential visual impacts from the proposed Air Traffic Control Tower.
- The need for additional coordination meetings with the project team, the Town and FAA.

Financial Impact:

This change order will be funded with Airport Capital funding, GL Account # 52592000-8025-AP031. The majority of the funding will be provided by federal and state participation. Below is the breakout:

- FAA Portion - $97,248
- ADOT Portion - $4,774
- Town Portion - $4,774

Staff Recommendation:

Staff recommends approval of the change order to the Dibble & Associates General Services Agreement for the Airport Control Tower, EA (AP031) project in the amount of $106,795.15.

Suggested Motion:

I move to approve the change order to the contract with Dibble & Associates in the amount of $106,795.15 for the Airport Control Tower, EA (AP031) project; to authorize the transfer of appropriations if necessary for the change order; and to authorize the Town Manager or designee to execute the necessary documents to effectuate the change order.

Attachments

Dibble ATCT EA Amendment

TO Airport Planning & Enviromental Documentation

---

p 602.957.1155 | 7878 North 16th Street, Suite 300
Phoenix, AZ 85020
dibblecorp.com

October 7, 2024

Mr. Galen Beem, Airport Superintendent
Marana Regional Airport
11700 W. Avra Valley Road
Marana, AZ 85653

RE: GENERAL SERVICES AGREEMENT
AIRPORT PROFESSIONAL PLANNING SERVICES
Town of Marana Project No: AP031
Planning and Environmental Documentation
New Air Traffic Control Tower
Marana Regional Airport

Dear Mr. Beem:

Dibble entered into an agreement with the Town of Marana (Town) under and subject to the terms of the General Service Agreement, dated May 19, 2020 (the "Controlling GSA") to prepare the necessary environmental documentation to advance the construction of an Air Traffic Control Tower (ATCT) at the Marana Regional Airport (AVQ). The Town issued a notice to proceed on April 3, 2023 for this project and subsequent task order term extension (383 calendar days from date executed on November 27, 2023 to add time through December 14, 2024).

The Scope of Services for the environmental documentation was divided into two schedules – Schedule A and Schedule B. Schedule A included the necessary planning tasks associated with the documentation leading to a Federal Aviation Administration (FAA) Determination to Prepare an Environmental Assessment (EA) or Environmental Impact Statement (EIS). Schedule B included required tasks associated with the preparation of an EA.

The project has been unavoidably delayed for several reasons including the following:

- Staff changes at FAA and protracted review periods of draft documents.
- The FAA Reauthorization Act of 2024 includes environmental provisions that now need to be considered in the EA.
- Additional unforeseen consultation with the National Park Service (NPS) related to potential visual impacts from the proposed ATCT.
- The need for additional coordination meetings with the project team, the Town and FAA.

Therefore, Dibble has prepared an amendment related to the additional work associated with Schedule B for the completion of the ATCT EA.

Dibble's total Not-to-Exceed (NTE) fee per the attached scope of work is:

Planning & Environmental Services:

1. Dibble ……$22,440.00
2. Dibble (direct costs) ……$0.00
3. SWCA Environmental Consultants…….. $84,355.15

Total Fee = $106.795.15

We look forward to working with you on this important project. If you need additional information or have questions, please do not hesitate to call us at 602-957-1155.

Sincerely,

Charlie McDermott, LEED AP
Aviation Planning Manager, Airport Development

Ryan Toner, PE
Vice President,
Airport Development Practice

SCOPE OF WORK AMENDMENT

New Air Traffic Control Tower
Planning and Environmental Documentation

Marana Regional Airport

In April 2023, Dibble entered into an agreement with the Town of Marana (Sponsor) under and subject to the terms of the General Service Agreement, dated May 19, 2020 (the "Controlling GSA") to prepare the necessary environmental documentation to advance the construction of an Air Traffic Control Tower (ATCT) at the Marana Regional Airport (AVQ).

The Scope of Services for the environmental documentation was divided into two schedules – Schedule A and Schedule B. Schedule A included the necessary planning tasks associated with the documentation leading to a Federal Aviation Administration (FAA) Determination to Prepare an Environmental Assessment (EA) or Environmental Impact Statement (EIS). Schedule B included required tasks associated with the preparation of an EA.

In general, the project has been unavoidably delayed for several reasons including staff changes at FAA and protracted review periods of draft documents, the FAA Reauthorization Act of 2024 includes environmental provisions that need to be considered in the EA, additional unforeseen consultation with the National Park Service (NPS) related to potential visual impacts from the proposed ATCT and the need for additional coordination meetings with the project team, the Town and FAA.

Therefore, Dibble has prepared this scope of work amendment related to the additional work associated with Schedule B for the completion of the ATCT EA pursuant to the requirements of Section 102(2)(c) of the *National Environmental Policy Act* (NEPA) *of 1969* (Public Law 91- 190, 42 United States Code 4321 et. seq.) as outlined in 40 Code of Federal Regulations (CFR) 1500-1508.

Schedule B – Preparation of an Environmental Assessment

B1. General

B1.1a **Project Management and Administration:** Dibble will provide additional project management and administration as described in Task B1.1 from the original scope of work for the duration of the EA preparation. Also, the PM shall continue managing all schedules and budgets, including invoicing and maintaining internal Dibble project controls related to staffing, schedules, and budgets.

B1.2a **Project Meetings:** Dibble will facilitate the following meetings:

- Additional 6 weekly meetings with the project team and the Sponsor until the draft EA is submitted to FAA.
- Additional 12 monthly meetings with the project team and the Sponsor.
- Additional 12 monthly meetings with FAA, Sponsor and project team for the duration of the EA.

Meetings will be attended by Dibble's Project Manager and Environmental Planner. All meetings will be virtual and are planned to be no longer than one hour. Dibble will prepare and publish draft and final meeting minutes for all meetings.

Attachments

- SWCA Environmental Scope of Work dated October 1, 2024

END OF SCOPE OF WORK

Firm:	Dibble		Contract Number: AP031
	Marana Regional Airport		PO Number: 22300517-01
Project:	**Planning and Environmental Documentation**		
	ATCT EA Preparation		
	Schedule B Amendment		FAA Number: 3-04-0058-029-23
Date:	10/4/2024		ADOT Number: E4FSS01E

DIBBLE

Summary				Dibble	Subconsultants
A. Planning & Environmental Phase Services					
		Fee	**Type**		
1	Dibble	$22,440.00	Not to Exceed	$22,440.00	
2	Dibble (Direct Expenses)	$0.00	Direct Cost	$0.00	
3	SWCA Environmental Consultants	$84,355.15	Not to Exceed		$84,355.15
					$0.00
				Total	
	Total Fee	***$106,795.15***		***$22,440.00***	***$84,355.15***

Firm:	Dibble	Contract Number:	AP031
	Marana Regional Airport	PO Number:	22300517.01
Project:	**Planning and Environmental Documentation**		
	ATCT EA Preparation		
	Schedule B Amendment	FAA Number:	3-04-0058-029-23
Date:	10/4/2024	ADOT Number:	E4FSS01E

DERIVATION OF FEE PROPOSAL SUMMARY

	Classification	Total Labor Hours	2024 Billing Rates	Total Costs
1	Principal Engineer	2	$250.00	$500.00
2	Senior Project Manager	54	$230.00	$12,420.00
3	Senior Planner	0	$215.00	$0.00
4	Planner	56	$170.00	$9,520.00
	Totals:	**112**		**$22,440.00**

ALLOWANCE FOR DIRECT COSTS AND SUBCONSULTANTS

	Item	Cost	Type of Compensation
1	Direct Expenses ……	$0.00	Direct Cost
2	SWCA Environmental Consultants….....	$84,355.15	NTE

Sub-Total for Direct Costs..... **$84,355.15**

TOTAL FEE $106,795.15

Firm:	Dibble		Contract Number: AP031
	Marana Regional Airport		PO Number: 22300517-01
Project:	**Planning and Environmental Documentation**		
	ATCT EA Preparation		
	Schedule B Amendment		FAA Number: 3-04-0058-029-23
Date:	10/4/2024		ADOT Number: E4FSS01E

PLANNING AND ENVIRONMENTAL PHASE SERVICES - LABOR HOURS

	SCHEDULE B TASKS	PRINCIPAL ENGINEER	SENIOR PROJECT MANAGER	SENIOR PLANNER	PLANNER				TOTAL HOURS BY TASK
B.1 General									
B.1.1a	Project Management and Administration	2	24						26
B.1.2a	Project Meetings		30		48				78
B.2 Preliminary Engineering Support (25% Design)									
B.2.1	Preliminary Engineering Design (25%)								0
B.2.2	Construction Activity Estimates								0
B3 Study Components									
B.3.1	Project Description (Chapter One)								0
B.3.2	Alternatives (Chapter Two)								0
B.3.3	Affected Environment (Chapter Three)								0
B.3.4	Environmental Consequences and Mitigation, if Necessary (Chapter Four)								0
B4 Documentation									
B.4.1	Preliminary Draft EA								0
B.4.2	Revised Preliminary Draft EA								0
B.4.3	Draft EA								0
B.4.4	Draft and Final EA Notices								0
B.4.5	Response to Public Comments								0
B.4.6	Final EA								0
B5 Public Outreach									
B.5.1	Public Workshop/Hearing				8				8
B6 Preparation of the Administrative Record									
B.6.1	Preparation of Administrative Record								0
	TOTAL HOURS BY CLASSIFICATION	2	54	0	56				112

SWCA®
ENVIRONMENTAL CONSULTANTS
Sound Science. Creative Solutions.®

343 West Franklin Street
Tucson, Arizona 85701
Tel 520.325.9194 Fax 520.325.2033
www.swca.com

October 1, 2024

Charlie McDermott, Aviation Planning Manager
Dibble
7878 North 16th Street, Suite 300
Phoenix, Arizona 85020-4669
Submitted via email: charlie.mcdermott@dibblecorp.com

Re: Marana Regional Airport (AVQ) Air Traffic Control Tower Environmental Assessment / 00065213-000-TUC

Dear Charlie McDermott:

The Town of Marana requested that SWCA Environmental Consultants (SWCA) prepare a scope of work and cost estimate modification to continue the necessary National Environmental Policy Act (NEPA) and associated resources analyses for the Marana Regional Airport (AVQ) Air Traffic Control Tower Environmental Assessment. Beginning in May 2023 through the present, the Federal Aviation Administration (FAA), Phoenix Airports District Office has required additional services beyond our original scope of work, including preparation of a built environment report and additional cultural resources surveys, additional visual resources and simulation development and consultation, Section 4(f) National Park Service coordination, and meetings not previously covered by the March 17, 2023 Independent Consultant Agreement (ICA).

The cost to complete these tasks, as described in the attached scope of work, is a time and materials, not-to-exceed total of $84,355.15. This scope of work includes updated, 2024 staff rates, The cost estimate is valid for 6 months, after which time we reserve the right to create a new cost estimate. Dibble has prepared a Master Scope of Work that outlines project approach to NEPA analysis. This SWCA scope of work relies on the information and assumptions provided in the Dibble Master Scope of Work. Information provided in the attached scope of work is intended to supplement Dibble's Master Scope of Work and provide additional level of detail and assumptions, as necessary, for tasks that will be managed by SWCA as a subconsultant to Dibble.

If the scope of work and cost estimate are acceptable to you, please send over Dibble's ICA. We will then return a signed ICA. Please contact me at (520) 402-4127 or theresa.knoblock@swca.com if you have any questions regarding this proposal.

Sincerely,

Theresa Knoblock
Tucson Senior Office Lead

SCOPE OF WORK

This change order has been issued by SWCA Environmental Consultants (SWCA) to reflect changes in the schedule, timing, and staging of deliverables, and requests for additional services outside the original Scope of Work for the Marana Regional Airport (AVQ) Air Traffic Control Tower Environmental Assessment project in Pima County, Arizona. Beginning in May 2023 through the present, the Federal Aviation Administration (FAA), Phoenix Airports District Office (ADO) has required additional services beyond our original scope of work, including preparation of a built environment report and additional cultural resources surveys, additional visual resources and simulation development and consultation, Section 4(f) National Park Service coordination, and meeting coordination amongst the FAA, National Park Service, the Town of Marana (Town), Dibble, and SWCA not previously covered by the March 17, 2023 Independent Consultant Agreement (ICA).

SWCA recommended the Town and Dibble support and fulfill these FAA requirements and received approval prior to undertaking our of scope work. Those requirements resulted in substantial research, coordination, and development of FAA materials by the SWCA Project Manager and specialists, as outlined below.

SCHEDULE A – PLANNING DOCUMENTATION FOR FAA DETERMINATION

All work outlined in SWCA's January 6, 2023, scope of work under Schedule A have been completed. An additional level of effort was required to complete Schedule A due to schedule extension, changes in FAA personnel, and project description changes. No additional scope is being requested; however, remaining budget from the Task B.2.1 was shifted to cover out-of-scope effort.

SCHEDULE B – PREPARATION OF AN ENVIRONMENTAL ASSESSMENT

TASK B.1.1 PROJECT MANAGEMENT

This task provides time for SWCA staff to manage the project, e.g., scheduling, regulatory guidance, project administration, and overall project management and included approximately 1 hour per month for the SWCA Project Manager (PM). This task assumed a project timeline of approximately 12 months. The project was contracted in March 2023, with work beginning in May 2023 and is anticipated to be completed in approximately July 2025, for a total of 27 months.

This change order requests an additional 24 hours of PM support, 22 hours of Assistant Project Manager (APM) support, and 8 hours of Project Control and billing support over 15 months. This estimate reflects actual levels of effort being expended per month for project management and coordination.

TASK B.1.2 PROJECT MEETINGS

The project was anticipated to occur over 12 months and the project management assumptions included 1-hour virtual project meetings facilitated by Dibble and attended by the SWCA PM every 2 weeks during the Schedule B

timeframe (estimated at 4 months), for a total of eight meetings and a budget of up to 26 staff-hours (APM/PM level) of meeting support. To date, SWCA has participated in eight meetings for which SWCA prepared agendas, facilitated the meetings, and prepared meeting notes. Please note that resource-specific meetings, such as separate meetings to address comments from the National Park Service or work out project details for the Built Environment report, are included in the resource-specific budgets below. Meetings were generally attended by additional SWCA staff to accommodate resource-specific questions.

This change order would cover up to 12 additional meetings from October 2024 through July 2025, as well as covering the additional staff hours in support of project meetings that have already occurred. This change order assumes that all meetings during Schedule B will be attended by up to two SWCA staff, generally the PM and APM. The total number of hours requested in this change order is 44 hours for SWCA staff in Senior Resource or project management roles.

TASK B.1.3 STUDY COMPONENTS (ENVIRONMENTAL ASSESSMENT)

The FAA authorized the project team to initiate formal preparation of the environmental assessment (EA) on September 16, 2024. The original scope of work assumed that notice-to-proceed on the full scope of Schedule B, including initiation of the EA documentation, would be released at once; however, the FAA requested that specific resource documents and sections be initiated ahead of preparation of the full EA including the biological, visual, and cultural resources analyses. The following additional out-of-scope items are included in this change order:

- The FAA requested early preparation and revisions of stand-alone versions of the Project Description and Purpose and Need, as well as a table of “Issues to be considered or dismissed from further analysis” table, and an outline of the EA prior to submittal of the full PDEA. SWCA has completed preparation and revisions of these documents.
- The FAA has provided input on their review process and timing for subsequent drafts and revisions of the EA, including preparation of the following documents and FAA reviews: Preliminary Draft EA (one FAA ADO review), Draft EA (one FAA ADO review then one ADO/FAA legal review), and Final EA (one FAA ADO review and one ADO/FAA legal review), for a total of three documents and five rounds of review.
- FAA also requested public comments be submitted as soon as received, in addition to the final comment summary. SWCA will coordinate with the Town and FAA on responses as needed.
- The Town and FAA requested preparation of Section 4(f) analysis, coordination letters, response to National Park Service comments, and a site visit that were not included in the original scope of work.

SWCA is requesting additional budget to cover this level of effort to split up document deliverables, edits, and revisions into specific sections rather than initiating the document as a whole. SWCA has considered the input regarding number and timing of reviews in our estimate. An additional 143 total labor hours are being requested at various staff rates from junior staff up to project manager. Remaining budget will be applied to this task as well.

TASK B.2.1 BIOLOGICAL RESOURCES

The biological resources evaluation is complete and accepted by the FAA. No further work is necessary for completion of the EA. Remaining budget will be reallocated to cover other services.

TASK B.2.2 CULTURAL RESOURCES

The cultural resources evaluation and Section 106 has been completed for this project and no further work is necessary for completion of the EA. However, additional services beyond the original scope of work were requested to complete Section 106, including:

- Preparation of new Class III surveys and report to cover unsurveyed areas with the area of potential effects (APE).
- Preparation of a Built Environment report.
- Preparation of Class I tables and figures to support an expanded area of analysis (3-mile viewshed APE)
- Conducting an in-person Arizona State Museum Archaeological Records Office search of the expanded 3-mile viewshed APE.
- Preparation of a cultural memorandum to support the geotechnical clearance.
- Attendance at additional project coordination meetings with the FAA and project team.

TASK B.2.3 VISUAL RESOURCES

The visual resources analysis has been completed for this project and accepted by the FAA. No further work is necessary for completion of the EA. However, additional services beyond the original scope of work were requested to complete the visual resources analysis, including:

- Attendance at meetings to coordinate with Genesis and Dibble regarding project information and data collection.
- Fieldwork and documentation to collect day and night photography for the visual simulations.
- Changes in the project description following preparation of the initial document (addition of new area related to removal of existing beacon and placement of utilities).
- Support responding to National Park Service concerns related to visual impact to potential viewers using the Santa Cruz River Trail, including staff preparation, travel, and attendance at a site visit on July 24, 2024, with the FAA and Town to collect additional data and then prepare summary findings.
- SWCA will coordinate and attend 1 follow up meeting with NPS, the Town and Dibble to discuss the proposed signage.

TASK B5 PUBLIC OUTREACH

No additional scope is requested.

TASK B6 PREPARATION OF THE ADMINISTRATIVE RECORD

No additional scope is requested.

COST ESTIMATE

Based on thoughtful consideration of the project requirements and a thorough estimate of the required labor and direct costs, SWCA proposes a time-and-materials budget not to exceed without client approval of **$84,355.15** to complete the project as presented in the table below.

To accommodate project changes and scheduling, it is assumed that SWCA will be able to use the overall project funding and will not be held to phase and task limits so long as the overall budget is not exceeded.

Table 1. Cost Estimate

TASK	LABOR $	EXPENSES $	FEE TYPE TOTAL $
Schedule A Planning Documentation for FAA Determination			
Tasks A3, A4, A5.4 SWCA Assistance on Schedule A tasks	--	--	--
Schedule B Preparation of an Environmental Assessment			
Task B.1.1 Project Management	10,382.00		10,382.00
Task B.1.2 Project Meetings	8,236.00		8,236.00
Task B.1.3 Study Components (EA)	17,294.00		17,294.00
Task B.2.1 Biological Resources	--	--	--
Task B.2.2 Cultural Resources	28,787.00	632.50	29,419.50
Task B.2.3 Visual Resources	16,964.00	1,208.65	18,172.65
Task B5 Public Outreach			
Task B6 Administrative Record			
PROJECT TOTAL	**82,514.00**	**1,841.15**	**84,355.15**

ASSUMPTIONS

- The EA will be completed by July 2025, and document deliverables will approximately follow the timeframes outlined in the schedule reviewed by the FAA dated September 9, 2024, with an EA initiation date of September 16, 2024.
- Dibble will assist SWCA in preparation of the climate change and floodplains analysis.
- No additional revisions to the biological, visual, and cultural resources reports will be required.
- No substantial changes in the project description will be made, particularly revisions that expand the project footprint.
- SWCA will prepare a draft decision document (FONSI or appropriate document) for FAA use and submit along with the review copy of the Final EA.

Rate Schedule: **2024 Rates**

Project Budget Summary

Project Name:	Marana Airport ATCT EA
Project No.:	61913-00-TUC
Annual Rate Escalation:	0%
Project Start (est.):	[Enter Date Here]
Project End (est.):	[Enter Date Here]

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for internal reference and are outside of the print area for pr

					Totals					Phase 03		Phase 06		Phase 07	
					Total All Phases					**FAA EA**		**Cultural**		**Visual**	
LABOR															
Name	Discipline Short	Level Short	Discipline	Level	Rate	Hours	Charge	% of Total Project	% of Labor Hrs	% of Lbr Charge	Hours	Charge	Hours	Charge	Hours	Charge
					$ -	-	$ -	0.0%	0.0%	0.0%	-	$ -	-	$ -	-	$ -
					$ -	-	$ -	0.0%	0.0%	0.0%	-	$ -	-	$ -	-	$ -
General Biller			Accounting - Billing		$ 95.00	8.00	$ 760.00	0.9%	1.7%	0.9%	2.00	$ 190.00	4.00	$ 380.00	2.00	$ 190.00
McFarlane, Genelyn	PC	S06	Project Controls	Specialist VI	$ 137.00	6.00	$ 822.00	1.0%	1.3%	1.0%	6.00	$ 822.00	-	$ -	-	$ -
Amato, Victoria	ER	S12	Environmental Resources	Specialist XII	$ 226.00	-	$ -	0.0%	0.0%	0.0%	-	$ -	-	$ -	-	$ -
Knoblock, Theresa	PL	S10	Planning	Specialist X	$ 189.00	83.00	$ 15,687.00	18.6%	17.4%	19.0%	57.00	$ 10,773.00	16.00	$ 3,024.00	10.00	$ 1,890.00
Rausch, Ryan	PL	S10	Planning	Specialist X	$ 189.00	46.00	$ 8,694.00	10.3%	9.6%	10.5%	46.00	$ 8,694.00	-	$ -	-	$ -
Campbell, Stacy	ER	S07	Environmental Resources	Specialist VII	$ 147.00	2.00	$ 294.00	0.3%	0.4%	0.4%	2.00	$ 294.00	-	$ -	-	$ -
Hergenrother, Robert	ER	S05	Environmental Resources	Specialist V	$ 123.00	-	$ -	0.0%	0.0%	0.0%	-	$ -	-	$ -	-	$ -
Mitchell, Lara	GS	S06	GIS/CADD	Specialist VI	$ 137.00	7.00	$ 959.00	1.1%	1.5%	1.2%	7.00	$ 959.00	-	$ -	-	$ -
Cox, Kelley	TW	S06	Technical Writer/Editor	Specialist VI	$ 137.00	8.00	$ 1,096.00	1.3%	1.7%	1.3%	8.00	$ 1,096.00	-	$ -	-	$ -
Mabe, Cari	TW	S08	Technical Writer/Editor	Specialist VIII	$ 158.00	8.00	$ 1,264.00	1.5%	1.7%	1.5%	8.00	$ 1,264.00	-	$ -	-	$ -
Desruisseaux, Danielle	TW	S09	Technical Writer/Editor	Specialist IX	$ 169.00	20.00	$ 3,380.00	4.0%	4.2%	4.1%	20.00	$ 3,380.00	-	$ -	-	$ -
Jordan, Tim	ER	S07	Environmental Resources	Specialist VII	$ 147.00	20.00	$ 2,940.00	3.5%	4.2%	3.6%	20.00	$ 2,940.00	-	$ -	-	$ -
Barr, David	CR	S09	Cultural Resources	Specialist IX	$ 169.00	51.00	$ 8,619.00	10.2%	10.7%	10.4%	-	$ -	51.00	$ 8,619.00	-	$ -
Lutes, Annie	CR	S09	Cultural Resources	Specialist IX	$ 169.00	70.00	$ 11,830.00	14.0%	14.7%	14.3%	10.00	$ 1,690.00	60.00	$ 10,140.00	-	$ -
Rawson, Paul	CR	S07	Cultural Resources	Specialist VII	$ 147.00	-	$ -	0.0%	0.0%	0.0%	-	$ -	-	$ -	-	$ -
Herrick, Dan	CR	S11	Cultural Resources	Specialist XI	$ 207.00	-	$ -	0.0%	0.0%	0.0%	-	$ -	-	$ -	-	$ -
Tremblay, Adrienne	CR	S10	Cultural Resources	Specialist X	$ 189.00	1.00	$ 189.00	0.2%	0.2%	0.2%	1.00	$ 189.00	-	$ -	-	$ -
Dunno, Glenn	GS	S11	GIS/CADD	Specialist XI	$ 207.00	36.00	$ 7,452.00	8.8%	7.5%	9.0%	4.00	$ 828.00	32.00	$ 6,624.00	-	$ -
					$ -	-	$ -	0.0%	0.0%	0.0%	-	$ -	-	$ -	-	$ -
Chapman, Cullen	PL	S10	Planning	Specialist X	$ 189.00	47.00	$ 8,883.00	10.5%	9.9%	10.8%	3.00	$ 567.00	-	$ -	44.00	$ 8,316.00
Branch, Spenser	PL	S07	Planning	Specialist VII	$ 147.00	4.00	$ 588.00	0.7%	0.8%	0.7%	-	$ -	-	$ -	4.00	$ 588.00
Bockey, Chris	PL	SM1	Planning	Subject Matter Expert I	$ 230.00	29.00	$ 6,670.00	7.9%	6.1%	8.1%	3.00	$ 690.00	-	$ -	26.00	$ 5,980.00
Openshaw, Garet	PL	S06	Planning	Specialist VI	$ 137.00	-	$ -	0.0%	0.0%	0.0%	-	$ -	-	$ -	-	$ -
Respall, Aramis	GS	S09	GIS/CADD	Specialist IX	$ 169.00	-	$ -	0.0%	0.0%	0.0%	-	$ -	-	$ -	-	$ -
Sawyer, Bryan	PL	S06	Planning	Specialist VI	$ 137.00	-	$ -	0.0%	0.0%	0.0%	-	$ -	-	$ -	-	$ -
					$ -	-	$ -	0.0%	0.0%	0.0%	-	$ -	-	$ -	-	$ -
					$ -	-	$ -	0.0%	0.0%	0.0%	-	$ -	-	$ -	-	$ -
Sangerman, Drew	PL	S01	Planning	Specialist I	$ 77.00	31.00	$ 2,387.00	2.8%	6.5%	2.9%	31.00	$ 2,387.00	-	$ -	-	$ -
					$ -	-	$ -	0.0%	0.0%	0.0%	-	$ -	-	$ -	-	$ -
			Labor Subtotal			477.00	$ 82,514.00	97.8%	100.0%		228.00	$ 36,763.00	163.00	$ 28,787.00	86.00	$ 16,964.00
			Communication Fee - % of Labor		0%		$ -	*0.0%*				$ -		$ -		$ -
			Labor Total			477.00	$ 82,514.00	97.8%			228.00	$ 36,763.00	163.00	$ 28,787.00	86.00	$ 16,964.00
TRAVEL EXPENSES															
			Description	Unit	Rate	# Units	Charge	% of Total Project			# Units	Charge	# Units	Charge	# Units	Charge
			Car / Full Size Truck Rental Daily	*Per Day*	70.00	1.00	$ 70.00	0.1%			-	$ -	-	$ -	1.00	$ 70.00
			Car / Full Size Truck Rental Weekly	*Per Week*	420.00	-	$ -	0.0%			-	$ -	-	$ -	-	$ -
			Car / Full Size Truck Rental Monthly	*Monthly*	1,680.00	-	$ -	0.0%			-	$ -	-	$ -	-	$ -
			4x4 Truck Daily	*Half Ton, Per Day*	75.00	2.00	$ 150.00	0.2%			-	$ -	2.00	$ 150.00	-	$ -
			Lodging/Housing	*Per Day*	200.00	1.00	$ 200.00	0.2%			-	$ -	-	$ -	1.00	$ 200.00
			Mileage	*Per Mile*	$ 0.625	-	$ -	0.0%			-	$ -	-	$ -	-	$ -
			Airfare	*Rate / Unit or Lump Sum*	$ 781.00	1.00	$ 781.00	0.9%			-	$ -	-	$ -	1.00	$ 781.00
			Travel Expenses Subtotal				$ 1,201.00	1.4%				$ -		$ 150.00		$ 1,051.00
			Markup		*15%*		*$ 180.15*	*0.2%*				$ -		$ 22.50		$ 157.65
			Per Diem	*per day*	$ 59.00	-	$ -	0.0%			-	$ -	-	$ -	-	$ -
			Travel Expenses Total				$ 1,381.15	1.6%				$ -		$ 172.50		$ 1,208.65
OTHER EXPENSES															
			Description	Unit	Rate	# Units	Charge	% of Total Project			# Units	Charge	# Units	Charge	# Units	Charge
			Permits	*Rate / Unit or Lump Sum*	$ 400.00	1.00	$ 400.00	0.5%			-	$ -	1.00	$ 400.00	-	$ -
			Postage	*Rate / Unit or Lump Sum*	$ -	-	$ -	0.0%			-	$ -	-	$ -	-	$ -
			Markup		*15%*		*$ 60.00*	*0.1%*				$ -		$ 60.00		$ -
			Other Expenses Total				$ 460.00	0.5%				$ -		$ 460.00		$ -
			TOTAL EXPENSES				$ 1,841.15	2.2%				$ -		$ 632.50		$ 1,208.65
			Subcontractor Fee Total				$ -	0.0%				$ -		$ -		$ -
			Project Phase Total				**$ 84,355.15**					**$ 36,763.00**		**$ 29,419.50**		**$ 18,172.65**

Note: Communication expense is not subject to 15% administrative fee.

TOTAL PROJECT	Charges
SWCA Labor Total	$ 82,514.00
Expenses Total	$ 1,841.15
Subcontractors Total	$ -
Total Project	$ 84,355.15
Tax Total	$ -
Total Including Taxes	$ 84,355.15

MARANA AZ
FINANCE

TASK ORDER

PROJECT NO.: AP031

PSA NO.: General Service Agreement

PROJECT DESCRIPTION: Planning & Environmental Documentation

REQUESTED BY: Greg Sendlak, Project Manager

ARTICLE 1. BACKGROUND

This Task Order is issued by the TOWN OF MARANA (the "Town") to DIBBLE ENGINEERING, INC. (the "Consultant") under and subject to the terms of the General Service Agreement, dated May 19, 2020 (the "Controlling GSA"). Terms used in this Task Order shall have the meanings set forth in the Controlling GSA.

ARTICLE 2. SCOPE

The Consultant will provide the following services, as detailed in Exhibit A attached to this Task Order and incorporated by reference here:

Dibble's January 16, 2023 proposal and Dibble's September 12, 2022 proposal

ARTICLE 3. SCHEDULE

Upon the Town's issuance of a Purchase Order, the Consultant shall complete the services described in Article 2 above, except as adjusted by one or more fully executed contract change orders or supplemental agreements.

ARTICLE 4. PAYMENT

4.01. In consideration of the performance of the services described in this Task Order, the Town shall pay the Consultant a maximum, not-to-exceed fee of $220,669.20 which shall constitute full and complete payment for all services required and rendered as described in Article 2 above, except as adjusted by one or more fully executed contract change orders or supplemental agreements.

4.02. The Consultant shall submit monthly invoices and other documentation in compliance with Article 6 of the Controlling GSA.

4.03. The Town shall make payments to the Consultant in compliance with Article 6 of the Controlling GSA.

ARTICLE 5. TERM

5.01 This Task Order shall be effective upon the Town's execution of this Task Order and shall continue in full force for a period of 244 calendar days unless terminated earlier in accordance with the Controlling PSA.

5.02 This Task Order shall serve as the Notice to Proceed to the Consultant effective April 3, 2023.

IN WITNESS WHEREOF, the Parties have executed this Task Order as of the dates written hereinbelow.

The "Town":

THE TOWN OF MARANA,
an Arizona municipal corporation

Yiannis Kalaitzidis
Finance and Purchasing Director
As "Town Representative" under the Controlling GSA

4/11/23
Date

The "Consultant":

DIBBLE ENGINEERING, INC.
an Arizona corporation

Ryan Toner, P.E.
Vice President

04/03/2023
Date

Exhibit A
Consultant's May 8, 2020 Proposal

[Scope of Work and Consultant's Proposal Following]

MARANA AZ

MARANA AZ
PUBLIC WORKS
By: Greg Adlish Date: 3/17/23

Capital Improvement Program
☒ No Exceptions Taken
☐ Accepted as Noted
☐ Revised and Resubmit
☐ Not Accepted

DIBBLE

SCOPE OF WORK

New Air Traffic Control Tower
Planning and Environmental Documentation
Marana Regional Airport

Dibble has been requested by the Town of Marana (Town) to prepare the necessary Planning and Environmental Documentation for a new Airport Traffic Control Tower (ATCT) at the Marana Regional Airport (Airport or AVQ) Marana, Arizona.

The Airport was accepted into the FAA Federal Contract Tower (FCT) in 2019 with a Benefit/Cost Ratio of 3.41 according to the Safety Risk Management Document, *New Airport Traffic Control Tower Siting Report* (*Siting Report)* prepared by AJT Engineering, Inc. dated October 25, 2022.

According to the *Siting Report*, the average daily operations count at AVQ is 247 based on 2020 data and includes 33% local GA, 34% itinerant GA, 22% military and 11% air taxi. Tenants include flight schools, maintenance, and avionics facilities. There are approximately 273 based aircraft including corporate jets, rotary wing, and single engine airplanes. There is an active skydiving company and military skydiving training throughout the year. Several large events draw many large corporate jets for several days. The 90,000 operations including 30,000 itinerant, diverse mix of traffic and events which justify the need for this airport to have controlled airspace.

This Scope of Services includes the necessary planning and environmental documentation to fully evaluate applicable environmental impact categories and prepare an Environmental Assessment (EA) pursuant to the requirements of Section 102(2)(c) of the *National Environmental Policy Act* (NEPA) *of 1969* (Public Law 91-190, 42 United States Code 4321 et. seq.) as outlined in 40 Code of Federal Regulations (CFR) 1500-1508. The preparation of an Environmental Impact Statement (EIS), should it prove necessary, is not included in this Scope of Services.

Since the Federal Aviation Administration (FAA), through its Phoenix Airports District Office (ADO), will serve as Lead Agency in the NEPA process for airport actions, the format and subject matter included within the EA will conform to the requirements and standards set forth by FAA. These are contained principally in FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures* and Order 5050.48, *National Environmental Policy Act (NEPA) Implementing Instructions for Airport Action.* In addition, the U.S. Department of Transportation

(DOT) *Interim Policy on Page Limits for NEPA Documents and Focused Analyses* (2019) will be followed with regard to EA page limits.

This Scope of Services assumes that one of the sites already considered in the approved *Siting Report* dated October 25, 2022, will be selected as the preferred site and that the *Siting Report* will provide the majority of the information necessary for incorporation into the EA, as appropriate.

This Scope of Services has been divided into two schedules – Schedule A and Schedule B. Schedule A includes the necessary planning tasks associated with the documentation leading to a FAA Determination to Prepare an EA or EIS. Schedule B includes required tasks associated with the preparation of an EA.

Schedule A – Planning Documentation for FAA Determination

A1. General

A1.1. **Project Management and Administration:** Dibble will provide project management and coordination of the planning team. This task also includes providing coordination between planning team members, the Town, Airport, FAA, and other interested stakeholders. Administration tasks such as internal project meetings, file coordination, and invoicing are also included as part of this task.

A1.2. **Project Meetings:** This task includes both internal and external project team meetings throughout Schedule A timeline. Dibble will facilitate virtual calls every two weeks, or as needed, with the project team to address questions and measure progress. Dibble will facilitate monthly calls with the Town and the FAA to report progress and address questions and/or comments. All meetings will be virtual and are planned to be no longer than one hour. Dibble will maintain a general summary of topics discussed.

A2. Section 163 Review

A2.1. **Section 163 Preparation and Submittal:** This task will identify the FAA action and confirm FAA authority for the proposed study. Dibble will prepare and submit to the FAA a formal Section 163 Determination request for the proposed study based on preliminary findings contained in the approved *Siting Report,* dated October 25, 2022.

A3. Identification of Connected Federal Actions

This task will identify any connected federal actions associated with the proposed study, especially those that may require other federal agency permits or approvals, including other FAA lines-of-business.

A3.1. **Identify Connected Federal Actions:** SWCA/Dibble will prepare a list of federal agency actions required for the proposed study to proceed. Additionally, a working list of past executed, presently planned, and future planned (five-year period) projects within the study area will be prepared and

referenced for dependence on the Proposed Action; this will later be used in the cumulative analysis during the preparation of the EA (or EIS).

A4. Identification of Lead, Cooperating, and Participating Agencies

A4.1. **Preparation of Working List:** SWCA/Dibble will prepare a working list of entities for agency scoping, including Indian tribes, and identify each agency's role in the proposed study.

A5. Preparation of Preliminary Study Components

This task includes the creation and documentation of several preliminary study components. These tasks will be completed concurrently and submitted together as one deliverable.

A5.1. **Purpose and Need Statement:** Dibble will prepare a preliminary Purpose and Need Statement for the proposed study. The Statement will be provided to both the FAA and the Town, in addition to other agencies identified as a part of the study if applicable.

A5.2. **Project Description:** Dibble will prepare a preliminary project description. Specific details related to the ultimate construction of the ATCT such as temporary use areas, airfield closures, staging areas, access roads, to name a few, will be included as a part of the description.

A5.3. **Alternatives Description:** Dibble will summarize the alternatives as found in the approved *Siting Report* dated October 25, 2022. This includes a discussion on the alternatives that were dismissed, those that were considered by the sponsor but rejected, and those that will be carried forward for this study's analysis.

A5.4. **Identification of Potentially Significant Environmental Issues:** SWCA will lead this task which is comprised of two components. The environmental impact categories as found in FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures* will be reviewed to identify 1) the categories that are not likely to have a significant impact on the proposed project, and 2) the categories that may have an impact on the proposed project and/or those that are viewed as the most important to the public and the sponsor for further investigation.

A5.4.1. **Screening of Environmental Resources Likely Impacted:** For the environmental categories with the potential to be impacted, SWCA will conduct an initial screening, either through desktop reviews and/or field assessments, to prepare a list of data gaps (See SWCA SOW, A5.4.1). This task also includes commencing the Special Purpose Law review process, Section 106 consultation (if needed) with State or Tribal Historic Preservation Officers (and other consulting parties such as certified local governments and Indian tribes), and Section 7 consultation (if needed) with the U.S. Fish and Wildlife Service. Any other technical assessments should also be started during this task.

A5.4.2. **Preparation of Treatment Measures Working List:** In addition to Task A5.4.1, SWCA will prepare a working list of treatment measures. The list should identify implementation, oversight,

and schedule of each measure, which treatment measures would avoid or minimize impacts and those that would mitigate impacts below a significance threshold.

A6. Schedule Preparation

This timeline is associated with Schedule A tasks only.

A6.1. **Prepare Schedule:** Dibble will create a schedule with milestones and tasks assigned to each entity (Town, FAA, Dibble, agencies). The schedule will also identify any assumptions associated with each task and identify key completion points for consultations and technical assessments.

A7. Preliminary Public Outreach Plan

A7.1. **Public Outreach Pre-planning:** Dibble will begin the pre-planning for the public outreach component. Dibble will consult and coordinate with the Town to determine where key documents will be made available to the public and recommend the length of public comment periods. The outcome of this task will be carried for in future tasks related to the implementation of the public outreach program.

A8. Summary of Planning Tasks

A8.1. Dibble will prepare a draft Summary of Planning Tasks Report identified herein for review by the Town and FAA. Dibble will facilitate one virtual meeting to review comments and questions received. Dibble will incorporate comments and prepare a final Summary of Planning Tasks Report for use by the FAA in making the official determination.

The estimated schedule of completion for the Consultant team to complete Schedule A tasks is ***two months*** excluding FAA review and outside agency consultation. An additional two – four months for outside agency consultation and review may be anticipated in the overall Schedule A timeframe.

FAA Determination

Based on the thoroughness and completeness of the planning and documentation tasks described in Schedule A, the FAA will make an official Determination to Prepare an EA (or EIS) for the proposed ATCT at AVQ. If the proposed project meets the inclusion criteria, the project and its associated milestones will be added into the Transportation Planning Dashboard.

EA Determination: Subsequent to the FAA's determination, the Town will authorize Dibble to prepare an EA in accordance with Schedule B.

EIS Determination: Subsequent to the FAA's determination, the Town will work with FAA directly and inform Dibble if additional services will be required. This scope of services does not include the preparation of an EIS.

Schedule B – Preparation of an Environmental Assessment

B1. General

B1.1 **Project Management and Administration:** Dibble will designate a Project Manager (PM) to act as the Town's representative for the EA. In conjunction with the Town, the PM will have the authority to transmit instructions, receive information, interpret, and define the Town's policies and decisions with respect to Dibble's services for the study/project. In addition, the PM shall manage contract/subcontract preparations, negotiations, and execution. Also, the PM shall manage all schedules and budgets, including invoicing and maintaining internal Dibble project controls related to staffing, schedules, and budgets. Lastly, Dibble shall implement a client communication process that involves ongoing email and phone calls during the duration of the EA.

B1.2 **Project Meetings:** This task includes both internal and external project team meetings throughout Schedule B timeline. Dibble will facilitate virtual calls every two weeks with the project team to address questions and measure progress. Dibble will facilitate monthly calls with the Town and FAA to report progress and address questions or comments. All meetings will be virtual and are planned to be no longer than one hour. Dibble will maintain a general summary of topics discussed.

B2. Preliminary Engineering Support (25% Design) and Construction Activity Estimates

B2.1 **Preliminary Engineering Design (25%):** The Town will provide Dibble with the necessary preliminary engineering support for the project which will focus on identifying potential design challenges, addressing environmental concerns, and establishing/refining preliminary quantities related to the following project tasks:

- Preliminary layout of the ATCT
- Project limits of construction/disturbance
- Borrow/stockpile areas, staging areas, and haul routes
- Storm drain improvements
- Vehicular access road and parking improvements
- Utility improvements (all)
- Preliminary construction schedule

Note: Dibble will perform a cursory review of the preliminary engineering for completeness only.

B2.2 **Construction Activity Estimates:** The Town will also provide Dibble with the necessary estimates of construction activity and duration.

Note: Dibble will perform a cursory review of the construction activity estimates for completeness only.

B3. Study Components

This task includes the components that will ultimately make up the Draft and Final EA for the ATCT at AVQ. These tasks will primarily be prepared by SWCA (see attached Scope of Work), with Dibble's oversight, coordination, and review.

B3.1 **Project Description (Chapter One):** Chapter One of the EA will include the following introductory sections of the EA: an introduction to NEPA and the EA process; background information on the airport; the Purpose and Need Statement (Task A5.1), a description of the Proposed Action; requested federal actions; and the EA document organization. The Project Description will be based on the preliminary engineering completed in Task B2.1 and will include a discussion of construction activity and project ground disturbances, in particular as it relates to the foundation. Although the project (i.e., an ATCT) is likely to be one that would be under FAA jurisdiction for approval per Section 163 of the *FAA Reauthorization Act of 2018,* if the results of FAA's Section 163 determination indicate that portions of the project are not subject to FAA approval actions, then the project description will distinguish between those portions of the project that are part of the federal Proposed Action from those portions of the project that are not part of the federal Proposed Action for purposes of the analysis.

B3.2 **Alternatives (Chapter Two):** Chapter Two of the EA will document the proposed ATCT's site selection process. It is assumed potential locations for the ATCT will have been vetted through the *Siting Report*. Using the *Siting Report* as a starting point for the analysis, the alternative sites will be compared against alternatives selection criteria to determine which sites are reasonable and feasible. All alternative sites meeting both the EA's reasonable and feasible criteria will be retained for further consideration in the analysis. As stated in FAA Order 5050.48, paragraph 706 (d)(7), an alternative can be eliminated from further consideration when the alternative has been judged "not reasonable." Whether a proposed alternative is reasonable depends, in large part, upon the extent to which it meets the purpose and need for the Proposed Action (FAA Order 1050.1F, paragraph 7-1.1[e]). FAA Orders 1050.1F and 5050.4B also state that "an EA may limit the range of alternatives to the proposed action and no action when there are no unresolved conflicts concerning alternative uses of available resources (FAA Order 1050.1F, para. 6-2.1[d]; FAA Order 5050.4B, para. 706[d][5]). 40 C.F.R. 1502.14(c) requires the evaluation of the No Action alternative regardless of whether it meets the stated purpose and need or is reasonable to implement."

B3.3 **Affected Environment (Chapter Three):** Chapter Three will include an inventory of existing conditions as it relates to the environmental resource categories. Based on the potential ATCT locations considered in the *Siting Report*, the area of disturbance for the Proposed Action is assumed to be less than five acres and has been previously disturbed by prior airport operations. Based on Dibble's knowledge of the site, previous environmental studies completed at the airport

(for example, the environmental inventory and overview contained in the 2018 Airport Master Plan, and up-to-date internet research) each resource category contained in FAA Orders 1050.1F and 5050.4B will be evaluated in this chapter of the EA. Any information which is made available from resources agencies as part of the agency scoping process to help identify the presence of sensitive environmental resources in the vicinity of the Proposed Action will also be reviewed and incorporated as applicable.

A detailed description of the affected environment will then be compiled to provide the baseline conditions for the environmental consequences' analysis. Exhibits will be provided, as needed, to visually present the information. The items listed below will be addressed in a level of detail commensurate with the importance of the resource, with less important information summarized, consolidated, or referenced, based on the Sponsor's knowledge of the project areas:

- Air quality
- Biological resources (based on existing field surveys and on-line databases)
- Climate
- Department of Transportation Act, Section 4(f)
- Farmlands
- Hazardous materials, solid waste, and pollution prevention
- Historical, architectural, archaeological, and cultural resources
- Land use
- Natural resources and energy supply
- Noise and compatible land use
- Socioeconomics, environmental justice, and children's environmental health and safety risks
- Visual effects (including light emissions)
- Water resources
- Other planning documents pertinent to the affected area

This task also includes developing an appropriate list of past, present, and future foreseeable projects within defined temporal and spatial study parameters for use in the cumulative analysis of incremental project effects completed.

B3.4 **Environmental Consequences and Mitigation, if Necessary (Chapter Four):** The purpose of this task is to determine if significant impacts would result from the Proposed Action alternative, the No Action alternative, or any other development alternatives appropriate for detailed analysis as determined during Task B3.2. The categories that are not likely to have a significant impact on the proposed project as identified in Task A5.4.1 will be summarized within for reference. Impact categories that may be affected by the Proposed Action, either directly or

indirectly (as defined by 40 CFR §1508 .8), are listed in Tasks B3.3. If it is determined that there are significant impacts in any given category, avoidance, minimization, or mitigation measures will be identified. The analysis will use quantitative measures whenever possible to describe impacts. If qualitative measures are used because quantitative measures are unavailable, the terms in the document will be defined and uses consistently (e.g., short-term is <6 months duration).

Note: *Chapters 3 and 4 may be combined per FAA Order 1050.1F Paragraph 6-2.1e to ensure a more concise document.*

B4. Documentation

This task includes the culmination of all previous tasks to produce a Draft and Final EA. It also includes a summary of the public notices and comments that will occur during this stage. SWCA will lead this task with Dibble oversight, coordination, and review.

A Draft EA is the product of several iterations based on consecutive Town and FAA reviews and comment. A Final EA also includes public and/or agency comment letters on the Draft EA and written responses to any comments received during the official comment period.

B4.1 **Preliminary Draft EA:** A Preliminary Draft EA for the Proposed Action will be prepared in accordance with FAA Orders 5050.48 and 1050.1F. This task includes the preparation of other required EA sections besides Chapters One through Four as described previously in Tasks B3.1 through B3.4. The Preliminary Draft EA, which is designed for internal review only, will be provided first to the Airport Sponsor prior to submittal to the FAA ADO for review and comment. The Preliminary Draft EA will be prepared for internal team review and provided electronically. Once the Airport Sponsor has provided their comments, an electronic submittal of the Preliminary Draft EA will be submitted to FAA via the Phoenix ADO's electronic submittal process.

B4.2 **Revised Preliminary Draft EA:** Following review, comments made by the FAA as a result of Task B4.1 will be incorporated into the environmental document using track changes. Electronic copies of the chapters containing the revisions will then be forwarded first to the Airport Sponsor and then back to the FAA ADO for review and concurrence. The FAA ADO will then undertake any required FAA legal counsel, "lines of business," and/or regional review.

B4.3 **Draft EA:** Revisions required by the FAA's legal counsel, "lines of business," and/or regional reviews will be incorporated into the environmental document and a final "screen check" version of the Draft EA will be submitted electronically to the FAA ADO for concurrence. Once FAA's authorization to print the Draft EA has been received, up to eight (8) printed copies and one (1) flash drive of the Draft EA in Adobe PDF format will be prepared.

Note: *The Draft EA made available to the public must be Section 508 compliant.*

B4.4 **Draft and Final EA Notices:** Once the Draft EA is available for public and agency comment (Task B4.3), a Notice of Availability (NOA) will be prepared in accordance with the requirements of FAA Orders 1050.1F and 5050.48 and submitted to the Airport Sponsor for publishing in an area-wide or local newspaper of general circulation. The NOA will notify the public of the availability of the document and will allow for a public comment period (to be determined by the FAA). Additionally, letters will be sent to the various resource agencies consulted to allow them an opportunity to review and comment on the Draft EA, as applicable direct mailings or the sending of email blasts can also be used to notify the public of the availability of the Draft EA.

Once the Final EA (and FAA decision document, for example, a *Finding of No Significant Impact*) is available, a Notice of Finding will be prepared and submitted to the Airport Sponsor for publishing in an area-wide or local newspaper of general circulation. This will conclude the Final EA process.

Note: *The Town will be responsible for placing press releases, newspaper notices, or public advertisements in appropriate newspapers, for posting notices on appropriate websites, and for any direct mailings or the sending of email blasts.*

B4.5 **Response to Public Comments:** Responses will be prepared to address all comments raised during the official comment period for the Draft EA. Responses will be submitted to the Town for internal review prior to inclusion into the Final EA. Revisions requested to the response to comments by the Town or FAA are included in this task.

B4.6 **Final EA:** The Final EA for the Proposed Action will include an appendix containing an affidavit of publication of the Notice of Availability (Task B4.4). The Final EA document will also include copies of all comments received during the public comment period and responses to comments as outlined in Task B4.5, the signed FAA decision document, and a signed Final EA cover.

Before printing the Final EA, the FAA ADO will be provided an electronic submittal of the "Pre-Final" EA in Adobe PDF format. After the incorporation of any requested changes, FAA will then complete its final review. Once approval to print the Final EA is received, eight (8) printed copies and two (2) flash drives of the Final EA will be prepared. FAA will be provided two (2) of the printed copies and one (1) flash drive; the Arizona Department of Transportation – Aeronautics Division can also be provided with an electronic copy for their files.

Note: *The Final EA made available to the public must be Section 508 compliant.*

B5. Public Outreach (Optional – TBD by FAA)

B5.1 **Public Workshop/Hearing:** If the FAA determines a public workshop/hearing is required, it is anticipated that one public information workshop will be held during the public review of the Draft EA and can be conducted using an "open house" format. The workshop will use informational display boards prepared by Dibble and SWCA will facilitate discussion with attendees. Members of the project team will attend the workshop to allow for one-on-one interaction with the public. Written comments received during the workshop will be summarized and included within a chapter or an appendix of the EA. Dibble will also provide and maintain sign-in sheets, comment forms, or other materials used during the workshop.

Notification of the workshop will be accomplished using press releases, newspaper advertising, email blasts, and/or direct mailings (using a small fact sheet or postcard format) to adjacent landowners, interested citizens, neighborhood associations, and other groups in the area that may have an interest in the environmental documents. Dibble will provide draft copy for any of these methods of communication, as requested.

NOTE: *The Town will be responsible for placing press releases, newspaper notices, or public advertisements in appropriate newspapers, for posting notices on appropriate websites, and for any direct mailings or the sending of email blasts.*

B6. Preparation of the Administration Record

B6.1 **Preparation of Administrative Record:** SWCA will prepare the required administrative Record for the EA. This task includes the following tasks for the preparation of an administrative record for the NEPA process:

- An index listing all the documents, their name, format, type, and if they contain information exempt from *Freedom of Information Act* (FOIA) release (e.g., archaeological site locations) will be prepared for the Administrative Record. The index will be editable in case FAA needs to add items.
- Documents that are incorporated by reference will be placed in the Administrative Record.
- Documents the agency relied on in preparing the NPEA document that are not publicly available will be placed in the Administrative Record. (Propriety material may be excluded if it is clearly identified as such in the NEPA document.)
- Scoping documents will be placed in the Administrative Record even if they pre-date the FAA involvement in the EA process.
- The Administrative Record will be provided to the FAA electronically only.

The work products that will be prepared at various stages throughout Schedule B are summarized in **Table 3**. The estimated schedule of completion for Schedule B tasks is ***four months*** excluding FAA review and approval.

TABLE 3 SUMMARY OF SCHEDULE B WORK PRODUCT DELIVERABLES			
Deliverables	TOWN	FAA	ADOT
Preliminary Draft EA	X	X	
Revised Preliminary Draft EA	X	X	
Draft EA	X	X	
Draft and Final EA Notices	X	X	
Response to Public Comments	X	X	
Final EA	X	X	X

Scope of Services Assumptions

- The Town is actively progressing the necessary preliminary engineering (25%) and construction estimates for use by Dibble in the preparation of the Planning and Environmental Documentation.
- No alternative ATCT sites besides those included in the siting study will be required to be carried forth into the detailed environmental analysis.
- No operational noise modeling will be required for the completion of this EA.
- The Town will be responsible for placing all NOAs in an appropriate newspaper, posting NOAs and public review documents on the Town or airport website, and placing hard copies of the Draft and Final EA in specified public viewing areas, such as public libraries.

Attachments

- SWCA Environmental Scope of Work (Schedule A & B) dated January 6, 2023

END OF SCOPE OF WORK

Firm:	Dibble		Contract Number:
	Planning and Environmental Services		Project Number:
Project:	**Planning and Environmental Documentation**		Task Number:
			Amendment Number: TBD
	Marana Regional Airport		FAA Number: TBD
Date:	**1/16/2023**		ADOT Number: TBD

A. Planning & Environmental Phase Services

	Summary	Fee	Type	Dibble	Subconsultants
1	Dibble	$68,184.00	Not to Exceed	$68,184.00	
2	Dibble (Direct Expenses)	$143.75	Direct Cost	$143.75	
3	SWCA Environmental Consultants	$135,233.26	Not to Exceed		$135,233.26
4	Genesis Consulting Group	$11,390.68	Not to Exceed		$11,390.68
				Total	
	Total Fee	***$214,951.69***		***$68,327.75***	***$146,623.94***

Firm:	Dibble	Contract Number:	0
	Planning and Environmental Services	Project Number:	0
Project:	**Planning and Environmental Documentation**	Task Number:	0
		Amendment Number:	TBD
	Marana Regional Airport	FAA Number:	TBD
Date:	1/16/2023	ADOT Number:	TBD

DERIVATION OF FEE PROPOSAL SUMMARY

	Classification	Total Labor Hours	Billing Rates	Total Costs
1	Principal Engineer	12	$245.00	$2,940.00
2	Senior Project Manager	157	$225.00	$35,325.00
3	Senior Planner	115	$215.00	$24,725.00
4	Planner	14	$170.00	$2,380.00
5	Project Engineer	10	$167.00	$1,670.00
6	Senior Technician	8	$143.00	$1,144.00
7	Admin Assistant	0	$85.00	$0.00
	Totals:	316		$68,184.00

ALLOWANCE FOR DIRECT COSTS AND SUBCONSULTANTS

	Item	Cost	Type of Compensation
1	Direct Expenses	$143.75	Direct Cost
2	SWCA Environmental Consultants	$135,233.26	NTE
3	Genesis Consulting Group	$11,390.68	NTE

Sub-Total for Direct Costs **$146,911.44**

TOTAL FEE **$215,095.44**

Firm:	Dibble	DIBBLE	Contract Number: 0
	Planning and Environmental Services		Project Number: 0
Project:	**Planning and Environmental Documentation**		Task Number: 4
			Amendment Number: TBD
	Marana Regional Airport		FAA Number: TBD
Date:	1/16/2023		ADOT Number: TBD

PLANNING AND ENVIRONMENTAL PHASE SERVICES - LABOR HOURS

	PRINCIPAL ENGINEER	SENIOR PROJECT MANAGER	SENIOR PLANNER	PLANNER	PROJECT ENGINEER	SENIOR TECHNICIAN	ADMIN ASSISTANT	TOTAL HOURS BY TASK
SCHEDULE A TASKS								
A1. General								
A1.1 Project Management & Administration	2	10						12
A2. Section 163 Review								
A2.1 Section 163 Preparation and Submittal		4	4					8
A3. Identification of Connected Federal Actions								
A3.1 Identify Connected Federal Actions		4	2					6
A4. Identification of Lead, Cooperating and Participating Agencies								
A4.1 Preparation of Working List		2	2					4
A5. Preparation of Preliminary Study Components								
A5.1 Purpose and Need Statement		8	8					16
A5.2 Project Description		10	8					18
A5.3 Alternatives Description		8	10	1		8		27
A5.4 Identification of Potentially Significant Environmental Issues		4	2	1				7
A5.4.1 Screening of Environmental Resources Likely Impacted		2	2	1				5
A5.4.2 Preparation of Treatment Measures Working List		2	2	1				5
A6. Schedule Preparation								
A6.1 Prepare Schedule		2	10	1				13
A7. Preliminary Public Outreach Plan								
A7.1 Public Outreach Pre-Planning		2	8	1				11
A8. Summary of Planning Tasks								
A8.1 Prepare Draft and Final Summary of Planning Tasks	2	12	16	1				31
SCHEDULE B TASKS								
B.1 General								
B.1.1 Project Management and Administration	2	10						12
B.1.2 Project Meetings		20	4					24
B.2 Preliminary Engineering Support (25% Design)								
B.2.1 Preliminary Engineering Design (25%)	2	2			6			10
B.2.2 Construction Activity Estimates	1	2			4			7
B3 Study Components								
B.3.1 Project Description (Chapter One)		4	2	1				7
B.3.2 Alternatives (Chapter Two)		8	2	2				12
B.3.3 Affected Environment (Chapter Three)		6	2	2				10
B.3.4 Environmental Consequences and Mitigation, if Necessary (Chapter Four)		6	2	2				10
B4 Documentation								
B.4.1 Preliminary Draft EA		4	6					10
B.4.2 Revised Preliminary Draft EA		2	4					6
B.4.3 Draft EA	1	4	8					13
B.4.4 Draft and Final EA Notices		1	1					2
B.4.5 Response to Public Comments		2	2					4
B.4.6 Final EA	1	4	6					11
B5 Public Outreach								
B.5.1 Public Workshop/Hearing		8						8
B6 Preparation of the Administrative Record								
B.6.1 Preparation of Administrative Record	1	4	2					7
TOTAL HOURS BY CLASSIFICATION	12	157	115	14	10	8	0	316

Firm:	Dibble	DIBBLE	Contract Number: 0
	Planning and Environmental Services		Project Number: 0
Project:	**Planning and Environmental Documentation**		Task Number: 0
			Amendment Number: TBD
	Marana Regional Airport		FAA Number: TBD
Date:	1/16/2023		ADOT Number: TBD

PLANNING AND ENVIRONMENTAL PHASE SERVICES DIRECT COSTS

1. PRINTING (Display Boards, Draft, & Final Report)

a.	0	24 Sheets @	$0.80	/sheet	$0.00
				STUDY PHASE TOTAL	**$0**

2. Travel

a.	1 Trips	250 Miles	@	$0.575 per mile	$144
				STUDY PHASE TOTAL	**$144**

SWCA
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January 6, 2023

Charlie McDermott, Aviation Planning Manager
Dibble
7878 North 16th Street, Suite 300
Phoenix, Arizona 85020-4669
Submitted via email: charlie.mcdermott@dibblecorp.com

Re: Environmental Services for the Marana Regional Airport Air Traffic Control Tower Project in Marana, Pima County, Arizona

Dear Charlie:

SWCA Environmental Consultants (SWCA) appreciates the opportunity to provide you with our scope of work (SOW) for environmental services for the Marana Regional Airport Air Traffic Control Tower Project in Marana, Pima County, Arizona.

Dibble has prepared a Master SOW that outlines its approach to National Environmental Policy Act (NEPA) analysis. This SWCA SOW relies on the information and assumptions in Dibble's Master SOW. It is intended to supplement Dibble's Master SOW and provide an additional level of detail and assumptions, as necessary, for tasks that will be managed by SWCA as a subconsultant to Dibble.

Thank you for providing us with the opportunity to work with you. If the SOW are acceptable to you, please provide us with contractual arrangements. Please contact me at (520) 402-4127 if you have any questions regarding this proposal.

Sincerely,

Theresa Knoblock
Tucson Senior Office Lead

SCOPE OF WORK

Dibble is working with the Town of Marana (Town) on the Marana Regional Airport (AVQ) Air Traffic Control Tower (ATCT) project in Pima County, Arizona. The Town requested that Dibble prepare a scope of work (SOW) and cost estimate to complete the necessary National Environmental Policy Act (NEPA) and associated resources analyses for the project to meet the requirements of the Federal Aviation Administration (FAA) regulations. Dibble requested that SWCA Environmental Consultants (SWCA) provide services as a subcontractor on the project.

Dibble has prepared a Master SOW that outlines the Team's approach to NEPA analysis. This SWCA SOW relies on the information and assumptions provided in Dibble's Master SOW. It is intended to supplement Dibble's Master SOW and provide an additional level of detail and assumptions, as necessary, for tasks that will be managed by SWCA as a subconsultant to Dibble. Task numbers reference the Schedule A and B task numbers in Dibble's Master SOW provided to the Town.

SCHEDULE A – PLANNING DOCUMENTATION FOR FAA DETERMINATION

SWCA will provide assistance with the following Dibble Master SOW Schedule A subtasks:

A3. Identification of Connected Federal Actions: SWCA will assist Dibble in preparing a list of federal agency actions required for the proposed study to proceed.

A4. Identification of Lead, Cooperating, and Participating Agencies: SWCA will assist Dibble in preparing a working list of entities for agency scoping, including Indian tribes, and identify each agency's role in the proposed study.

A5.4 Identification of Potentially Significant Environmental Issues SWCA will lead this task, which will identify 1) the categories that are not likely to have a significant impact on the proposed project, and 2) the categories that may have an impact on the proposed project and/or those that are viewed as the most important to the public and the sponsor (i.e., AVQ and the Town) for further investigation. This task includes the following subtasks:

- **A5.4.1 Screening of Environmental Resources Likely Impacted:** For the environmental categories with the potential to be impacted, SWCA will conduct an initial screening, either through desktop reviews and/or field assessments, to prepare a list of data gaps. This task also includes assisting FAA with initiation of the Special Purpose Law review process, if needed. This includes Section 106 consultation with State or Tribal Historic Preservation Offices (SHPOs/THPOs) and other consulting parties such as certified local governments and Indian tribes, and Section 7 consultation with the U.S. Fish and Wildlife Service (USFWS). Any other technical assessments will also be started during this task. SWCA will assist the Bureau of Indian Affairs by preparing draft coordination letters and other materials to initiate these processes. Formal consultation with other state and federal agencies such as SHPO and USFWS is ultimately the responsibility of the FAA as the lead agency.
- **A5.4.2 Preparation of Treatment Measures Working List:** SWCA will prepare a working list of treatment measures. The list will identify implementation, oversight, and schedule of each measure, which treatment measures will avoid or minimize impacts, and which treatment measures will mitigate impacts below a significance threshold.

SCHEDULE B – PREPARATION OF AN ENVIRONMENTAL ASSESSMENT

TASK B1.1. PROJECT MANGEMENT

SWCA will provide appropriate direction and project management for the development of the environmental assessment (EA) and associated tasks, as each is undertaken and completed. Dibble will be solely responsible to the sponsor and will act as a liaison between the Airport Authority, tribal staff, interested parties, and FAA to ensure the project is completed in a quality and timely manner.

This task provides time for SWCA staff to communicate with Dibble and the Town via telephone or email. In addition, this task provides time for SWCA staff to manage the project, e.g., scheduling, regulatory guidance, project administration, and overall project management.

TASK B1.2. PROJECT MEETINGS

This task includes both internal and external project team meetings throughout the Schedule B timeline. SWCA will attend Dibble-facilitated virtual calls every 2 weeks and will provide support at monthly meetings with the Town and FAA as requested. All meetings will be virtual and are planned to be no longer than 1 hour. SWCA's project manager (PM) will attend meetings.

TASK B3. STUDY COMPONENTS

SWCA will lead the preparation of the draft and final EA. SWCA will prepare these documents in accordance with Council on Environmental Quality and FAA guidelines. These guidelines require that the EA be prepared as outlined in the Dibble Master SOW (Tasks B3.1 through B3.4). This SOW assumes that the EA will need to address the Proposed Action alternative (i.e., the preferred site), the No Action alternative, and the other three alternate sites evaluated in the siting study in equal detail. SWCA will prepare a preliminary draft EA, a revised preliminary draft EA, a draft EA, and draft and final EA notices (draft notice of availability and draft finding of no significant impact). SWCA will also prepare a response to public comments as further detailed in Dibble Master SOW, Task B4.

As noted in the Dibble Master SOW, the EA will address the following resources:

- Air quality
- Biological resources (based on existing field surveys and on-line databases)
- Climate
- Department of Transportation Act, Section 4(f)
- Farmlands
- Hazardous materials, solid waste, and pollution prevention
- Historical, architectural, archaeological, and cultural resources
- Land use
- Natural resources and energy supply
- Noise and compatible land use
- Socioeconomics, environmental justice, and children's environmental health and safety risks
- Visual effects (including light emissions)
- Water resources

- Other planning documents pertinent to the affected area

SWCA will prepare stand-alone reports to evaluate impacts to biological, cultural and visual resources.

TASK B3.3.1. BIOLOGICAL RESOURCES

This SWCA task will provide the information necessary to complete Dibble's Master SOW Tasks B3.3, Affected Environment (Chapter Three), and B3.4, Environmental Consequences and Mitigation, if Necessary (Chapter Four). The purpose of this task is to collect the biological resources information necessary to support the EA.

Before conducting the site visit of the alternative project areas, an SWCA biologist will 1) review the USFWS species list for Pima County generated through the Information for Planning and Consultation system and 2) will review the online occurrence records for special-status species near the project area using the Arizona Game and Fish Department's Arizona Heritage Geographic Information System online environmental review tool. The SWCA biologist will then visit the project area to document the existing conditions and record any information related to the following regulations: Endangered Species Act, Migratory Bird Treaty Act, Arizona Department of Agriculture (ADA)–administered Arizona Native Plant Law, and ADA noxious weed regulations. In addition, Section 404 of the Clean Water Act will be addressed. Lastly, information on wildlife strikes from the FAA strike database will be included for the EA analysis.

SWCA will then prepare a technical memorandum report to document findings and any recommendations regarding the results of the data review and the site visit for each alternative. In addition, the report will include recommendations for maintaining compliance with the regulations and contain information to support the EA document. This report will be delivered as an electronic (PDF) file.

SUBTASK B3.3.1 ASSUMPTIONS

- No impacts to any Endangered Species Act–listed species will be identified; therefore, a formal biological evaluation report and subsequent Section 7 consultation will not be required for this project.
- Access to the project area, if restricted, will be arranged by a client representative.
- If for any reason SWCA staff are not able to survey the project area as a result of access restrictions, additional costs could be incurred beyond the amount proposed herein.

TASK B3.3.2. CULTURAL RESOURCES

This SWCA task will provide the necessary information related to Dibble's Master SOW Tasks B3.3, Affected Environment (Chapter Three), and B3.4, Environmental Consequences and Mitigation, if Necessary (Chapter Four).

The purpose of this task is to collect the necessary cultural resources information to support the EA. This task is also intended to provide support for the Section 106 consultation process on behalf of the FAA, if needed. This task is divided into three subtasks—archaeological resources, architectural resources, and Section 106 support—all of which are detailed below.

SUBTASK B3.3.2 A. ARCHAEOLOGICAL RESOURCES

As part of the Section 106 process, the FAA must consider effects on historic properties, including archaeological sites that are eligible for the National Register of Historic Places (NRHP). The proposed ATCT location has been subject to an intensive Class III pedestrian survey, which was conducted in April 2022 for a proposed apron reconstruction. The results of this survey are summarized in *Cultural Resources Survey for the Marana Regional Airport Hangar Apron Reconstruction Project, Pima County, Arizona* prepared by SWCA's Tucson office. Because the

project area has been recently surveyed, SWCA anticipates that no additional fieldwork will be necessary relative to archaeological resources and that the prepared summary report will suffice for the cultural resources inventory.

If requested, SWCA will prepare a letter report or technical memorandum outlining the extent of the previous survey and its results, which will support the FAA with its obligations under Section 106. The 2022 survey report is provided as an attachment to this document.

SUBTASK B3.3.2 B. ARCHITECTURAL RESOURCES

In addition to archaeological resources, the FAA must also consider the built environment and architectural resources that may qualify as historic properties (i.e., eligible for the NRHP). AVQ began as an auxiliary airfield, built to support training activities at the nearby Marana Army Airfield (today, Pinal Airpark) in the early 1940s during World War II. The initial airfield only included a series of intersecting runways, and no additional infrastructure was generally constructed at these touch-and-go airfields. Based on a preliminary review of aerial imagery and available airport records, there are three buildings at the airport today that are of historic age (i.e., at least 50 years old since first constructed), including two T-hangars and one larger hangar, all three of which were built between 1960 and 1972.

SWCA will conduct a brief field visit to photograph these three hangars, note architectural details, and capture the setting of the project area. As requested by the FAA, fieldwork will also include representative photographs of the overall airport, including the runway system. After fieldwork, SWCA will prepare a report that will evaluate the three hangars for the NRHP and will consider the airport property as a whole to ascertain whether a historic district is present. Evaluation of significance and assessment of integrity for the individual hangars and the airport (as a potential district) will be in accordance with established guidance provided by the National Park Service (NPS) in its published National Register Bulletins. Additionally, SWCA will prepare an Arizona Historic Property Inventory Form (HPIF) for each of the three hangars as required by the Arizona SHPO.

SWCA will submit the draft architectural report to Dibble for review and will incorporate any changes based on comments prior to submission to the FAA. If necessary, SWCA will revise the draft report to address any comments from the FAA as the federal lead agency. The FAA will be responsible for submitting the report to SHPO through its government-to-government consultation obligations. SWCA will address a third round of comments from the SHPO to finalize the report.

SUBTASK B3.3.2 C. SECTION 106 SUPPORT

SWCA will also provide support to the FAA in the form of consultation letter review. SWCA will review 2–3 letters, with two rounds of edits each in support of the Section 106 process and to assist the FAA with its consultation efforts. The FAA will be responsible for the production and/or mailing (standard or electronically) the finalized Section 106 consultation letters to consulting parties.

SUBTASK B3.3.2 ASSUMPTIONS

- The FAA will consult with SHPO on the project area of potential effects (APE) in accordance with Section 106 guidance. Once established, SWCA will be provided with the project APE prior to beginning work under this task.
- The project area has been sufficiently surveyed in its entirety for archaeological resources, and no additional fieldwork will be required for Subtask 6A. A letter report or technical memorandum may be prepared to summarize the adequacy of past investigations covering the project area, if needed.
- Subtask 6A includes one round of revisions based on Dibble's comments and one round of revisions based on comments from the FAA. This subtask does not include costs for review by any other agency other than the FAA.

- Because no archaeological survey will be required, Subtask 6A does not include any costs associated with project registration or curation of project records at the Arizona State Museum (ASM). If project changes occur that require Class III archaeological survey, a separate scope and cost estimate will need to be prepared to account for fieldwork, report preparation, and fees incurred to conduct survey under SWCA's Arizona Antiquities Act blanket permit (2023-50bl).
- There are three hangars at the airport that are of historic age (i.e., at least 50 years old since the time of construction). Subtask 6B includes costs associated with field documentation and evaluation of up to three historic-era architectural resources. If more than three historic-era architectural resources are encountered at the airport, additional costs may be incurred due to documentation and reporting requirements.
- Subtask 6B does not include preparation of any as-built plans, measured drawings, architectural descriptions, or other documentation associated with the Historic American Buildings Survey or Historic American Engineering Record programs administered by the NPS.
- Subtask 6B includes three rounds of revisions based on Dibble, FAA, and SHPO comments. This subtask does not include costs associated with review by any other agencies other than the FAA and SHPO.
- Subtask 6C does not include costs associated with meeting attendance or other coordination that may occur as part of the Section 106 consultation.
- Subtask 6C does not include preparation of a memorandum of agreement, memorandum of understanding, or any other documentation that may be required under the Section 106 process.

TASK B3.3.3. VISUAL RESOURCES

This SWCA task will provide the necessary information related to Dibble's Master SOW Tasks B3.3, Affected Environment (Chapter Three), and B3.4, Environmental Consequences and Mitigation, if necessary (Chapter Four).

The visual resource analysis and subsequent technical report is designed to identify visually sensitive landscapes and to identify proposed project features or ongoing proposed project operations that have the potential to affect visually sensitive landscapes within the area. The goals of the visual resource analysis are to 1) identify locally, regionally, and/or nationally known locations where people commonly view and value the landscape, and 2) assess the change to the overall visual landscape and the effects on sensitive views from sensitive viewing locations.

SUBTASK B3.3.3 A. VIEWSHED ANALYSIS

Using GIS modeling technologies, SWCA will complete viewshed analysis from Site 5 to provide a general sense of the proposed project visibility within 5 miles of the project components (e.g., the ATCT). This analysis will be based on "bare earth" visibility, which reflects the worst-case scenario in determining visibility in this landscape using the best available GIS data, for example, digital elevation models, photogrammetry or LiDAR ground surface data. High-resolution and current satellite imagery may be obtained by SWCA data acquisition team. Viewshed analyses will model and illustrate areas in the landscape that would potentially have views of the proposed project components and may require further field study. SWCA will coordinate with Dibble and the Town to identify public-viewing platforms, also referred to as key observation points (KOPs) where the proposed project may be visible to the public.

SUBTASK B3.3.3 B. KEY OBSERVATION POINTS AND BASELINE PHOTOGRAPHS

Following completion of a viewshed analysis, SWCA will work with stakeholders and necessary parties (e.g., the Town and AVQ) to identify up to four KOPs for the proposed project. KOPs will be identified where the view of the project area will be most revealing or where there is high viewer sensitivity. SWCA's visual resource specialists will visit each KOP to take baseline photographs and document existing visual conditions.

SUBTASK B3.3.3 C. IMPACT EVALUATION

The analyses will be prepared by planning and environmental professionals with educational and career experience in the evaluation of visual impact. This will provide a systematic basis for evaluating impacts to visual resources. The methodology will be consistent with the policies, procedures, and guidelines in established visual impact assessment methodologies and includes but is not limited to the Bureau of Land Management's Visual Resource Management System, the NPS Visual Impact Assessment Evaluation Guide, and various state agency programs. Using the basic visual elements of form, line, color, and texture, the visual contrast analysis provides a qualitative assessment of anticipated contrast between the existing landscape character and the proposed activities and/or facilities. Factors influencing the assessment include distance of the proposed project elements from the KOP and the level of perceived contrast between the proposed project elements and the existing landscape. The existing landscape character and inherent visual quality will be described for the analysis area based on landform patterns and features, vegetation communities and patterns, built features, land use patterns, scarcity, and/or surface water resources.

SUBTASK B3.3.3 D. VISUAL SIMULATIONS

Based on preliminary desktop research, SWCA will develop representative photorealistic simulations from up to four identified KOPs. Below is an outline of the individual simulations that will be created from each KOP based on architectural and engineering drawings provided by the applicant in either AutoCAD, construction documents, or GIS-based software.

- Preferred action
  - Daytime simulation from each KOP (4 simulations)
  - Nighttime simulation from one representative KOP (1 simulation)
- Three alternative actions
  - Daytime simulation from each KOP for each alternative (12 simulations)
  - Nighttime simulation from one representative KOP (3 simulations)
- Total number of simulations equals 20

For each simulation, the GPS location of the existing condition photo will be incorporated into AutoCAD/GIS for accuracy in relation to the proposed project. Digital elevation models and KOP locations will then be combined to create base imagery used in the simulation modeling process. Using 3Ds Max software, each KOP location will then be overlaid in the simulated 3D environment modeled after the existing topographic conditions, and relative to the ATCT design information which will be modeled in 3D based on plan and elevation information provided, then confirmed using reference information in AutoCAD. Within the simulated 3D environment, realistic materials and textures will be applied to the proposed project design data. The time of day and date will also be set within the environment, so the lighting and shadows cast on the models represent the same conditions within the site photos. Simulated cameras will then be set up in the 3D environment based on the GPS locations and the camera and lens settings used in the field. Snapshots are then taken from the virtual cameras and exported as rendered images for use in creating the finished simulations. The next step in the visual simulation process consists of merging the rendered images of the proposed project into the field photos using Adobe Photoshop software. These merged images will represent photo-realistic simulations of the ATCT as viewed from each selected KOP.

SUBTASK B3.3.3 E. VISUAL RESOURCES TECHNICAL REPORT

All data and information gathered in the above tasks (e.g., viewshed models, visual simulations, etc.) will be used for analysis purposes and included in the visual resources technical report. The report will outline the background for visual resources impact methodology, including explanation of significance criteria as defined by NEPA, FAA, and other regulatory or local visual guidance, as applicable; proposed project description; study area definition; local

baseline conditions; analysis of potential impacts; and any necessary mitigation measures to minimize impacts to aesthetics to support the EA.

B3.3.3 DELIVERABLES

- SWCA will develop simulations from each selected KOP representing the existing condition and post-construction condition, for a total of (20) simulations.
- All deliverables will be in electronic format and will consist of imagery that can be used for internal reviewing purposes.
- SWCA will submit an administrative draft visual resources technical report as well as a final visual resources technical report.

TASK B3.3.3 ASSUMPTIONS

- Dibble will provide any available electronic design files and/or GIS shapefiles of the project design features, site layout, project limits, and other information as requested (ATCT construction details, sections, dimensions, CAD linework, etc.) to aid in the development of simulations.
- SWCA will monitor and evaluate weather conditions leading up to the scheduled site visit. If weather or atmospheric conditions (e.g., rain, wildfire, smoke) will affect the opportunity for quality photographs to support the visual simulation development, SWCA will coordinate any project delays with Dibble and the Town.
- Visual mitigation options will be determined by Dibble, who will provide information regarding materiality, etc.
- Depending on completed research and outreach, additional KOPs may need to be added.
- SWCA will provide Dibble and the Town with draft simulations for one 5-business-day review and comment period.
- Any adjustments or revisions to the visual simulations after final submittal to Dibble and the Town, or special requests, may require modification to scope of services and estimated fee.

TASK B5. PUBLIC OUTREACH

As detailed in Dibble's Master SOW Task B5, SWCA will facilitate one public information workshop during the public review of the draft EA, likely held in an open house format. The SWCA PM and appropriate resource staff will manage the workshop and respond to public questions. SWCA also will provide a welcome table that includes staff to request sign-in, collect comments, and take meeting minutes. Please note that a court reporter will not be provided and is not required for EA public workshops.

SWCA will prepare draft press releases, newspaper notices, or public advertisements for the Town's use. This SOW does not include hosting a website or drafting materials for a project website.

TASK B6. PREPARATION OF THE ADMINISTRATIVE RECORD

SWCA will maintain and prepare the required administrative record for the EA in coordination with the FAA and the Town. The administrative record will be provided to the FAA electronically only.

As discussed in the Dibble Master SOW, the administrative record will include the following:

- An index listing all documents, including name, format, type, and whether they contain information exempt from Freedom of Information Act release (e.g., archaeological site locations). The index will be editable to allow the FAA to add items.

- Documents incorporated by reference
- Documents the FAA relied on in preparing the NEPA document that are not publicly available (proprietary material may be excluded if it is clearly identified as such in the NEPA document)
- Scoping documents, even if they pre-date FAA's involvement in the EA process.

Genesis Consulting Group, LLC

SCOPE OF WORK
New Air Traffic Control Tower
Planning and Environmental Documentation
Marana Regional Airport

TASK B3.3.3. VISUAL RESOURCES

This **Genesis Consulting Group, LLC** task, in coordination with Dibble/SWCA will provide the necessary location and photographic information related to Dibble's Master SOW Tasks B3.3, Affected Environment (Chapter Three), and B3.4, Environmental Consequences and Mitigation.

The Visual Resource Analysis is designed to identify visually sensitive landscapes and to identify proposed project features or operations that have the potential to affect visually sensitive landscapes within the area. The goals of the visual resource analysis are to 1) identify locally, regionally, and/or nationally known locations where people commonly view and value the landscape, and 2) assess the change to the overall visual landscape and the effects on sensitive views from sensitive viewing locations.

In support of the Visual Resource Analysis and related tasks, the **Genesis Consulting Group, LLC** will provide photographic equipment and services necessary to support a visual impact analysis that will be conducted for this EA. Utilizing DSLR, and UAS (Drone) mounted camera systems with high megapixel capabilities, Genesis will provide ground-based photography, and aerial photography as necessary to satisfy requirements. Deliverables will include all required photographs of each identified site, or Key Observation Points (KOP), and each will bear a GPS latitude/longitude location marking, elevation of photograph, compass direction, and other required site identifications. Deliverable photographs will be in JPEG, PING or similar format.

SUBTASK B3.3.3 A. VIEWSHED ANALYSIS

Using GIS modeling technologies, Dibble and SWCA will complete a viewshed analysis from Site 5 to provide a general sense of the proposed project visibility within 5 miles of the project components (e.g., the ATCT). Viewshed analyses will model and illustrate areas in the landscape that would potentially have views of the proposed project components and may require further field study. SWCA will coordinate with Dibble and the Town to identify public-viewing platforms, also referred to as key observation points (KOPs) where the proposed project may be visible to the public.

SUBTASK B3.3.3 B. KEY OBSERVATION POINTS AND BASELINE PHOTOGRAPHS

Following completion of a viewshed analysis, SWCA will work with stakeholders and necessary parties (e.g., the Town and AVQ) to identify up to four KOPs for the proposed project. KOPs will be identified where the view of the project area will be most revealing or where there is high viewer sensitivity. In the role of vision resource specialist, the **Genesis Consulting Group, LLC** will visit each KOP or required site, and initiate a series of daytime and nighttime photographs from each location. These photographs will be used in establishing the baseline visual condition and as a basis for determining impacts to the existing visual character of the area through the effects analysis. Photorealistic simulations showing the existing condition and proposed condition based on project design data will be provided to and developed by Dibble/SWCA to support the effects analysis. For each simulation, the GPS location of the existing condition photo will be incorporated into AutoCAD/GIS for accuracy in relation to the proposed project.

SWCA
ENVIRONMENTAL CONSULTANTS
Sound Science. Creative Solutions.®

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Tucson, Arizona 85701
Tel 520.325.9194 Fax 520.325.2033
www.swca.com

January 13, 2023

Charlie McDermott, Aviation Planning Manager
Dibble
7878 North 16th Street, Suite 300
Phoenix, Arizona 85020-4669
Submitted via email: charlie.mcdermott@dibblecorp.com

Re: Environmental Services for the Marana Regional Airport Air Traffic Control Tower Project in Marana, Pima County, Arizona: Fee Proposal

Dear Charlie:

SWCA Environmental Consultants (SWCA) appreciates the opportunity to provide you with our Cost Estimate to provide environmental services for the Marana Regional Airport Air Traffic Control Tower Project in Marana, Pima County, Arizona. This cost estimate supports the SWCA portion of the Dibble January 2023 New Air Traffic Control Tower Planning and Environmental Documentation Scope of Work.

SWCA will initiate our proposed scope of work based on the below **time and materials not-to-exceed** fee of **$135,233.26** upon the appropriate notice to proceed.

Thank you for providing us with the opportunity to work with you. Please contact me at (520) 402-4127 or theresa.knoblock@swca.com if you have any questions regarding this proposal.

Sincerely,

Theresa Knoblock
Tucson Senior Office Lead

COST ESTIMATE

The total time and materials, not-to-exceed cost for the environmental services that we have proposed for the project in this scope of work are detailed below.

Table 1. Cost Estimate.

Task	Labor	Expenses	Total
Schedule A Planning Documentation for FAA Determination			
Task A3, A4, A5.4 SWCA Assistance on Schedule A tasks	$ 13,412.00		$ 13,412.00
Schedule B Preparation of an Environmental Assessment			
Task B.1.1. Project Management	$ 2,576.00		$ 2,576.00
Task B.1.2. Project Meetings	$ 4,186.00		$ 4,186.00
Task B.1.3. Study Components (EA)	$ 27,890.00		$ 27,890.00
Task B.2.1 Biological Resources	$ 6,953.50	$ 58.94	$ 7,012.44
Task B.2.2 Cultural Resources	$ 17,608.25	$ 179.69	$ 17,787.94
Task B.2.3 Visual Resources	$ 44,306.00	$ 247.25	$ 44,553.25
Task B5. Public Outreach	$ 11,992.00	$ 2,515.63	$ 14,507.63
Task B6. Administrative Record	$ 3,308.00		$ 3,308.00
PROJECT TOTAL	**$ 132,231.75**	**$ 3,001.51**	**$ 135,233.26**

ASSUMPTIONS

Schedule A

- Costs included to complete Schedule A tasks are based on the assumption that SWCA will be able to initiate background data collection that is part of Tasks B2.1, B2.3, and B2.3. If Schedule A is authorized separately from Schedule B, modification of this estimate would be required.

Schedule B

- This project is anticipated to occur over 12 months.
- No impacts to any Endangered Species Act–listed species will be identified; therefore, a formal biological evaluation report and subsequent Section 7 consultation will not be needed or required for this project.
- Access to the project area, if restricted, will be arranged by a client representative.
- If for any reason SWCA staff are not able to survey the project area as a result of access restrictions, additional costs could be incurred beyond the amount proposed herein.
- Up to two rounds of review and addressing edits are included in this proposal for all document submittals.
- No impacts to any Endangered Species Act–listed species will be identified; therefore, a formal biological evaluation report and subsequent Section 7 consultation will not be required for this project.
- Any task not expressly described herein is not included in the proposed cost.
- Access to the project area, if restricted, will be arranged by a client representative.
- If for any reason SWCA staff are not able to survey the project area as a result of access restrictions, additional costs could be incurred beyond the amount proposed herein.

- The FAA will consult with SHPO on the project area of potential effects (APE) in accordance with Section 106 guidance. Once established, SWCA will be provided with the project APE prior to beginning work under this task.
- The project area has been sufficiently surveyed in its entirety for archaeological resources, and no additional fieldwork will be required for Subtask 6A. A letter report or technical memorandum may be prepared to summarize the adequacy of past investigations covering the project area, if needed.
- Subtask 6A includes one round of revisions based on Dibble's comments and one round of revisions based on comments from the FAA. This subtask does not include costs for review by any other agency other than the FAA.
- Because no archaeological survey will be required, Subtask 6A does not include any costs associated with project registration or curation of project records at the Arizona State Museum (ASM). If project changes occur that require Class III archaeological survey, a separate scope and cost estimate will need to be prepared to account for fieldwork, report preparation, and fees incurred to conduct survey under SWCA's Arizona Antiquities Act blanket permit (2023-50bl).
- There are three hangars at the airport that are of historic age (i.e., at least 50 years old since the time of construction). Subtask 6B includes costs associated with field documentation and evaluation of up to three historic-era architectural resources. If more than three historic-era architectural resources are encountered at the airport, additional costs may be incurred due to documentation and reporting requirements.
- Subtask 6B does not include preparation of any as-built plans, measured drawings, architectural descriptions, or other documentation associated with the Historic American Buildings Survey or Historic American Engineering Record programs administered by the NPS.
- Subtask 6B includes three rounds of revisions based on Dibble, FAA, and SHPO comments. This subtask does not include costs associated with review by any other agencies other than the FAA and SHPO.
- Subtask 6C does not include costs associated with meeting attendance or other coordination that may occur as part of the Section 106 consultation.
- Subtask 6C does not include preparation of a memorandum of agreement, memorandum of understanding, or any other documentation that may be required under the Section 106 process.
- Dibble will provide any available electronic design files and/or GIS shapefiles of the project design features, site layout, project limits, and other information as requested (ATCT construction details, sections, dimensions, CAD linework, etc.) to aid in the development of simulations.
- SWCA will monitor and evaluate weather conditions leading up to the scheduled site visit. If weather or atmospheric conditions (e.g., rain, wildfire, smoke) will affect the opportunity for quality photographs to support the visual simulation development, SWCA will coordinate any project delays with Dibble and the Town.
- Visual mitigation options will be determined by Dibble, who will provide information regarding materiality, etc.
- Depending on completed research and outreach, additional KOPs may need to be added.
- SWCA will provide Dibble and the Town with draft simulations for one 5-business-day review and comment period.
- Any adjustments or revisions to the visual simulations after final submittal to Dibble and the Town, or special requests, may require modification to scope of services and estimated fee.

Rate Schedule: 2023 Standa

Project Budget Summary

Project Name:	Marana Airport ATCT EA
Project No:	61913-00-TUC
Annual Rate Escalation:	0%
Project Start (est.):	Enter Date Here
Project End (est.):	Enter Date Here

s A-E are for internal reference and are outside of the print area for pr

						Phase 01		Phase 02		Phase 03		Phase 04		Phase 05		Phase 06		Phase 07	
						Schedule A: SWCA assistance		Planning Study		FAA EA		Public Involvement		Biological		Cultural		Visual	
LABOR																			
Office	Name	Discipline Short	Level Short	Discipline	Level	Rate	Hours	Charge	Hours	Charge	Hours	Charge	Hours	Charge	Hours	Charge	Hours	Charge	Hours	Charge
GEN	General Biller			Accounting - Billing		$ 95.00	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	1.00	$ 95.00	-	$ -
PHX	McFarlane, Genelyn	PC	506	Project Controls	Specialist VI	$ 120.00	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	2.00	$ 240.00	-	$ -
GEN	Amaro, Victoria	ER	509	Environmental Resources	Specialist IX	$ 161.00	-	$ -	-	$ -	4.00	$ 644.00	-	$ -	-	$ -	-	$ -	-	$ -
TUC	Knoblock, Theresa	PL	509	Planning	Specialist IX	$ 161.00	21.00	$ 3,381.00	-	$ -	70.00	$ 11,270.00	20.00	$ 3,220.00	10.00	$ 1,610.00	2.00	$ 322.00	-	$ -
PHX	Kovach, Ryan	PL	509	Planning	Specialist IX	$ 161.00	9.00	$ 1,449.00	-	$ -	4.00	$ 644.00	-	$ -	-	$ -	-	$ -	-	$ -
TUC	Campbell, Stacy	ER	505	Environmental Resources	Specialist V	$ 117.00	8.00	$ 936.00	-	$ -	10.00	$ 1,170.00	-	$ -	-	$ -	-	$ -	-	$ -
TUC	Hesgenother, Robert	ER	502	Environmental Resources	Specialist II	$ 85.00	-	$ -	-	$ -	-	$ -	-	$ -	38.50	$ 3,272.50	-	$ -	-	$ -
TUC	Mitchell, Lora	GS	505	GIS/CADD	Specialist V	$ 117.00	-	$ -	-	$ -	4.00	$ 468.00	-	$ -	9.00	$ 1,053.00	1.00	$ 117.00	-	$ -
TUC	Cox, Kelley	AD	505	Administration	Specialist V	$ 117.00	4.00	$ 468.00	-	$ -	26.00	$ 3,042.00	16.00	$ 1,872.00	3.50	$ 409.50	6.00	$ 702.00	-	$ -
PHX	Matte, Cori	AD	503	Administration	Specialist III	$ 97.00	2.00	$ 194.00	-	$ -	4.00	$ 388.00	-	$ -	0.50	$ 48.50	1.25	$ 121.25	-	$ -
PHX	Desrosiers, Danielle	TW	507	Technical Writer/Editor	Specialist VII	$ 140.00	4.00	$ 560.00	-	$ -	18.00	$ 2,520.00	-	$ -	4.00	$ 560.00	6.00	$ 840.00	-	$ -
TUC	Jordan, Tim	ER	506	Environmental Resources	Specialist VI	$ 120.00	26.00	$ 3,380.00	-	$ -	40.00	$ 5,200.00	24.00	$ 3,120.00	-	$ -	-	$ -	-	$ -
TUC	Bort, David	CR	507	Cultural Resources	Specialist VII	$ 140.00	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	8.00	$ 1,120.00	-	$ -
PUG	Lutes, Annie	CR	506	Cultural Resources	Specialist VI	$ 120.00	-	$ -	-	$ -	12.00	$ 1,560.00	-	$ -	-	$ -	70.00	$ 9,100.00	-	$ -
TUC	Rawson, Paul	CR	505	Cultural Resources	Specialist V	$ 117.00	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	13.00	$ 1,521.00	-	$ -
SAC	Herrick, Dan	CR	509	Cultural Resources	Specialist IX	$ 161.00	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	10.00	$ 1,610.00	-	$ -
PHX	Tremblay, Adrienne	CR	508	Cultural Resources	Specialist VIII	$ 150.00	8.00	$ 1,200.00	-	$ -	8.00	$ 1,200.00	-	$ -	-	$ -	4.00	$ 600.00	-	$ -
PUG	Dyrno, Glenn	GS	508	GIS/CADD	Specialist VIII	$ 150.00	8.00	$ 1,200.00	-	$ -	18.00	$ 2,700.00	6.00	$ 900.00	-	$ -	8.00	$ 1,200.00	-	$ -
						$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
TUC	Chapman, Caitlyn	ER	509	Environmental Resources	Specialist IX	$ 161.00	4.00	$ 644.00	-	$ -	6.00	$ 966.00	-	$ -	-	$ -	-	$ -	37.00	$ 5,957.00
PHX	Branch, Spencer	PL	505	Planning	Specialist V	$ 117.00	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	109.00	$ 12,753.00
PUG	Backes, Chris	PL	512	Planning	Specialist XII	$ 215.00	-	$ -	-	$ -	4.00	$ 860.00	-	$ -	-	$ -	-	$ -	10.00	$ 2,150.00
SLC	Silverstein, Grace	ER	504	Environmental Resources	Specialist IV	$ 107.00	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	40.00	$ 4,280.00
SAC	Newell, Angela	GS	509	GIS/CADD	Specialist IX	$ 161.00	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	26.00	$ 4,186.00
PUG	Sawyer, Bryan	PL	504	Planning	Specialist IV	$ 107.00	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	140.00	$ 14,980.00
						$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
						$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
						$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
TUC	Sangerman, Drew	PL	501	Planning	Specialist I	$ 72.00	-	$ -	-	$ -	74.00	$ 5,328.00	40.00	$ 2,880.00	-	$ -	-	$ -	-	$ -
				Labor Subtotal			94.00	$ 13,412.00	-	$ -	302.00	$ 37,960.00	106.00	$ 11,992.00	65.50	$ 6,953.50	132.25	$ 17,608.25	362.00	$ 44,306.00
				Communication Fee - % of Labor		0%		$ -		$ -		$ -		$ -		$ -		$ -		$ -
				Labor Total			94.00	$ 13,412.00	-	$ -	302.00	$ 37,960.00	106.00	$ 11,992.00	65.50	$ 6,953.50	132.25	$ 17,608.25	362.00	$ 44,306.00
TRAVEL EXPENSES																			
				Description	Unit	Rate	# Units	Charge	# Units	Charge	# Units	Charge	# Units	Charge	# Units	Charge	# Units	Charge	# Units	Charge
				Travel Expenses Total				$ -		$ -		$ -		$ 215.63		$ 35.94		$ 179.69		$ 372.50
OTHER EXPENSES																			
				Description	Unit	Rate	# Units	Charge	# Units	Charge	# Units	Charge	# Units	Charge	# Units	Charge	# Units	Charge	# Units	Charge
				Other Expenses Total				$ -		$ -		$ -		$ 2,300.00		$ 23.00		$ -		$ 74.75
				TOTAL EXPENSES				$ -		$ -		$ -		$ 2,515.63		$ 58.94		$ 179.69		$ 247.25
				Project Phase Total				$ 13,412.00		$ -		$ 37,960.00		$ 14,507.63		$ 7,012.44		$ 17,787.94		$ 44,553.25

Note: Communication expense is not subject to 15% administrative fee.

TOTAL PROJECT	Charges
SWCA Labor Total	$ 122,231.75
Expenses Total	$ 3,001.50
Subcontractors Total	$ -
Total Project	$ 135,233.25
Tax Total	$ -
Total Including Taxes	$ 135,233.25

MARANA REGIONAL AIRPORT
New Air Traffic Control Tower
Planning and Environmental Documentation
2023

	A	B	C	D	E	H	I	J	K
1	**ELEMENTS AND TASKS - DBE PROGRAM UPDATE**	**Project Principal 208.93**		**Senior Planner 202.69**		**Administration 77.95**		**Totals of Element**	
2		**Hours**	**Cost**	**Hours**	**Cost**	**Hours**	**Cost**		
3									
4	**ELEMENT 1 - PROJECT MANAGEMENT (Dibble)**								
5	***Task 1.1 Project Management and Administration***								
6	***Sub Total***								
7									
8	**TASK B3.3.3. VISUAL RESOURCES**								
9	***SUBTASK B3.3.3 B. KEY OBSERVATION POINTS AND BASELINE PHOTOGRAPHS***								
10	***Daytime Photography***	8.00		8.00					
11	***Nightime Photography***	8.00		8.00					
12	***Data Analysis and Photo Selection***	8.00		8.00		4.00			
13	***Sub Total***	**24.00**	**$ 5,014.32**	**24.00**	**$ 4,864.56**	**4.00**	**$ 311.80**	**$10,190.68**	
14									
15									
16									
17	**Subtotal Hours and Fees**	**24.00**	**$ 5,014.32**	**24.00**	**$ 4,864.56**	**4.00**	**$ 311.80**	**$10,190.68**	
18									
19	**Total Hours**		**52**						
20	**Travel and Expenses**		**$ 1,200.00**						
21	**Total Fees**		**$ 11,390.68**						
22									
23									
24	**Total (NTE)**		**$ 11,390.68**						
25									
26									
27									
28									

GENESIS CONSULTING GROUP

p 602.957.1155 | 7878 North 16th Street, Suite 300
f 602.957.2838 | Phoenix, AZ 85020
dibblecorp.com

September 12, 2022

MARANA AZ
PUBLIC WORKS

Capital Improvement Program
☒ No Exceptions Taken
☐ Accepted as Noted
☐ Revised and Resubmit
☐ Not Accepted
By: Greg Dollak Date: 3/17/23

Galen Beem
Airport Superintendent
Marana Regional Airport
11700 W. Avra Valley Rd.
Marana, AZ 85653

RE: **AIRPORT CONSULTING SERVICES PROPOSAL**
Task 6 for General Airport Engineering On-Call Services
Marana Regional Airport
Disadvantaged Business Enterprise (DBE) Reporting for Year 2023

Dear Galen:

We appreciate the opportunity to provide airport consulting services to the Town of Marana for DBE participation reporting for federal fiscal year 2023 for Marana Regional Airport. Maintaining a current DBE Program is one provision of the FAA grant assurances for Airport Improvement Program (AIP)-funded projects. This project/scope of work includes helping the Town track and report DBE participation on federally funded environmental assessment for the proposed Air Traffic Control Tower (ATCT) between October 1, 2022 and September 30, 2023.

Dibble will provide general project management, support, and coordination throughout the contract/task period. Genesis Consulting Group (Genesis), a subconsultant to Dibble under our Professional Services Contract 2018-148, will complete all necessary federal DBE reporting.

The Dibble team will complete the services noted in the general Scope of Work above and Genesis' detailed Scope of Work (attached) for a lump sum fee of **$5,573.76**, which consists of a Dibble fee of $1,000.00 and a Genesis fee of $4,573.76.

We are very much looking forward to continuing our partnership with the Town of Marana on this important project. If you need additional information or have questions, please do not hesitate to call.

Sincerely,

Carmen M. Rose, P.E
Project Manager, Airport Development Practice
Dibble

Ryan W. Toner, P.E.
Vice President/Transportation Business Unit Leader
Dibble

DIBBLE

MARANA AZ

Marana Regional Airport (AVQ)
Disadvantaged Business Enterprise Program (DBE)
Federal Fiscal Year (FFY) 2023
Scope of Work
Revised 8.11.2022

Dibble Engineers and Genesis Consulting Group, LLC (Consultant) have been requested by the Marana Regional Airport (Sponsor) to prepare a Year-2 Annual DBE Update for the recently completed Disadvantaged Business Enterprise (DBE) Program, Triennial DBE Goals Methodology Report - FFY 2022 – 2024.
The primary tasks include:

1. Update the DBE Program, for FFY 2023, for annual/project level federally funded projects that exceed a cumulative value of $250,000/FFY.
2. Calculate annual/project level specific goals for the projects undertaken in the FFY.

ELEMENT 1
PROJECT MANAGEMENT AND ADMINISTRATION

Task 1.1 Project Management and Administration

Dibble will provide and direct project management and coordination between team members, the Sponsor, and other interested stakeholders, as necessary. Administration shall include tasks such as file coordination and organization and on-going miscellaneous project communications throughout the course of the program update phase. Monthly invoicing shall be submitted to the Sponsor in a format acceptable to the Sponsor.

ELEMENT 2
UPDATE DISADVANTAGED BUISNESS ENTERPRISE PROGRAM FOR ANNUAL UPDATES AND PROJECT SPECIFIC GOALS AND ANNUAL UPDATES

Task 2.1 Develop Annual and Project Level Specific DBE Goals

Update the DBE Program, for FFY 2023, for annual/project level federally funded projects that exceed a cumulative value of $250,000/FFY.

- The two-step process will be conducted as prescribed by the regulations contained in 49 CFR Part 26, to determine base figures necessary to calculate annual/project level DBE goals. Methodology's chosen will be based on demonstrable evidence of market conditions and be designed to attain a goal that is rationally related to the relative availability of DBEs in the market area.

- The goals will reflect the relative availability of ready, willing, and able DBE's. Research of these DBE's will be conducted as necessary to develop the DBE goals.
- The Consultant will determine the reasonable local market area for ready and willing DBE's.

Task 2.2 Deliverable - Draft Annual and Project Level DBE Goals
Calculate project level DBE goals for projects undertaken in FFY 2023 and submit for review. One meeting will be held internally to review recommended goals for project level DBE participation

Task 2.3 Deliverable – Final Annual and Project level DBE Goals for FFY 2023
After concurrence with Sponsor, produce final project level DBE goals for projects undertaken in FFY 2023.

ELEMENT 3
FAA REPORTING

Task 3.1 Prepare/Update Historic Uniform Report of DBE Commitments/Award and Payments for FFY 2023
Consultant will prepare and update historical Marana Regional Airport DBE participation data utilizing the FAA Civil Rights Connect Website, including Uniform Report of DBE Commitment and Award for Federal Fiscal Years 2022 and 2023 as required.

DELIVERABLES AND MEETINGS	TASK	MEETINGS
DELIVERABLES		
Draft Annual and Project level DBE Goals for FFY 2023	2.2	1
Final Annual and Project level DBE Goals for FFY 2023	2.3	
Prepare/Update Historic Uniform Report of DBE Commitments/Award and Payments for FFY 2023Project Kick-off Meeting	3.1	

End of Scope of Services

MARANA REGIONAL AIRPORT
Disadvantaged Business Enterprise Program
Elements, Tasks, and Fees

	A	B	C	D	E	H	I
1							
2	**ELEMENTS AND TASKS - AVQ DBE PROGRAM UPDATE (Year 2) FFY 2023**	**Project Principal 199.58**		**Senior Planner 184.14**		**Administration 59.40**	
3		**Hours**	**Cost**	**Hours**	**Cost**	**Hours**	**Cost**
4							
5							
6	**ELEMENT 1 - PROJECT MANAGEMENT**						
7	***Task 1.1 Project Management and Administration***						
8	***Sub Total***	**0.00**		**0.00**			
9							
10	***ELEMENT 2 - ANNUAL UPDATES AND PROJECT SPECIFIC GOALS***						
11	***Task 2.1 - Annual Goals and Methodology Reports FFY 2023***	4.00		6.00			
12	***Task 2.2 - Draft Project/Annual Goals and Methodology Report***	2.00		4.00			
13	***Task 2.3 - Final Annual Goals and Methodology Report***	2.00		2.00			
14	***Sub Total***	**8.00**	**$ 1,596.64**	**12.00**	**$ 2,209.68**		
15							
16							
17	***ELEMENT 4 - FAA ANNUAL REPORTING***						
18	***Task 3.1 Prepare Program Uniform Report of DBE Commitments/Awards and Payments***	2.00		2.00			
19	***Sub Total***	**2.00**	**$ 399.16**	**2.00**	**$ 368.28**		
20							
21	**Subtotal Hours and Fees**	**10.00**	**$ 1,995.80**	**14.00**	**$ 2,577.96**		
22							
23	**Total Fees**		**$ 4,573.76**				
24	**Expenses**						
25	**Printing**						
26	**Total Program Year 2023 (Lump Sum)**		**$ 4,573.76**				

Council-Regular Meeting **C4**

Meeting Date: 11/19/2024

To: Mayor and Council

From: Debbie Thompson, Deputy Town Clerk

Date: November 19, 2024

Subject: Approval of Study Session Summary Minutes of October 29, 2024, and approval of Regular Council Meeting Summary Minutes of November 6, 2024 (David L. Udall)

Attachments

Study Session Summary Minutes, 10-29-2024

Regular Council Meeting Summary Minutes, 11/06/2024

MARANA TOWN COUNCIL
STUDY SESSION
11555 W. Civic Center Drive, Marana, Arizona 85653
Second Floor Conference Center, October 29, 2024, at or after 6:00 PM

Ed Honea, Mayor
Jon Post, Vice Mayor
Patti Comerford, Council Member
Jackie Craig, Council Member
Herb Kai, Council Member
John Officer, Council Member
Roxanne Ziegler, Council Member

SUMMARY MINUTES

CALL TO ORDER AND ROLL CALL

Mayor Honea called the meeting to order at 6:00 PM and directed the Deputy Town Clerk to call the roll. **Council Member Craig** was absent. **Council Member Officer** was absent for the Roll Call, Pledge, and Approval of Agenda but was present at 6:02 PM. All other Council Members were present, constituting a quorum.

PLEDGE OF ALLEGIANCE/INVOCATION/MOMENT OF SILENCE: Led by **Mayor Honea.**

APPROVAL OF AGENDA

Council Member Ziegler moved to approve the agenda as presented. Council Member Kai seconded the motion. Motion passed, 5-0.

DISCUSSION/DIRECTION/POSSIBLE ACTION

D1 Relating to Tourism; presentation providing an update on the Town of Marana Tourism Master Plan; discussion and possible direction on current plan progress (Stefanie Boe)

[Council Member Officer was now present.]

A copy of the presentation slides is on file with the Town Clerk's Office. Clarifying questions were asked and answered throughout the presentation. For more detailed information, including images and charts, please see the presentation slides.

Town Manager Mr. Rozema, introduced **Tourism & Marketing Manager Stefanie Boe**, the Tourism Master Plan consultants, and the Tourism Master Plan. He explained that this presentation was meant to provide an update to the Council and provide an opportunity for the Tourism Committee to present its work thus far and to receive guidance and direction from the Council regarding the Plan.

Ms. Boe provided an overview of the Tourism Master Plan. She highlighted the Town's tourism-related billboards on Interstate 10 and explained that they help people realize they are in Marana when they are traveling on the Interstate. She said the Town won the Office of Tourism Award for a partnership with Oro Valley for the Tucson Bicycle Classic. **Ms. Boe** introduced **Mr. Matthew Landkamer** and **Ms. Stacy Humphrey** from **Whereabout Destination Strategies**, the Town's consulting firm for the Tourism Master Plan.

Council Member Ziegler asked where the billboards are located. **Ms. Boe** said that one is located right by Estes Elementary School and the other is not far from that location. She explained the billboards are facing traffic as people come into Tucson from Phoenix.

Ms. Boe provided some history on the Tourism Master Plan. She said the official kick off was in February 2024. She said the Tourism Committee has been working to gather and bring information to the Council for input. One of the highlights of the planning sessions were trips taken to Gilbert and Queen Creek. Another part of the research involved having an in-market assessment that involved one of the consultants posing as a tourist or shopper at various locations in Marana. For a timeline of the efforts put forward so far on the Tourism Master Plan, please see the presentation slides.

Mr. Landkamer and **Ms. Humphrey** then presented. They introduced themselves and their company and described their experience. They specialize in communities similar in size to Marana and focus on helping communities develop a robust and lasting visitor economy over time.

Mr. Landkamer said that they drafted a Vision for the Town's Tourism Master Plan. Some of the themes and highlights to consider for the Plan were represented in the following words: trailblazing, welcoming, friendly, family, businesses, and festivals. For more detail, please see the presentation slides. The consultants also developed a

Competitive Position Statement designed to help the Town understand the current State of Marana and what tourism assets it currently has. During the presentation, the consultants explained the current state of tourism in Marana and outlined different phases of what tourism growth could look like in Marana. They outlined the Tourism Master Plan timeline and explained next steps. For more detail, please see the presentation slides.

Mayor Honea commented that Marana was built on Cotton Farming and requested that cotton farming should be represented somewhere in the plan.

Council Member Ziegler commented that the Town does not have a lot of restaurants in North Marana. **Ms. Humphrey** said that while there were not a lot of restaurants now, the Plan is designed for the future and part of the plan is to help grow the restaurant environment in the Town.

Vice Mayor Post asked for clarification regarding the goals of the Tourism Master Plan. He said he was interested in the scope of the Plan.

Mr. Landkamer explained that the Plan has several objectives designed to shape tourism in the Town for the next ten years. He explained that there will be measurable objectives to make sure the Town is moving in the right direction. **Ms. Humphrey** said the Tourism Master Plan helps the Town to have a steering wheel that will help the Town reach the vision it embraces. Please see the presentation slides for more detail.

Vice Mayor Post asked if the Plan included ways of finding out who is coming to the Town now. He asked how in depth Plan will go. **Ms. Boe** reminded the Council that the Tourism Master Plan is a part of the Town's Strategic Plan Five and said data was being obtained and evaluated regarding where people are coming from, how to attract more people to Marana, and how to get people to stay longer. She said the Tourism Master Plan is a very comprehensive plan that includes all aspects of tourism. She emphasized that the Plan will be data driven and very transparent. **Vice Mayor Post** thanked **Ms. Boe** for her explanation.

Council Member Ziegler wanted to know if Town staff knew how much money tourism brings into the community. **Economic Development Director Curt Woody** stated that the Town of Marana brings in approximately $200 million a year in economic impact from tourism. He clarified that it was not money coming into the Town as an entity directly, but that it was the estimated economic impact within the Town limits. **Council Member Ziegler** asked to see data on the numbers. **Mr. Woody** said he would send her the information. **Finance Director Yiannis Kalaitzidis** said that during Fiscal Year 2024, the bed tax fund brought in $1,734,000.00. He said before that it was around $1.9 million per year.

Council Member Kai commented that the Tucson Rodeo brings in several million dollars a year and that the Town should be able to capture some of that. **Council Member Ziegler** agreed and mentioned other events in Tucson that bring money into Marana from hotel stays, restaurants, and shopping.

Vice Mayor Post asked for a definition of tourism. **Ms. Humphrey** explained that tourism is any visitation from greater than 50 miles away. She explained that the current key drivers for tourism in the Town are people visiting friends and relatives that live in the Town, outdoor recreation, agri-western experiences, and day visitation for Town festivals. She said the Town is currently generating mostly one-day-visit tourism and isn't generating as much income from overnight stays. She explained that overnight stays significantly increase the economic impact of tourism.

Vice Mayor Post asked if it would be considered tourism if someone came down from the Phoenix Metro area and used the Loop path in Marana/Pima County. **Ms. Humphrey** confirmed that that type of visit would be considered tourism.

Vice Mayor Post commented that the Plan's goals were good and that they really fit what the Council wants. **Mayor Honea** commented that the Town needed to focus on hotel stays and dining and tap into tourism already brought to the Town by activities and events provided by the region. He also would like to focus on finding out what can be done to get people to spend money in Marana.

Vice Mayor Post agreed and said that sometimes Marana piggybacks off of Tucson events because the Town lacks some of the things that promote tourism.

Council Member Ziegler agreed and said that Marana has been living off of greater Tucson events and asked what the Town will do to become a destination. She said Marana needs to establish itself as a destination, and that we need more than just our current events.

Mayor Honea pointed out that the Ritz Carlton is probably the closest thing the Town has to a destination. **Council Member Officer** suggested the Tortolita Mountains with a focus on bat and bird watching were possible reasons for people to visit and stay. **Council Member Ziegler** said the El Rio Preserve was a great amenity and said many of the Town's residents do not know about it and that it could be improved and promoted for bird watchers. **Mayor Honea** agreed and added that the new Aquatic Center can become another destination. **Council Member Kai** suggested golf tournaments as another possible tourist draw.

Vice Mayor Post brought up the importance of advertising, and the importance of getting the word out about what there is to do in Marana. **Ms. Boe** said it was important to capitalize on things that Marana already has going on, including partnering with and supporting organizations that already exist in the town. She said she would like to start a grant fund to help non-profits grow and advertise what they have to offer. She pointed out that there are many untapped possibilities for tourism, including the Heritage Park where the Town has 160 acres of under-utilized land. She also discussed the importance of having a powerful SEO (search engine optimization) and explained how the Town has the most powerful SEO in the area and many of the Town's events are highlighted when a search is done.

Discussion ensued between Council Members and **Ms. Boe** regarding possibilities to increase tourism in the Town, including visits to the Saguaro National Park, Ironwood Forest, the Town's signature events, and the Tortolita Mountains.

Ms. Humphrey reiterated the importance of using data to track attendance at events. She also explained the importance of having a catchment area, where a tourist stays in one place and visits other places.

Mayor Honea highlighted the importance of having people stay the night in Marana.

Council Member Ziegler said the Town should find ways to support businesses like Lil Abner's. **Ms. Boe** and **Town Attorney Jane Fairall** reminded the Council that there are legal limits on how the Town can assist private businesses.

Council Member Comerford thanked **Ms. Boe** and the consultants for seeking Council input regarding the Tourism Master Plan while it was in its early stages of development as opposed to presenting the Council with a finished product.

Mr. Rozema summarized the Council's input thus far and highlighted the importance of the Town's work on developing Marana's downtown. He said the Tourism Master Plan is an important tool to help draw people to the Town of Marana.

EXECUTIVE SESSIONS

Pursuant to A.R.S. § 38-431.03, the Town Council may vote to go into executive session, which will not be open to the public, to discuss certain matters.

E1 Executive Session pursuant to A.R.S. §38-431.03 (A), Council may ask for discussion or consideration, or consultation with designated Town representatives, or consultation for legal advice with the Town Attorney, concerning any matter listed on this agenda for any of the reasons listed in A.R.S. §38-431.03 (A).

FUTURE AGENDA ITEMS

Notwithstanding the Mayor's discretion regarding the items to be placed on the agenda, if three or more Council members request that an item be placed on the agenda, it must be placed on the agenda for the second regular Town Council meeting after the date of the request, pursuant to Marana Town Code Section 2-4-2(B).

Mayor Honea asked for future agenda items. There were no requests for future agenda items.

ADJOURNMENT

Mayor Honea asked for a motion to adjourn the meeting.

Vice Mayor Post moved to adjourn the meeting. Council Member Kai seconded the motion. Motion passed, 6-0. Meeting adjourned at 7:10 PM.

CERTIFICATION

I hereby certify that the foregoing are the true and correct minutes of the Marana Town Council Study Session Meeting held on October 29, 2024. I further certify that a quorum was present.

_____

Debbie Thompson, Deputy Town Clerk

DRAFT

MARANA TOWN COUNCIL
REGULAR COUNCIL MEETING
11555 W. Civic Center Drive, Marana, Arizona 85653
Council Chambers, November 6, 2024, at or after 6:00 PM

Ed Honea, Mayor
Jon Post, Vice Mayor
Patti Comerford, Council Member
Patrick Cavanaugh, Council Member
Herb Kai, Council Member
John Officer, Council Member
Roxanne Ziegler, Council Member

SUMMARY MINUTES

CALL TO ORDER AND ROLL CALL

Mayor Honea called the meeting to order at 6:01 PM and directed the Town Clerk to call the roll. **Council Member Kai** was absent. All other Council Members were present, constituting a quorum.

PLEDGE OF ALLEGIANCE/INVOCATION/MOMENT OF SILENCE: Led by **Mayor Honea.**

APPROVAL OF AGENDA

Mayor Honea asked for a motion to approve the agenda.

Council Member Ziegler moved to approve the agenda. Council Member Officer seconded the motion. Motion passed, 6-0.

CALL TO THE PUBLIC

PROCLAMATIONS

MAYOR AND COUNCIL REPORTS: SUMMARY OF CURRENT EVENTS

Council Member Cavanaugh complemented the Loop extension recently completed in Marana along with all who participated to make it possible. He also complemented Parks and Recreation staff on their work at the El Rio Preserve.

Vice Mayor Post welcomed **Council Member Cavanaugh** to his first meeting on the Town Council. He said he was excited to work with him and expected the Council would continue to do good things.

Mayor Honea congratulated **Council Member Ziegler** and **Council Member Cavanaugh** on their recent election and welcomed **Council Member Cavanaugh** to the Town Council. He said he has worked with **Council Member Cavanaugh** and thinks he will do great on the Council.

MANAGER'S REPORT: SUMMARY OF CURRENT EVENTS

Town Manager Terry Rozema said there were 83 single-family residential permits issued for the month of October. He said 93 were issued last October. He said construction of phase one of the Saguaro Bloom park has begun and is going well and provided an update on the construction of the Marana Aquatics and Recreation Center (the MARC). He said the MARC still has an estimated completion date of May 2025. He said the Town's Christmas tree is currently being assembled in preparation for the Holiday Festival on December 7, 2024. He also reminded the Council that there were several upcoming RTA Next public outreach meetings.

Council Member Ziegler asked about what is on the agenda for the RTA Next meetings. **Mr. Rozema** explained that RTA staff will present and provide the public the opportunity to ask questions and fill out a survey. He said the purpose of the meetings is to receive public feedback on the projects currently contemplated. **Council Member Ziegler** asked if the City of Tucson was going to their voters on this. **Mr. Rozema** explained that separate from the RTA initiative, the City was going to its voters with a half-cent sales tax ballot initiative for various quality of life issues.

Mayor Honea highlighted that the purpose of the RTA next outreach meetings is to receive public input.

PRESENTATIONS

P1 Relating to Budget; presentation of first quarter results (July-September) for the Town's General Fund and other selected major funds for the 2024-2025 fiscal year (Yiannis Kalaitzidis)

Finance Director Yiannis Kalaitzidis presented on this item. A copy of the presentation slides is on file with the Town Clerk's Office. **Mr. Kalaitzidis** provided the Council with an overview of the Town's first quarter results for the Town's General Fund and other selected major funds for the 2024-2025 fiscal year. For detailed information, please see the presentation slides.

CONSENT AGENDA

The Consent Agenda contains items requiring action by the Council which are generally routine items not requiring Council discussion. A single motion and affirmative vote will approve all items on the Consent Agenda, including any resolutions or ordinances. Prior to a motion to approve the Consent Agenda, any Council member may remove any item from the Consent Agenda and that item will be discussed and voted upon separately.

C1 Ordinance No. 2024.023: Relating to Business Regulations; revising Marana Town Code Title 9 (Business Regulations), Chapter 9-14 (Short-Term and Vacation Rentals), Section 9-14-9 (Compliance with laws; prohibited uses) to provide that accessory dwelling units may only be used for short-term rentals if and while the owner resides on the property that contains the accessory dwelling unit; and designating an effective date (Jane Fairall)

C2 Resolution No. 2024-098: Relating to Budget; approving the addition of a new Capital Improvement Project known as the Network Redesign project in the fiscal year 2024-2025 budget (Ricardo Carlos)

C3 Resolution No. 2024-099: Relating to Development; approving the final plat for Mandarina - Parcel 1, Lots 1-122 & Tracts A-M generally located north of Tangerine Road and east of Interstate 10 within a portion of Section 31, Township 11 South and Range 12 East (Scott Radden)

C4 Resolution No. 2024-100: Relating to Development; approving the final plat for Mandarina- Parcel 2, Lots 123-182 & Tracts A-E generally located north of Tangerine Road and east of Interstate 10 within a portion of the east half of Section 36, Township 11 South, Range 11 East and a portion of the west half of Section 31, Township 11 South and Range 12 East (Scott Radden)

C5 Approval of Regular Meeting Summary Minutes of October 15, 2024 (David L. Udall)

Vice Mayor Post moved to approve the consent agenda. Council Member Officer seconded the motion. Motion passed, 6-0.

LIQUOR LICENSES

BOARDS, COMMISSIONS AND COMMITTEES

COUNCIL ACTION

ITEMS FOR DISCUSSION / POSSIBLE ACTION

D1 Relating to Development and Public Works; update, discussion, and possible direction regarding public and private projects and development applications on the Town's Marana Current and Proposed Projects internet site (Jason Angell)

Development Services Director Jason Angell provided an update and answered questions related to public and private projects and development applications in the Town, as currently listed on the following website:

https://maranaegov.com/portal/apps/experiencebuilder/experience/?draft=true&id=dae15ad306fb4a3fba65ee3babc21d54&page=Page&views=Water-Management%2CInspections

D2 Relating to Mayor and Council; selection of the Vice Mayor (David L. Udall)

Mayor Honea moved to select Jon Post as Vice Mayor for the Town of Marana. Council Member Comerford seconded the motion. Motion Passed, 5-1, with Council Member Ziegler voting Nay.

EXECUTIVE SESSIONS

Mayor Honea asked for a motion to go into Executive Session on items E2, E3, and E4.

Vice Mayor Post so moved. Motion passed, 6-0.

[An Executive Session was held on Items E2 through E4, beginning at 6:26 PM and concluding at 7:22 PM.]

Once back in open session, **Mayor Honea** asked for motions on Items E2, E3, and E4. The motions are reflected below.

Pursuant to A.R.S. § 38-431.03, the Town Council may vote to go into executive session, which will not be open to the public, to discuss certain matters.

E1 Executive Session pursuant to A.R.S. §38-431.03 (A), Council may ask for discussion or consideration, or consultation with designated Town representatives, or consultation for legal advice with the Town Attorney, concerning any matter listed on this agenda for any of the reasons listed in A.R.S. §38-431.03 (A).

E2 Executive Session pursuant to A.R.S. § 38-431.03(A)(7), discussion or consultation with the Town Manager, Finance Director, and Town Attorney in order to consider the Town's position and instruct its representatives regarding negotiations for the possible purchase of real property owned by Marana Health Center, Inc. located near the Marana Municipal Complex.

Vice Mayor Post moved to direct Town staff to proceed as discussed in Executive Session. Council Member Officer seconded the motion. Motion passed, 6-0.

E3 Executive Session pursuant to A.R.S. § 38-431.03(A)(7), discussion or consultation with the Town Manager, Finance Director, and Town Attorney in order to consider the Town's position and instruct its representatives regarding negotiations for the possible purchase of real property owned by Oracle Greenock, LLC located near Gladden Farms Community Park

Vice Mayor Post moved to direct Town staff to proceed as discussed in Executive Session. Council Member Comerford seconded the motion. Motion passed, 6-0.

E4 Executive session pursuant to A.R.S. §38-431.03 (A)(3) and (4) for discussion or consultation with the Town's attorneys and to instruct the Town's representatives concerning the litigation entitled *Southern Arizona Home Builders Association v. Town of Marana,* Pima County Superior Court Case No. C20184411.

Council Member Cavanaugh moved to direct Town staff to proceed as discussed in Executive Session. Vice Mayor Post seconded the motion. Motion passed, 6-0.

FUTURE AGENDA ITEMS

Notwithstanding the Mayor's discretion regarding the items to be placed on the agenda, if three or more Council members request that an item be placed on the agenda, it must be placed on the agenda for the second regular Town Council meeting after the date of the request, pursuant to Marana Town Code Section 2-4-2(B).

Mayor Honea asked for future agenda items.

Council Member Ziegler requested a status update on the Airport's Master Development Lease negotiations. She said it has been a while and felt that Pima Aviation

has not communicated with the Town. **Mr. Rozema** said Town staff could provide an update during a Council meeting or during upcoming two-on-two meetings**. Council Member Ziegler s**aid the Town needed to complete the contract by the end of the calendar year. **Mr. Rozema** said the Council authorized a six-month extension of the Lease and **Town Clerk / Assistant Town Attorney David Udall** said the Lease, as extended, would expire in March 2025. **Council Member Ziegler** asked if the Town had heard from Pima Aviation. **Mr. Udall** said Town staff has heard a little bit from them, but not much.

Council Member Ziegler said it was fine to receive an update in upcoming two-on-two meetings.

ADJOURNMENT

Mayor Honea asked for a motion to adjourn.

Vice Mayor Post moved to adjourn the meeting. Motion passed, 6-0. The meeting was adjourned at 7:25 PM.

CERTIFICATION

I hereby certify that the foregoing are the true and correct minutes of the regular Town Council meeting held on November 6, 2024. I further certify that a quorum was present.

_____

David L. Udall, Town Clerk

DRAFT

Council-Regular Meeting **A1**

Meeting Date: 11/19/2024

To: Mayor and Council

From: Austin Shreffler, Planner

Date: November 19, 2024

Strategic Plan Focus Area:
Not Applicable

Subject: PUBLIC HEARING: Ordinance No. 2024.024: Relating to Development; approving a modification of a rezoning condition of Marana Ordinance No. 2021.016, which rezoned approximately 49 acres of land located approximately one-quarter mile south of Ina Road, west of Silverbell Road, to revise a provision of the ordinance that required all utilities outside of the Western Area Power Administration (WAPA) easement to be located underground (Austin J. Shreffler)

Discussion:

On August 17, 2021, the Mayor and Council adopted Ordinance No 2021.016, approving the rezoning of approximately 49 acres of land generally located approximately one-quarter mile south of Ina Road, west of Silverbell Road, from R-16 (Residential) to R-6 (Residential). The rezoning ordinance included a number of conditions, including condition #15 which requires all utilities to be underground, and all utility trenches to be revegetated with the exception of the overhead electric WAPA (Western Area Power Administration) easement. The applicant, Bud Cardinal, has requested that Ordinance No 2021.014, condition 15 be modified to exempt the existing overhead TEP electric line from undergrounding and to clarify that all new utilities servicing the rezoning area shall be underground. The applicant is requesting this modification based on recent TEP upgrades to the existing line due to summer moonsoon damage and conflicts with the Open Space Covenant. This condition modification is insubstantial enough to not require or benefit from Planning Commission consideration. Notice of this public hearing was published as required by law.

Section 2, Condition #15 of Ordinance No. 2021.016 is proposed to be revised as follows, with deletions shown with strikeouts and additions shown underlined:
All open space easements and wildlife corridors shall be left entirely undisturbed and in their natural desert state, except for necessary utility installations, which shall be revegetated. All such easements and corridors shall be dedicated to the appropriate entity, acceptable to the Town and at a time acceptable to the Town. All new utilities which will service the Rezoning Area shall be underground, and all utility trenches shall be revegetated to be identical with the surrounding desert . ~~with the exception of~~ All existing ~~the~~ overhead electric lines within existing TEP andWAPA easements ~~which~~ shall be to WAPA and TEP specifications and are not required to be underground.

Staff Recommendation:

This is a discretionary item for the Council to consider. Staff has no objection to the requested rezoning condition modification.

Suggested Motion:

I move to adopt Ordinance No. 2024.024, approving a modification of a rezoning condition of Marana Ordinance No. 2021.016 which required the property owner to underground all utilities, including the existing overhead TEP electric line.

Attachments

Ordinance No. 2024.024
Applicant Request
Location Map
Application
Ordinance 2021.16

MARANA ORDINANCE NO. 2024.024

RELATING TO DEVELOPMENT; APPROVING A MODIFICATION OF A REZONING CONDITION OF MARANA ORDINANCE NO. 2021.016, WHICH REZONED APPROXIMATELY 49 ACRES OF LAND LOCATED APPROXIMATELY ONE- QUARTER MILE SOUTH OF INA ROAD, WEST OF SILVERBELL ROAD, TO REVISE A PROVISION OF THE ORDINANCE THAT REQUIRED ALL UTILITIES OUTSIDE OF THE WESTERN AREA POWER ADMINISTRATION (WAPA) EASEMENT TO BE LOCATED UNDERGOUND

WHEREAS the Mayor and Council of the Town of Marana adopted Ordinance No. 2021.016 on August 17, 2021, approving a rezoning of approximately 49 acres of land located approximately one-quarter mile south of Ina Road, west of Silverbell Road; and

WHEREAS approval of the rezoning was subject to a number of conditions, including condition 15 which requires, among other things, all utilities to be underground with the exception of the overhead electric Western Area Power Administration (WAPA) line; and

WHEREAS the property owner has applied to the Town to modify condition 15 to permit existing Tucson Electric Power (TEP) lines to remain above ground; and

WHEREAS the Mayor and Council find that modification of condition 15 as set forth in this ordinance is insubstantial enough not to require or benefit from Planning Commission consideration, and that this ordinance is in the best interests of the Town and its citizens.

NOW, THEREFORE, BE IT ORDAINED by the Mayor and Council of the Town of Marana, Arizona, as follows:

Section 1. Section 2, condition 15 of Marana Ordinance No. 2021.016 is hereby revised as follows, with deletions shown with ~~strikeouts~~ and additions shown with double-underlining:

15. All open space easements and wildlife corridors shall be left entirely undisturbed and in their natural desert state, except for necessary utility installations, which shall be revegetated. All such easements and corridors shall be dedicated to the appropriate entity, acceptable to the Town and at a time acceptable to the Town. All new utilities which will service the Rezoning Area shall be underground, and all utility trenches shall be revegetated to be identical with the surrounding desert. ~~with the exception of~~ All existing ~~the~~ overhead electric lines within existing TEP and WAPA easements ~~which~~ shall be to WAPA and TEP specifications and are not required to be underground.

Section 2. All ordinances or parts of ordinances in conflict with the provisions of this

ordinance are repealed as of the effective date of this ordinance.

Section 3. If any section, subsection, sentence, clause, phrase or portion of this ordinance is for any reason held to be invalid or unconstitutional by the decision of any court of competent jurisdiction, the decision shall not affect the validity of the remaining portions of this ordinance.

PASSED AND ADOPTED by the Mayor and Council of the Town of Marana, Arizona, this 19th day of November 2024.

_____
Mayor Ed Honea

ATTEST:

_____
David L. Udall, Town Clerk

APPROVED AS TO FORM:

_____
Jane Fairall, Town Attorney

Bud and Penny Cardinal Family LLLP
c/o Bud Cardinal
7608 North La Cholla Boulevard
Tucson, Arizona 85741

October 24, 2024

VIA EMAIL

Town of Marana
c/o Town of Marana Planning
11555 West Civic Center Drive
Marana, Arizona 85653
maranaplanning@MARANAAZ.GOV

Re: Silverbell Ridge Rezoning Condition #15 Modification

Dear Town of Marana:

This letter outlines a request for a modification (the "Rezoning Condition Modification") to Marana Ordinance No. 2021.016, Condition #15 ("Condition 15) for the Silverbell Ridge Single-Family Residential Subdivision in Marana, Arizona (the "Property"). The following is the current Condition 15:

> "All open space easements and wildlife corridors shall be left entirely undisturbed and in their natural desert state, except for necessary utility installations, which shall be revegetated. All such easements and corridors shall be dedicated to the appropriate entity, acceptable to the Town and at a time acceptable to the Town. All utilities shall be underground, and all utility trenches shall be revegetated to be identical with the surrounding desert with the exception of the overhead electric WAPA easement which shall be to WAPA specifications."

A Property depiction has been included in **Exhibit A** which includes existing and proposed utilities. There are two Tucson Electric Power ("TEP") lines and one Western Area Power Administration ("WAPA") Line that are or will be located throughout the project:

1. The first is a new underground electric line to be constructed to service the subdivision and future homes which commences at the Southwest corner of Ina and Silverbell up to and throughout the subdivision. All of the newly constructed lines servicing the subdivision will be located underground within public rights-of-way.
2. The second is an existing TEP line (the "Existing Line"), which the utility provider has confirmed the line carries 46kV.
3. Lastly, a high-voltage (over 48kV) WAPA transmission line (the "WAPA Lines") is located adjacent to the TEP line, within a 100' right-of-way easement.

The intent throughout the original rezoning process, as noted in several of the other rezoning conditions, and as memorialized in the Open Space Covenant, was to keep these corridors in their current state and not further disturb the wildlife corridors. In addition, TEP has recently completed upgrades to the Existing Line which bifurcates the site. Both of these factors are further described below:

- **Tucson Electric Power Project:** In response to summer monsoon damage, TEP recently completed an upgrade of the Existing Line from old wood structures to new, 65' steel poles. TEP's project concluded in September 2024 and if these lines were to be undergrounded, TEP's recent investment and efforts would be destroyed. Please also note that the Existing Line is not being connected to in order to service the Rezoning Area and future residences.

- **Open Space Covenant:** During rezoning efforts in 2021, neighbors and local conservation groups required several items to be included within the rezoning conditions to ensure that planned natural open space ("NUOS") on the Property was maintained in perpetuity in order to protect the mapped wildlife corridors in the area. We dedicated the Town of Marana land depicted in **Exhibit A** after the zoning was approved to ensure these wildlife corridoes were protected.

  The onsite areas outside of the development envelope will be protected in perpetuity as NUOS and a pending covenant (the "NUOS Covenant") is to be recorded with the final plat, as attached in **Exhibit B**. The area in which the Existing Line traverses includes NUOS as articulated in the OS Covenant, and shall:

  - *Be forever preserved as NUOS* for the conservation of natural habitat for wildlife, the protection of rare and unique native plants and animals, and the scenic enjoyment of the Beneficiary and the public (Recital A in **Exhibit B**).

    By undergrounding the Existing Line, this causes further disturbance to the NUOS areas.

  - The OS Covenant allows for development of, or the granting of, access, rights-of-way or easements for new roads or *new utilities*, except as approved of by the Town of Marana and as expressly permitted by the Ordinance (Section 2.f)

    The Existing Line is not a new utility, it is an existing utility that shall remain in its current state to further comply with the OS Covenant.

  - The OS Covenant allows for repair, maintenance, *and/or replacement of* constructed drainage ways or channels, signage, fences, walls, or other improvements; *provided, however, such incursions shall be temporary in nature* (Section 2.m(iii)).

While undergrounding of the Existing Line would be considered replacement of a utility, it would not be temporary in nature, and thus, in conflict with the OS Covenant.

With the above considerations, we request the following modifications to Condition 15:

> "All open space easements and wildlife corridors shall be left entirely undisturbed and in their natural desert state, except for necessary utility installations, which shall be revegetated. All such easements and corridors shall be dedicated to the appropriate entity, acceptable to the Town and at a time acceptable to the Town. All **new** utilities **which will service the Rezoning Area** shall be underground, and all utility trenches shall be revegetated to be identical with the surrounding desert**.** ~~with the exception of~~ **All existing** ~~the~~ overhead electric **lines within existing TEP and** WAPA easement**s** which shall be to WAPA **and TEP** specifications **and are not required to be underground**."

We appreciate your consideration of this request and look forward to hearing from you.

Thank you,

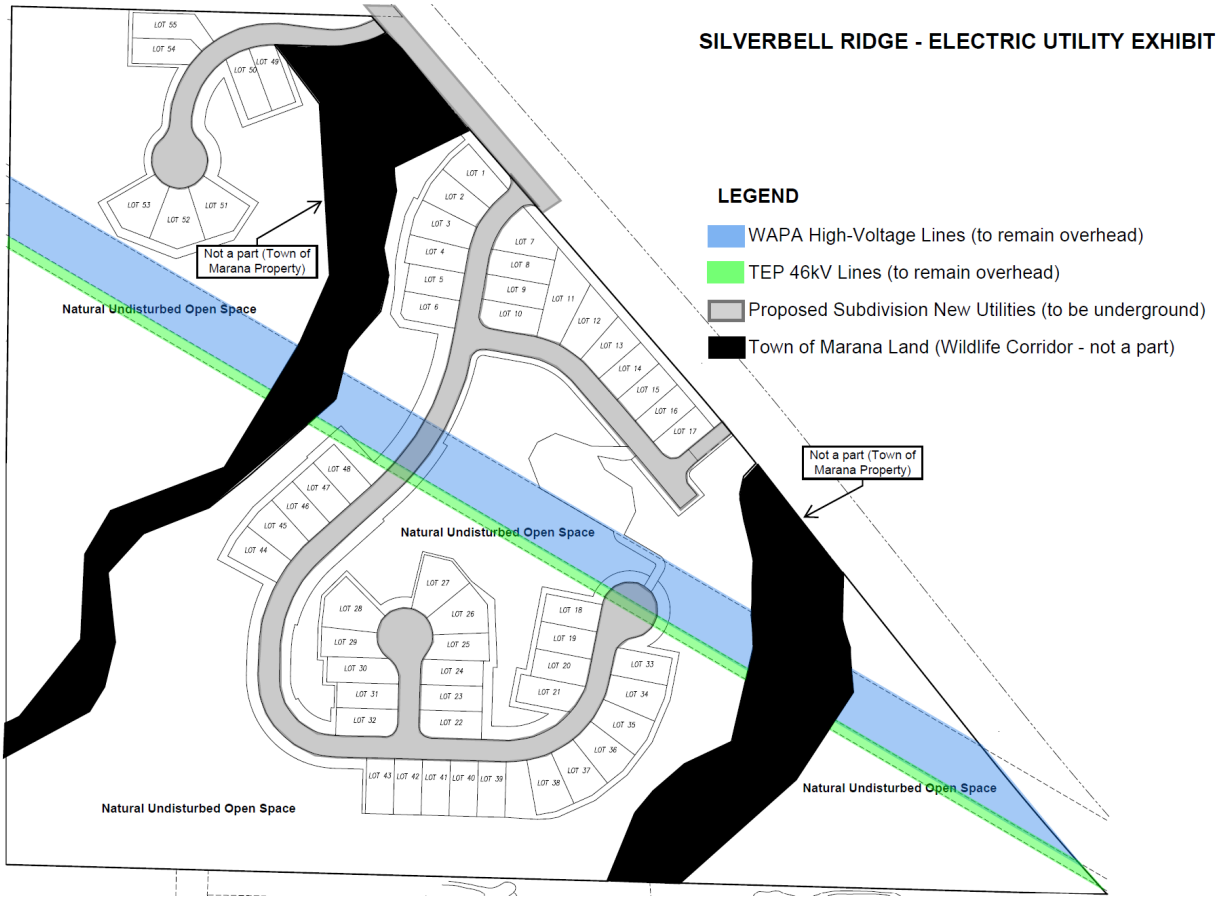


Charles Bud Cardinal

cc: Briana Rader, Mattamy Homes
Austin Shreffler, Town of Marana Planning
Matt Taylor, Town of Marana Planning

Exhibit A

Property Depiction & Electric Utility Exhibit & Photo




Old TEP Wood Poles (being removed)
Existing WAPA Line
New 65' TEP Steel Poles

Exhibit B

Open Space Covenant

When Recorded Return To:

_____
_____
_____
Attn: _____

OPEN SPACE COVENANT FOR SILVERBELL RIDGE

THIS OPEN SPACE COVENANT FOR SILVERBELL RIDGE (the "Covenant") is made on this ____ day of _____, 202_ (the "Effective Date"), by Fidelity National Title Agency, Inc., an Arizona corporation, as Trustee under its Trust No. 60,204, and not otherwise, its heirs, successors, assigns, and grantees (collectively, "Owner") for the benefit of Wildlife Corridor Preservation Initiative, Inc., an Arizona non-profit corporation ("Beneficiary"). The Owner and the Beneficiary may be individually referred to as a "Party" or collectively, as the "Parties."

RECITALS

A. Owner is the owner of that certain real property, more particularly described on Exhibit "A" attached hereto and incorporated herein by this reference (the "Property").

B. As a condition to the establishment of appropriate zoning for the Property, the Town of Marana Council required that the portion of the Property more particularly described and depicted on Exhibit "B" (the "Restricted Area") be forever preserved as natural undisturbed open space ("NUOS") for the conservation of natural habitat for wildlife, the protection of rare and unique native plants and animals, and the scenic enjoyment of the Beneficiary and the public, all as set forth in that certain Marana Ordinance No. 2021.016, recorded August 20, 2021, in Sequence: 20212320150, Pima County Records (the "Ordinance"). Additionally, as more fully set forth below, certain portions of the Restricted Area may be utilized for infrastructure improvements as herein provided.

C. In consideration of the foregoing, the promises, representations and warranties set forth in this Covenant, and good and other valuable consideration, the receipt and sufficiency of which are acknowledged, the Parties agree as follows:

COVENANT

1. Recitals. The Recitals stated above are true and correct and constitute a part of this Covenant.

2. Restrictions. The Restricted Area will be forever preserved as NUOS, subject to the terms and conditions of this Covenant. This Covenant runs with the land and binds the Owner and its successors and assigns and may not be amended and removed without the written consent of the Beneficiary and the Town of Marana. The following is a nonexclusive list of prohibited activities in the Restricted Area:

a. Development, including rezoning, further subdividing or lot splitting;

b. Construction or placement of new or additional buildings or structures (excluding utilities);

c. Alteration of the ground surface or natural vegetation, except as may be needed for invasive species or vegetative disease removal and management and habitat restoration or enhancement;

d. Impound, diversion, or alteration of any natural watercourse unless for watershed enhancements to improve species habitat or to maintain the Property's mitigation values;

e. Alteration of any part of the Restricted Area (NUOS) unless for watershed enhancements to improve species habitat or to maintain the Property's mitigation values, such as Natural Infrastructure for Dryland Streams (NIDS), Dr. Laura Norman, USGS;

f. Development of, or the granting of, access, rights-of-way or easements for new roads or new utilities, except as approved of by the Town of Marana and as expressly permitted by the Ordinance;

g. Filling, excavation, dredging, mining, drilling, exploration, or extraction of minerals, hydrocarbons, soils, sand gravel, rock or other materials on or below the surface of the Restricted Area;

h. Storage, accumulation, or disposal of hazardous materials, trash, garbage, solid waste or other unsightly material;

i. Confinement of livestock;

j. Residential use for mobile homes, treehouses, playhouses, travel trailers, tent trailers, self-propelled recreational vehicles, and similar structures or vehicles;

k. Any modification of the topography through the placement of soil, dredging spoils, or other material, unless for watershed enhancement to improve species habitat or to maintain the Property's mitigation values, reduce soil erosion, or to protect public health, safety and welfare;

l. Off-road vehicular or pedestrian travel or access on the Restricted Area, except as otherwise specifically permitted in Section 2(m) below and for those activities that enhance wildlife connectivity and/or for Beneficiary to monitor and enforce restrictions; and

m. Notwithstanding the foregoing or any provision herein to the contrary, the following are permitted incursions into the Restricted Area: (i) invasive species/vegetative disease management and monitoring, Beneficiary's monitoring, watershed enhancements to improve species habitat or to maintain the Property's mitigation values, reduce soil erosion, or to protect public health, safety and welfare; (ii)

construction and development of the residential subdivision, and maintenance of utility facilities and easements by utility providers; and (iii) the repair, maintenance, and/or replacement of constructed drainage ways or channels, signage, fences, walls, or other improvements by the Owner (or any homeowners' association formed for the community); provided, however, such incursions shall be temporary in nature and reasonably necessary to accomplish the foregoing purposes. Following any of the foregoing activities, the disturbed areas shall be revegetated substantially and materially similar to the surrounding desert.

3. Reserved Rights of Owner; Effect of Ordinance. Except for the specific restrictions provided in this Covenant, the Owner and its successors-in-interest and assigns reserve all rights in the Property including, without limitation, the right of exclusive use, possession and enjoyment of the Property, and the right to sell, transfer, lease, mortgage or otherwise encumber the Property. Nothing contained in this Covenant will be construed as a grant to the public or any other person or entity, of any right to enter upon any part of the Property, except the Beneficiary for the limited purpose set forth herein to enter the Restricted Area to confirm compliance with this Covenant at a minimum, quarterly. In addition, and notwithstanding any provision in this Covenant to the contrary, nothing herein shall otherwise prohibit or restrict any activities by Owner that are permitted under the Ordinance, nor shall this Covenant impose any additional obligations on the Owner (financial or otherwise) that are not specifically identified and required by the Ordinance.

4. Consideration. On or before thirty (30) days after the recordation of this Covenant, Beneficiary in consideration of Owner's execution and delivery of this Covenant, will pay Ten and No/100 Dollars ($10.00) to Owner.

5. Beneficiary's Right of Enforcement. If the Beneficiary reasonably determines that there is a breach of this Covenant, it may, but is not obligated to, enforce the terms of this Covenant, but only after following the procedures set forth in this Section 5. Prior to any enforcement action, Beneficiary must deliver written notice to Owner setting forth the alleged breach of the Covenant and the corrective action sufficient to cure the breach. The written notice must provide that Owner will have thirty (30) days from receipt of the notice to commence good faith efforts to cure the breach or to provide written notice of its disagreement with the allegations of such breach. If owner fails to contest such breach, commence curing the breach within such thirty (30) day period or fails to continue good faith efforts to cure such breach until fully cured, Beneficiary may bring an action for specific performance to enforce the terms of this Covenant.

6. Limitation on Enforcement. Owner will not be liable for any injury or change in the Restricted Area resulting from acts beyond Owner's control including unforeseeable acts of trespass, fire, flood, storm, drought, pests, natural disasters, wildlife, natural earth movement, vegetative disease, or resulting from any action taken by Owner under emergency conditions to prevent, abate or mitigate significant injury to the Restricted Area or adjoining property. The foregoing shall not abrogate the Owner's obligations to remove invasive non-native species from the Restricted Area as required by the Ordinance.

7. Entry by Beneficiary. Beneficiary shall defend, indemnify, protect and hold harmless Owner and its successors and assigns from and against any and all damages, costs losses, expenses, including reasonable attorneys' fees and litigation expenses, and liability, arising from or relating to Beneficiary's, its employees', agents', representatives', contractors', or any other person

affiliated with Beneficiary, entry upon the Restricted Area or Property or third party claims arising from any act or omission of Beneficiary or its agents, representatives, employees, or contractors upon the Restricted Area or Property.

8. Attorneys' Fees. In the event of any legal action or proceeding for the enforcement of any right or obligation herein contained, the prevailing party shall be entitled to recover from the unsuccessful party its costs and reasonably attorneys' fees incurred in the preparation and prosecution of such action or proceeding.

9. Governing Law and Jurisdiction. The laws of the State of Arizona shall govern the interpretation, validity, performance, and enforcement of this Covenant. The Parties hereto irrevocably consents to jurisdiction and venue in Pima County, Arizona and agrees not to attempt to remove or transfer any action properly commenced in Pima County, Arizona.

10. Severability. Any determination by any court of competent jurisdiction that any provision of this Covenant is invalid or unenforceable shall not affect the validity or enforceability of any of the other provisions hereof.

11. Assignment of Owner's Rights. Owner may assign its rights hereunder to a homeowner's association by an instrument expressly assigning such rights recorded in the Official Records of Pima County, Arizona without written consent of the Beneficiary. The homeowner's association may not terminate, rescind or revoke any rights, approvals or consents previously granted by Owner to Beneficiary, without the express written consent of Beneficiary. When Owner or its successor in interest has conveyed the Restricted Area to the homeowner's association, this Covenant, and all of Owner's rights and obligations hereunder, shall automatically be deemed to have been assigned to and assumed by the homeowner's association without the need for the execution or recording of any additional instrument.

12. No Agency. Nothing in this Covenant shall be deemed or construed by either party or by any third person to create the relationship of principal and agent or of limited or general partners or of joint venturers or of any other association between the Parties.

13. Covenants to Run with Land. It is intended that each of the easements, covenants, conditions, restrictions, rights and obligations set forth herein shall run with the land and create equitable servitudes in favor of the Beneficiary, shall bind every person having any fee, leasehold or other interest therein and shall inure to the benefit of the respective Parties and their successors, assigns, heirs, grantees, and personal representatives.

14. Integration Clause. This Covenant represents the entire agreement of Owner and Beneficiary with respect to this Covenant.

15. Notices. All notices, requests, demands and other communications required or permitted by this Covenant shall be delivered by personal delivery, or deposited with the United States Postal Service, return receipt requested, or delivered by a nationally recognized private courier service, with proper postage or other charges prepaid and properly addressed as follows:

If to Beneficiary: Wildlife Corridor Preservation Initiative, Inc.
6363 N. Swan Rd.
Ste. 151

Tucson, Arizona 85718

If to Owner: To the Owner of the Restricted Area named and at the address provided in the Pima County, Arizona property tax records.

[Remainder of Page Left Intentionally Blank]

[Signature Page Follows]

IN WITNESS WHEREOF, Owner and Beneficiary have executed this Covenant as of the Effective Date.

OWNER:

Fidelity National Title Agency, Inc., an Arizona corporation, as Trustee under its Trust No. 60,204, and not otherwise

By:_____

Name:_____

Title:_____

STATE OF ARIZONA)
) ss.
County of Pima)

The foregoing instrument was acknowledged before me this _____ day of _____, 202_, by _____, the _____ of Fidelity National Title Agency, Inc., an Arizona corporation, as Trustee under its Trust No. 60,204, and not otherwise, for and on behalf thereof.

_____
Notary Public

My Seal and Commission Expiration Date:

Beneficiary Disclosure – Arizona Revised Statutes Section 33-404: The sole beneficiary of Trust No. 60,204 is Bud & Penny Cardinal Family LLLP, an Arizona limited liability limited partnership, whose address is 7608 North La Cholla Blvd., Tucson, Arizona 85741-4201.

BENEFICIARY:

WILDLIFE CORRIDOR PRESERVATION INITIATIVE, INC.,
an Arizona non-profit corporation

By:_____
Name:_____
Title:_____

STATE OF ARIZONA)
) ss.
County of Pima)

This instrument was acknowledged before me on _____, 202_ by Carolyn Campbell, the Director of Wildlife Corridor Preservation Initiative, Inc., an Arizona non-profit corporation, on behalf of said corporation.

_____
Notary Public

My Commission Expires:

EXHIBIT A

Legal Description of Property

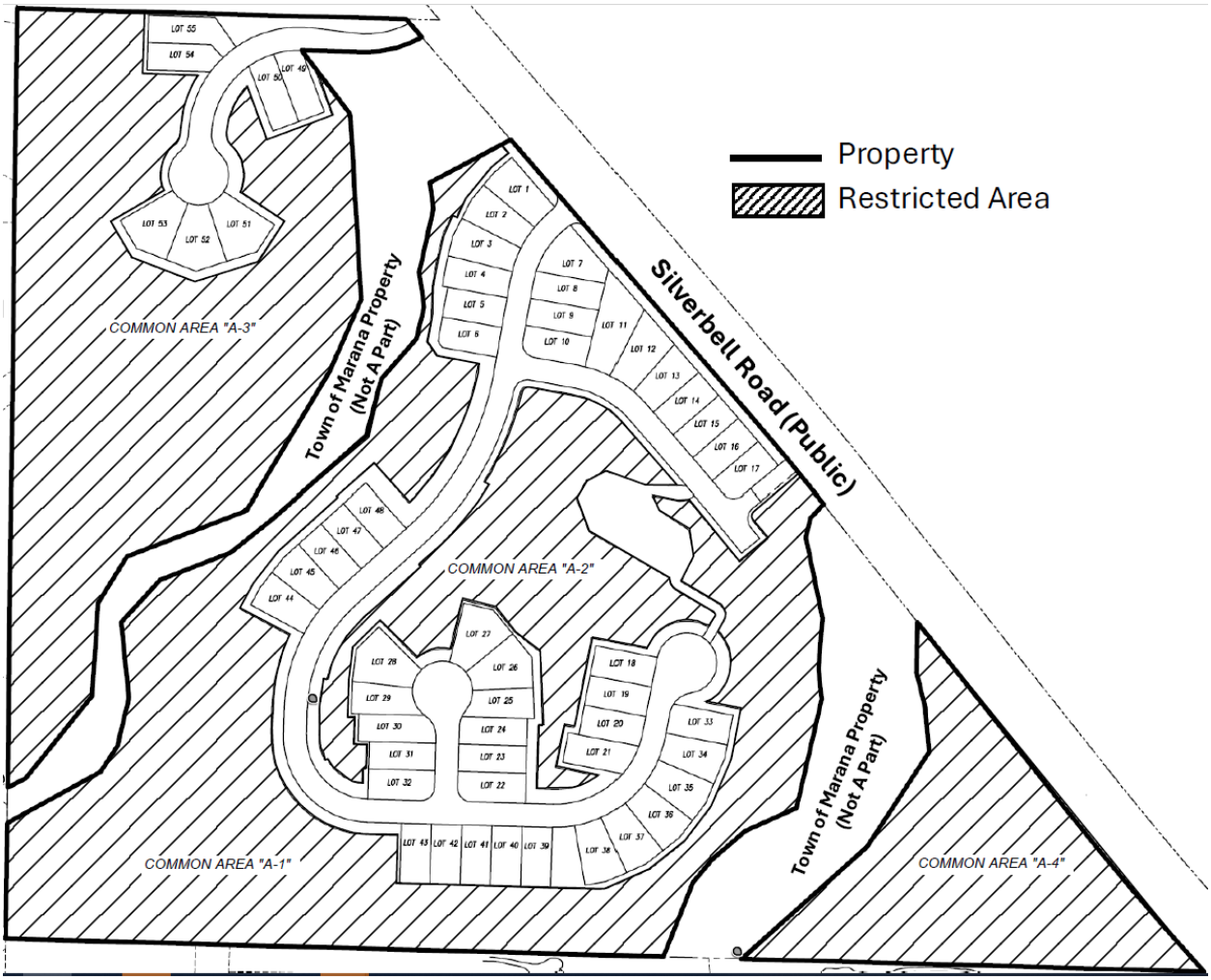
Lots 1-55 and Common Areas “A-1” through “A-4” (“Natural Open Space”), Common Areas “B-1” through “B-5” (Landscape/Grading/Drainage) and Common Area “C” (Recreation), according to the Final Plat of Silverbell Ridge, recorded on _____, 202_, at Sequence Number _____ in the Official Records of Pima County, Arizona, being a re-subdivision of Silverbell Ridge Estates Subdivision, Blocks 1-3, according to the plat recorded in recording No. 20182500098, Records of Pima County, Arizona.

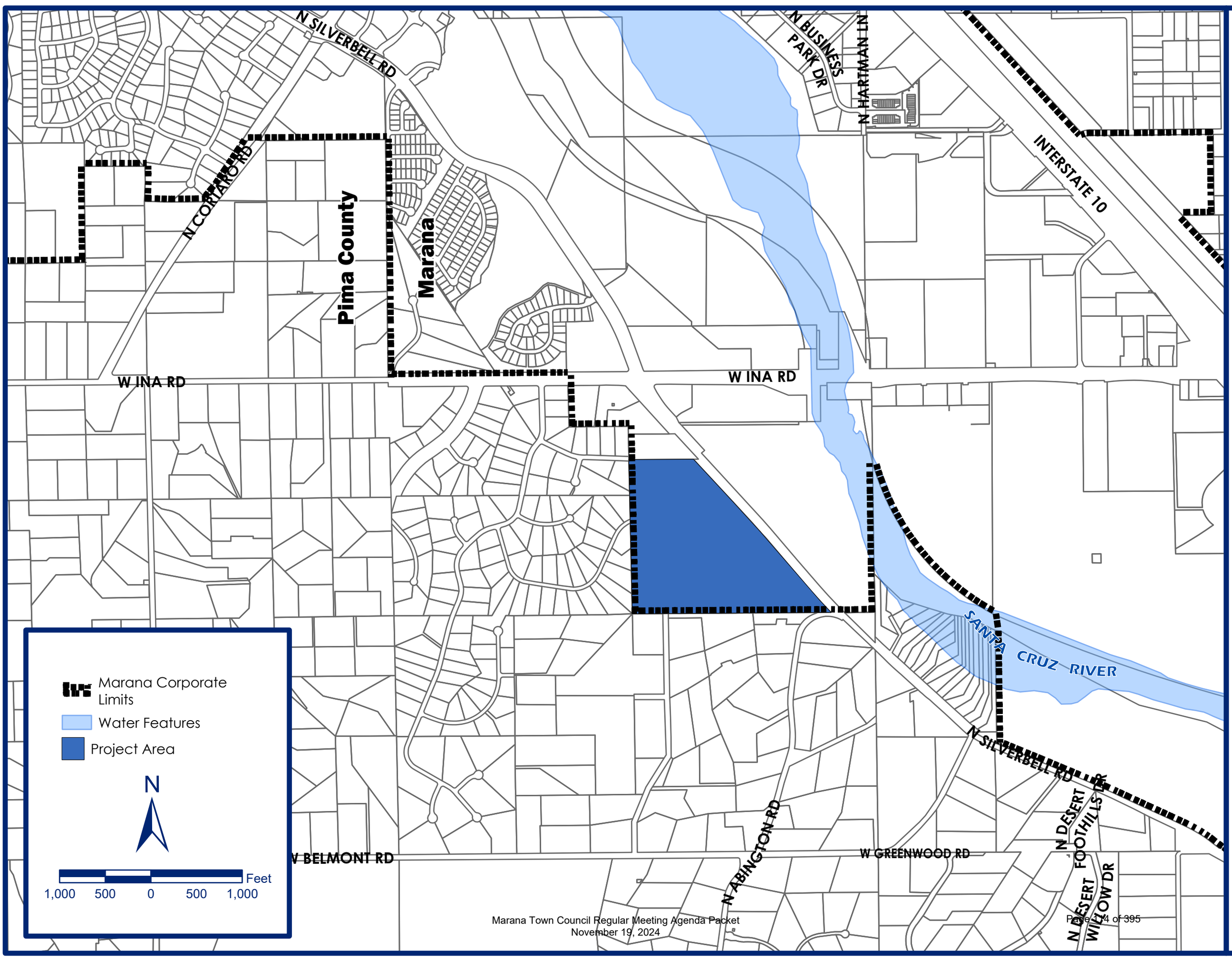
EXHIBIT B

Legal Description of Restricted Area

Common Areas "A-1" through "A-4" ("Natural Open Space"), according to the Final Plat of Silverbell Ridge, recorded on _____, 202_, at Sequence Number _____ in the Official Records of Pima County, Arizona, being a re-subdivision of Silverbell Ridge Estates Subdivision, Blocks 1-3, according to the plat recorded in recording No. 20182500098, Records of Pima County, Arizona.

Depiction of Restricted Area




N SILVERBELL RD
N CORTARO RD
Pima County
Marana
N BUSINESS PARK DR
N HARTMAN LN
INTERSTATE 10
W INA RD
W INA RD
SANTA CRUZ RIVER
N SILVERBELL RD
W BELMONT RD
N ABINGTON RD
W GREENWOOD RD
N DESERT FOOTHILLS DR
N DESERT WILLOW DR
Marana Corporate Limits
Water Features
Project Area
N
Feet
1,000 500 0 500 1,000

MARANA AZ

Development Services / maranaAZ.gov
11555 West Civic Center Drive / Marana, AZ 85653
Ph (520) 382-2600 / Fax (520) 382-2641

PROJECT APPLICATION

Instructions

Information about project submittal requirements can be found online by reviewing the submittal checklist for the proposed scope of work at https://www.maranaaz.gov/developmentservicesforms.

- Applicants can submit electrically by email. Please follow the information resource on "How to Submit Electronically."
- Submit the completed application along with all forms and attachments electronically by email to maranaplanning@maranaAZ.gov for planning related applications or deveng@maranaAZ.gov for engineering related applications. If means to submit electronically are unavailable, applicants can submit in person using a print copy to:

  Development Services
  Marana Municipal Complex, Second Floor
  11555 W Civic Center Dr. Building A2
  Marana, AZ 85653
- The application and review status can be viewed through Permit Tracker, our On-line Application & Information System, utilizing the project search menu.
- Notice of correction or approval will be communicated via email to the applicant listed on the application.

Payment

Fee information can be found on the online at maranaAZ.gov/finance. An invoice will be provided by email to the applicant for payment. Payment can be made in the form of credit card, cash or check payable to the Town of Marana.

- Credit card over the phone, please call (520) 382-2600
- In person or by mail, please send checks to:

  Town of Marana, Cashiering
  11555 W Civic Center Dr. Building A2
  Marana, AZ 85653

Licensing Time Frame

Pursuant to and subject to A.R.S. § 9-836 (2019), the Town of Marana hereby establishes its licensing time frames, available here.

Contact Information

For planning related questions about this form, please contact Marci Johns by email at maranaplanning@maranaAZ.gov or call (520) 382-2600.

For development engineering questions about this form, please contact Charity Teresi by email at deveng@maranaAZ.gov or call (520) 382-2600.

MARANA AZ

Development Services / maranaAZ.gov
11555 West Civic Center Drive / Marana, AZ 85653
Ph (520) 382-2600 / Fax (520) 382-2641

PROJECT APPLICATION

APPLICATION TYPE

❑ Annexation	❑ Development Plan	❑ Development Plan Package	❑ General Plan Amendment
❑ Rezone	❑ Minor Land Division	❑ Translational Rezone	❑ Conditional Use Permit
❑ Specific Plan	❑ Landscape Plan	❑ Native Plant Plan/Exception	❑ SWPP
❑ Variance	❑ Hydraulic Model	❑ Sewer Capacity Assurance	❑ Sign Program
❑ Plat	❑ Improvement Plan	❑ Report (Type): _____	☒ Other: Zoning Modificatio

PROJECT INFORMATION

Project Name: Silverbell Ridge			
Description of Project: Single-Family Residential Subdivision			Number of Lots: 55
Parcel No.(s): 214-041-170, -180, -190			Gross Area (Acres): 49
Project Address: 6975 N. Silverbell Road, Marana, AZ 85743			
Ref. Project No.: PRV2309-002			

CONTACT INFORMATION

Owner: Bud & Penny Cardinal Family LLLP	Contact Name: Bud Cardinal		
Address: 7608 N. La Cholla Blvd.	City: Tucson	State: AZ	Zip: 85741
Email: budc@theriver.com	Phone No.: (520) 906-2868		
Applicant: Bud Cardinal	Contact Name: Bud Cardinal		
Address: 7608 N. La Cholla Blvd.	City: Tucson	State: AZ	Zip: 85741
Email: budc@theriver.com	Phone No.: (520) 906-2868		
Consultant/Engineer: Mattamy Homes	Contact Name: Briana Rader		
Address: 3561 E. Sunrise Dr., Suite 247	City: Tucson	State: AZ	Zip: 85718
Email: briana.rader@mattamycorp.com	Phone No.: (520) 444-9364		

APPLICANT AUTHORIZATION

By signing below, I hereby acknowledge that I have read the information provided online at maranaaz.gov/arsnotice and certify that the information set forth in this application are true and correct to the best of my knowledge. I am either the owner of the property or I have been **authorized in writing** by the owner to file this application. (If the applicant is not the owner, attach written authorization from the owner)

Bud Cardinal		10/24/2024
Applicant Name (PRINT)	Signature	Date

FOR OFFICIAL USE ONLY

Revision Date 05/16/2023

Project No._____ **Date Received**_____

GABRIELLA CÁZARES-KELLY, RECORDER
Recorded By: LW
DEPUTY RECORDER
41

SMARA
TOWN OF MARANA
PICKUP

SEQUENCE: 20212320150
NO. PAGES: 22
08/20/2021
10:05:50

MARANA ORDINANCE NO. 2021.016

RELATING TO DEVELOPMENT; APPROVING A REZONING OF APPROXIMATELY 49 ACRES OF LAND LOCATED APPROXIMATELY ONE-QUARTER MILE SOUTH OF INA ROAD, WEST OF SILVERBELL ROAD, FROM R-16 (RESIDENTIAL) TO R-6 (RESIDENTIAL)

WHEREAS C & C Construction Co., Inc., (the "Property Owner") owns 49 acres of land located approximately one-quarter mile south of Ina Road, west of Silverbell Road within Section 2, Township 13 South, and Range 12 East, described on Exhibit "E" attached to and incorporated in this ordinance by this reference (the "Rezoning Area"); and

WHEREAS the Property Owner has authorized The Planning Center to submit an application to rezone the Rezoning Area from R-16 (Residential) to R-6 (Residential); and

WHEREAS the Marana Planning Commission held a public hearing on this Rezoning on July 28, 2021, and voted five to zero (with two Commissioners absent) to recommend that the Town Council approve this Rezoning, subject to the recommended conditions; and

WHEREAS the Marana Mayor and Town Council held a public hearing on August 17, 2021 and determined that the application for rezoning should be approved; and

NOW, THEREFORE, BE IT ORDAINED by the Mayor and Council of the Town of Marana, Arizona, as follows:

Section 1. The zoning of the Rezoning Area is hereby changed from R-16 (Residential) to R-6 (Residential).

Section 2. This Rezoning is subject to the following conditions, the violation of which shall be treated in the same manner as a violation of the Town of Marana Land Development Code (but which shall not cause a reversion of this Rezoning), and which shall be binding on the Property Owner and their successors in interest (all of whom are collectively included in the term "Property Owners" in the following conditions):

1. Compliance with all applicable provisions of the Town's Codes and Ordinances current at the time of any subsequent development including, but not limited to, requirements for public improvements and payment of application fees and applicable development impact fees.
2. Any preliminary plat or development plan for any portion of the Rezoning Area shall be in substantial conformance with the tentative development plan (shown

as "Exhibit A" attached to and incorporated by this reference in this ordinance) presented to and approved by the Town Council as part of this Rezoning.

3. A master drainage study must be submitted by the Property Owners and accepted by the Town Engineer prior to Town approval of a preliminary plat or development plan for any portion of the Rezoning Area.
4. The Property Owners shall design and construct a continuous left-turn lane along the entire frontage of the Rezoning Area. The design shall be subject to approval by the Town Engineer.
5. A water infrastructure and phasing plan (WIP) must be submitted by the Property Owners and accepted by the water provider prior to approval of a preliminary plat for any portion of the Rezoning Area. The WIP shall identify all on-site and off-site water facilities needed to serve the proposed development. The WIP shall include all information required by the water provider, such as (but not limited to) analysis of water use and fire flow requirements, and well source, reservoir, and booster station infrastructure needed to serve the proposed development. If the water provider requires a water service agreement as a condition of service to the proposed development, the Property Owners must enter into a water service agreement with the water provider consistent with the accepted WIP.
6. A master sewer plan must be submitted by the Property Owners and accepted by Pima County Regional Wastewater Reclamation Department (the "wastewater utility") prior to the approval of any final plat or development plan for the Rezoning Area. The master sewer plan shall identify all on-site and off-site wastewater facilities needed to serve the proposed development, and shall include all information required by the wastewater utility. If the wastewater utility requires a sewer service agreement as a condition of service to the proposed development, the Property Owners must enter into a sewer service agreement with the wastewater utility consistent with the accepted master sewer plan.
7. The Property Owners must design and construct any roadway, drainage, water, and wastewater improvements, and dedicate or acquire any property rights associated with those improvements, that the Town requires based on the data and findings of the accepted traffic impact analysis, the accepted master drainage study, the accepted WIP, the accepted master sewer plan, and other studies approved in connection with the approval of a preliminary plat or development plan for any portion of the Rezoning Area.
8. The final design of all streets and circulation facilities, including any gated or emergency access, must be accepted by the Northwest Fire District prior to Town Council consideration of a final plat for any portion of the Rezoning Area.
9. The Rezoning Area shall be limited to a maximum of 57 lots, laid out in substantial conformance with the tentative development plan attached as Exhibit A. Site disturbance in the 49-acre Rezoning Area shall not exceed 34% or 725,710 square feet.

10. No approval, permit or authorization by the Town of Marana authorizes violation of any Federal or State law or regulation or relieves the Property Owners from responsibility to ensure compliance with all applicable federal and state laws and regulations, including the Endangered Species Act and the Clean Water Act. The Property Owners should retain appropriate experts and consult appropriate Federal and State agencies to determine any action necessary to assure compliance with applicable laws and regulations.
11. The Property Owners shall transfer to Marana, by the appropriate Arizona Department of Water Resources form, those water rights being IGR, Type I or Type II for the Town providing designation of assured water supply and water service to the Rezoning Area. If Type I or Type II is needed on the Rezoning Area, the Town and the Property Owners shall arrive at an agreeable solution to the use of those water rights appurtenant to the affected portion of the Rezoning Area.
12. Prior to the issuance of any grading permits, the Property Owners shall submit evidence to the Town that all federal permit requirements have been met through the Army Corps of Engineers and the State Historic Preservation Office, if federal permits are required for the development of the Rezoning Area.
13. The Property Owners shall not cause any lot split of any kind without the written consent of the Town of Marana.
14. The Property Owners shall provide the necessary authorization and documentation from the Western Area Power Administration (WAPA) with the subsequent plat submittal.
15. All open space easements and wildlife corridors shall be left entirely undisturbed and in their natural desert state, except for necessary utility installations, which shall be revegetated. All such easements and corridors shall be dedicated to the appropriate entity, acceptable to the Town and at a time acceptable to the Town. All utilities shall be underground, and all utility trenches shall be revegetated to be identical with the surrounding desert with the exception of the overhead electric WAPA easement which shall be to WAPA specifications.
16. Lots 18-57 as designated on Exhibit A are restricted to one story and a maximum height of 20 feet. Two story homes are permitted on Lots 1-17 as designated on Exhibit A.
17. The preliminary plat for the Rezoning Area shall establish a minimum lot size of 6,000 square feet and the rezoning parcel will be mass graded.
18. There shall be no connectivity between Waycross Road, Martingale Lane, Bridle Way, or Abington Lane and any access point, right of way, road, or lot within the Rezoning Area.
19. There shall be a 120 - foot "No Disturbance" bufferyard along the southern boundary of the Rezoning Area (as identified on Exhibit A).
20. There shall be a 100 – foot "No Disturbance" bufferyard along the western boundary of the Rezoning Area (as identified on Exhibit A).

21. The Property Owners, through the Town of Marana's normal notification process, shall notify the impacted parties, as specified in Exhibit B attached to and incorporated by this reference in this ordinance, if any request is made to modify, eliminate, or add to the conditions listed in this ordinance.
22. The minimum width of the two designated wildlife corridors shall be 230 feet and, where possible, revegetation shall occur in disturbed areas beyond the 230-foot minimum width. Reseeding with a native Mohave, Chihuahua and/or Sonoran arid/adapted mix of groundcovers, mid-story shrubs and canopy trees, including hackberry (Cletis pallida), is preferable for areas where it is impossible to reliably deliver water.
23. This Rezoning is subject to the Residential Design Standards found in the Marana Land Development Code as amended from time to time.
24. The Property Owners agree to enter into a finance contract establishing their contribution for schools. The Property Owners shall provide written documentation that an agreement with the Marana Unified School District is completed prior to the issuance of the first single-family residential building permit for the Rezoning Area. A receipt of payment shall be provided with each individual residential building permit.
25. No view fencing shall be allowed on lots facing the two wildlife corridors.
26. All outdoor lighting shall be down-lit and shall adhere to "dark sky-friendly" lighting design, and such language shall be placed in the Conditions, Covenants and Restrictions.
27. All Natural Undisturbed Open Space set-asides shall be protected in perpetuity, by either a Restrictive Covenant or Conservation Easement and such language shall be placed in the Conditions, Covenants and Restrictions. Prior to or upon requesting a building permit for any lot in the Rezoning Area, the Property Owners shall record a covenant, to run with the land, memorializing the terms of this condition.
28. Free-ranging domestic animals shall be prohibited in the subdivision and such language shall be placed in the Conditions, Covenants and Restrictions.
29. No side or backyard gates shall be constructed leading to undisturbed open space areas on each lot or within the two onsite wash corridors and such language shall be placed in the Conditions, Covenants and Restrictions.
30. Upon the effective date of this Ordinance, the Property Owners shall have a continuing responsibility to remove from the Rezoning Area invasive non-native species, including those listed in Exhibit C attached to and incorporated by this reference in this ordinance. Acceptable methods of removal include chemical treatment, physical removal, or other known effective means of removal. Property Owners and future owners of individual lots in the Rezoning Area shall keep private lots, including enclosed yards, free of invasive non-native plant species detailed in Exhibit C. Prior to or upon requesting a building permit for any lot in

the Rezoning Area, the Property Owners shall record a covenant, to run with the land, memorializing the terms of this condition.

31. The Property Owners shall place "no trespassing" signs along the south boundary of the Rezoning Area and signs directing people to stay out of the washes.
32. The Property Owners shall landscape the area near the emergency access roadway with a continuous row of shrubs at the time of the emergency roadway construction, as depicted on Exhibit A, the Tentative Development Plan.
33. The Property Owners shall incorporate Low Impact Development techniques to accommodate drainage such as rock-lined channels with sandy bottoms and one and two rock dams.
34. The Property Owners shall install a non-asphalt, stabilized all weather surface for the emergency access road.
35. The Property Owners shall construct a 6-foot decorative masonry wall along the back of lots 33-43 located along the south boundary to reduce noise and light impacts as depicted on Exhibit A, the Tentative Development Plan.
36. The Property Owners shall install wildlife-friendly fencing in one of two locations identified on Exhibit A, the Tentative Development Plan, prior to building permit approval of lot 44 to discourage the creation of unauthorized trails and ATV roads to access the Waycross neighborhood.
37. Property owners shall secure a license from WAPA, and provide evidence of, for the areas on Street A that encroach into the WAPA/TEP easement prior to approval of the preliminary plat.
38. Property owners shall secure, and provide evidence of, a license from WAPA for pedestrian access from the cul-de-sac on Street A to the recreation area for the residents of Lots 18-48 prior to approval of the preliminary plat.
39. The two wildlife corridors located on Town owned A.P.N. 214-04-1150 and identified on Exhibit A, the Tentative Development Plan, shall be preserved in perpetuity to ensure continued wildlife passage. The corridors will be subject to a restrictive covenant or conservation easement and protected with fencing and flagging during construction.
40. The Property Owners shall enter into an open space covenant with a reputable conservation entity to ensure that the open space areas approved within the Rezoning Area remain open space in perpetuity.
41. The Property Owners and future owners of individual lots in the Rezoning Area shall use the attached redlined Town of Marana Regulatory Plant List, Exhibit D, to vegetate all developable landscape areas in the Silverbell Ridge Rezoning area.

Section 3. All ordinances, resolutions and motions and parts of ordinances, resolutions, and motions of the Marana Town Council in conflict with the provisions of this ordinance are hereby repealed, effective as of the effective date of this ordinance.

Section 4. If any section, subsection, sentence, clause, phrase or portion of this ordinance is for any reason held to be invalid or unconstitutional by the decision of any

court of competent jurisdiction, such decision shall not affect the validity of the remaining portions of this ordinance.

PASSED AND ADOPTED by the Mayor and Council of the Town of Marana, Arizona, this 17th day of August, 2021.

Mayor Ed Honea

ATTEST:

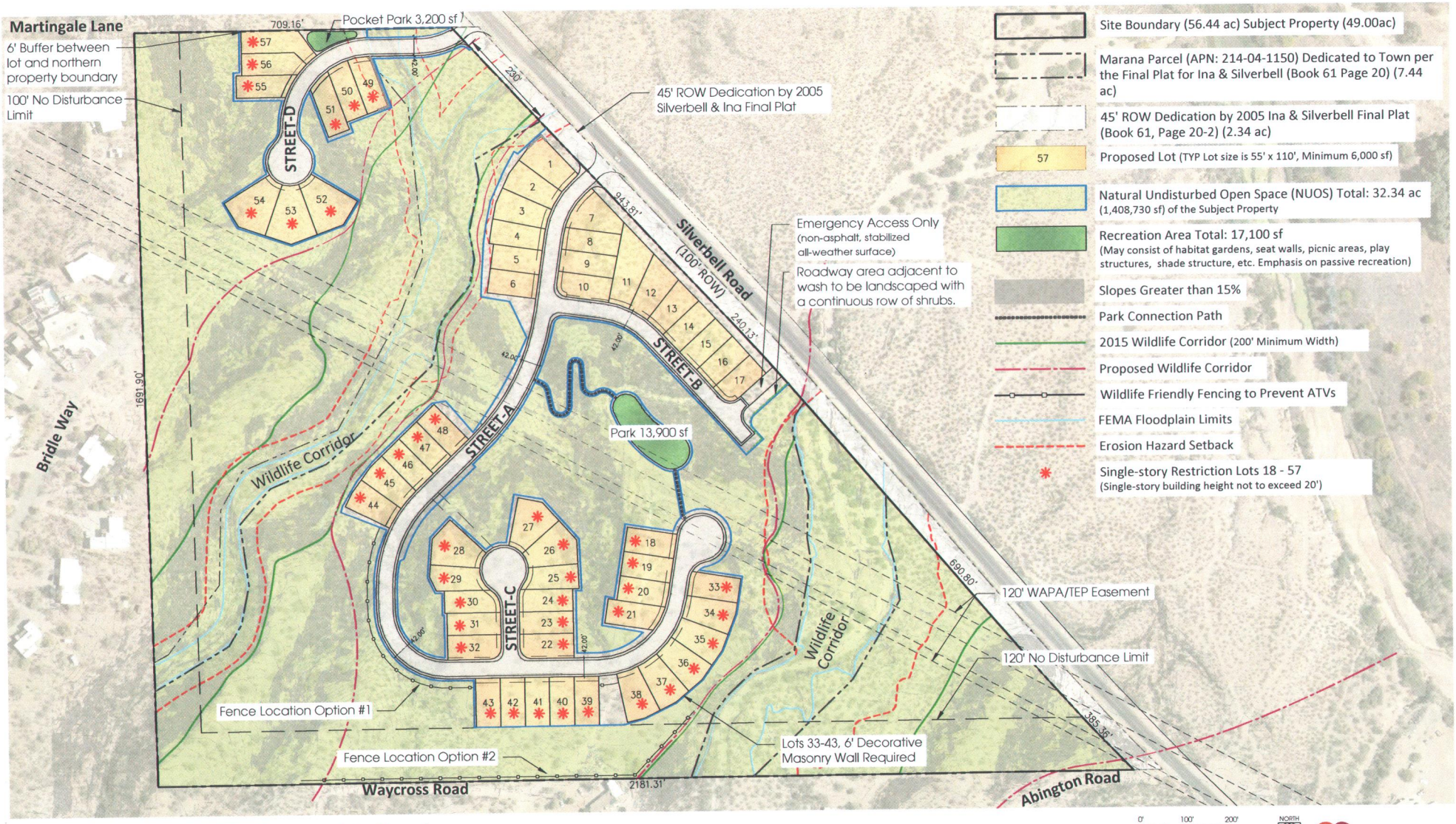
Cherry L. Lawson, Town Clerk

APPROVED AS TO FORM:

Jane Fairall, Town Attorney

MARANA AZ
ESTABLISHED 1977

TENTATIVE DEVELOPMENT PLAN



Silverbell Ridge Estates

0' 100' 200'
SCALE: 1"=200'-0"
PROJECT: CAC-06 DATE: 07/28/21
FILE NAME: CAC-06_TDP.DWG

NORTH

THE PLANNING CENTER
a division of TPC Group, Inc.

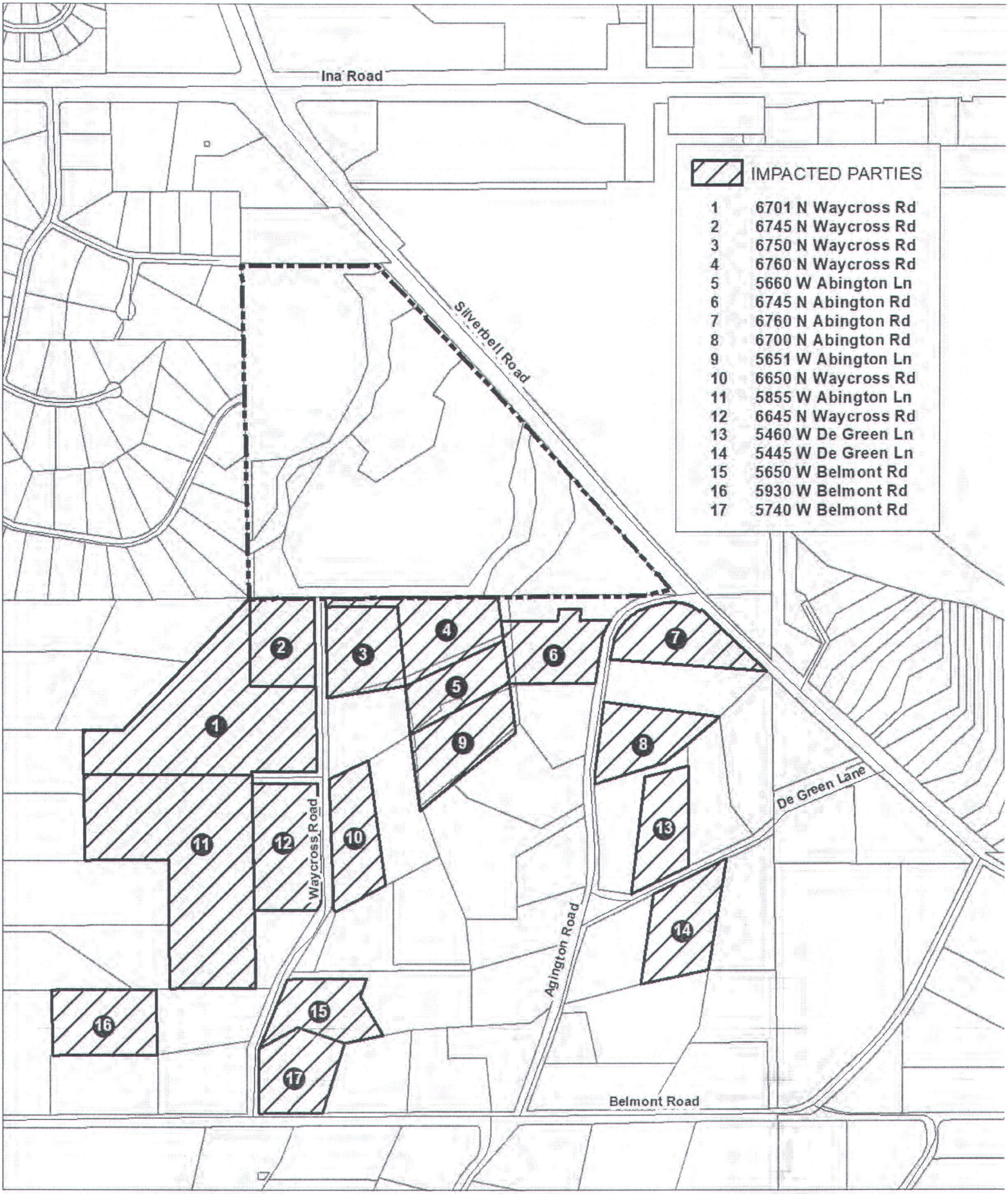


EXHIBIT "B"
IMPACTED PARTIES

FILE NAME: Impacted Parties_6x8_CAC-06.mxd
SOURCE: Pima County GIS, 2021

Exhibit C

Invasive Non-Native Plant Species Subject to Control

Scientific Name	Common Name
Ailanthus altissima	*Tree of Heaven*
Alhagi pseudalhagi	*Camelthorn*
Arundo donax	*Giant reed*
Baccharis sarothroides	*Desert Broom*
Brassica tournefortii	*Sahara mustard*
Bromus rubens	*Red brome*
Bromus tectorum	*Cheatgrass*
Centaurea melitensis	*Malta starthistle*
Centaurea solstitalis	*Yellow starthistle*
Cynodon dactylon	*Bermuda grass (exclude sod hybrid)*
Digitaria spp.	*Crabgrass*
Elaeagnus angustifolia	*Russian olive*
Eragrostis spp.	*Lovegrass (exclude E. intermedia, plains lovegrass)*
Melinis repens	*Natal grass*
Mesembryanthemum spp.	*Iceplant*
Oncosiphon piluliferum	*Globe Chamomile aka Stinknet*
Peganum harmala	*African rue*
Pennisetum ciliare	*Buffelgrass*
Pennisetum setaceum	*Fountain grass*
Rhus lancea	*African sumac*
Salsola spp.	*Russian thistle*
Schinus spp.	*Pepper tree*
Schismus arabicus	*Arabian grass*
Schismus barbatus	*Mediterranean grass*
Sorghum halepense	*Johnson grass*
Tamarix spp.	*Tamarisk*

7/16/2021

Exhibit D

Town of Marana

*Redlined Town of Marana Regulatory Plant List
OFFICIAL REGULATORY PLANT LIST

(*Acceptable Silverbell Ridge subdivision vegetation as determined and redlined by Coalition for Sonoran Desert Protection on 7/12/21)

LOW WATER USE / DROUGHT TOLERANT PLANT LIST

The plants on this list can be grown with moderate to no supplemental irrigation once they are established. Occasionally, for good appearance, supplemental irrigation may be applied during the growing season. In addition to the cacti on this list, any cacti salvaged and tagged in compliance with state agricultural and horticultural regulations may be used.

All of the plants on the Plant List meet the Arizona Department of Water Resources (ADWR) standard for low consumption.

Some plants on the list may fall under more than one plant type category (e.g. Acacia constricta can be grown as a tree or a shrub depending upon the growth habit that is preferred).

Applications for additions, deletions or exceptions to the list may be submitted to the Zoning Administrator.

Key to symbols:

A - Accent Plant
***** - Toxic; may be harmful if eaten. (For more information call Arizona Poison Control Center at (520) 626-6016.)
C - Cactus
Gc - Groundcover
I - Invasive -- may spread and intrude into natural areas.
Gr - Ornamental Grass
sh - Semi-hardy -- some dieback in a hard frost
S - Shrub
(t) - Tender (may be severely damaged or killed in a hard frost)
Sc - Succulent (other than cacti)
- Exceptions to the nomenclature in Hortus III.
T - Tree
an - Annual
V - Vine
p - Perennial
cl - Seasonal Color (showy flowers, fall color or berries).

CD - Chihuahuan Desert Region - (broadly interpreted to include a large area of north central and northwest Mexico, southwest Texas, southern New Mexico and extreme southeast Arizona.)
SD - Sonoran Desert Region - (broadly interpreted to include the arid and semi-arid areas of northwest Mexico, southeast California and most of Arizona south of the Mogollon Rim.)

(Note: Chihuahuan and Sonoran Desert Regions annotated by Matt Johnson, Native Plant Society.)

Approximate Watering Needs (depending on soil and climate conditions)

1 - No supplemental irrigation once established.
2 - Once a month during the growing season once established.
3 - Twice a month during the growing season once established.
4 - Once a week during the growing season once established.

TABLE 7-2

Town of Marana
OFFICIAL REGULATORY PLANT LIST

BOTANICAL NAME	COMMON NAME	STATUS	ORIGIN	NEEDS	HARDY
Abronia villosa	Sand verbena	Gc, an	SD	1	
~~Acacia abyssinica~~	~~Abyssinian Acacia~~	~~T~~	~~Africa~~	~~3~~	~~(sh)~~
~~Acacia aneura~~	~~Mulga~~	~~T~~	~~Australia~~	~~2~~	~~(sh)~~
Acacia angustissima	White Ball Acacia	S	SD	2	(sh)
Acacia berlandieri	Guajillo	S,T	CD	3	
Acacia constricta	Whitethorn Acacia, Mescat	T,S*	SD, CD	1	
~~Acacia crasspedocarpa~~	~~Waxleaf Acacia~~	~~T,S~~	~~Australia~~	~~1~~	
~~Acacia cultriformis~~	~~Knife Leaf Acacia~~	~~T,S~~	~~Australia~~	~~2~~	~~(sh)~~
Acacia greggii	Cat's Claw Acacia	T,S	SD, CD	1	
Acacia minuta (smallii)	Southwestern Sweet Acacia	T,S,cl	SD, CD	2	
~~Acacia notabilis~~	~~Acacia~~	~~S~~	~~Australia~~	~~2~~	
~~Acacia redolens~~	~~Prostrate Acacia~~	~~S,Gc~~	~~Australia~~	~~2~~	
Acacia rigidula	Black Brush Acacia	S,T	CD	3	
~~Acacia salicina~~	~~Weeping Wattle~~	~~T,cl~~	~~Australia~~	~~2~~	~~(sh)~~
~~Acacia saligna~~	~~Wattle Tree~~	~~T~~	~~Australia~~	~~1-2~~	~~(sh)~~
Acacia schaffneri	Twisted Acacia	T	CD	1-2	
~~Acacia stenophylla~~	~~Pencilleaf Acacia~~	~~T~~	~~Australia~~	~~1-2~~	
~~Acacia willardiana~~	Palo Blanco	T	SD	1-2	(sh)
Agave americana	Century Plant	Sc	CD	1-2	
Agave colorata	Agave	Sc	SD	1	
Agave filifera	Agave	Sc	CD	1-2	
Agave huachucensis	Huachuca Agave	Sc	SD	1-2	
Agave lophantha (univittata)	Agave	Sc	CD	2	
Agave ocahui	Ocahui Agave	Sc	SD	1-2	
Agave palmeri	Palmer Agave	Sc	SD	1	
Agave victoriae-reginae	Victoria Regina Agave	Sc	CD	1-2	
Agave vilmoriniana	Octopus Agave	Sc	SD	1-2	(sh)
~~Aloe barbadensis~~	~~Barbados Aloe~~	~~Sc,cl~~	~~Africa~~	~~2-3~~	~~(sh)~~
~~Aloe ferox~~	~~(sh) Cape Aloe~~	~~Sc,cl~~	~~Africa~~	~~2-3~~	
~~Aloe saponaria~~	~~Mediterranean Aloe~~	~~Sc,cl~~	~~Africa~~	~~2-3~~	~~(sh)~~
Aloysia gratissimma	Fragrant Bush, Bee Brush	S	SD, CD	2	
Aloysia wrightii	Wright's Oregano, Lemon Verbena	S	SD, CD	2	
Ambrosia (Franseria)	Triangle-leaf	S	SD		

BOTANICAL NAME	COMMON NAME	STATUS	ORIGIN	NEEDS	HARDY
deltoidea	Bursage				
Ambrosia (Franseria) dumosa	White Bursage	S	SD	1	
Anisacanthus thurberi	Desert Honeysuckle	S	SD	2	
Antigonon leptopus	Queen's Wreath	V,cl	SD	2-3	(t)
Aristida purpurea	Purple Three-Awn	Gr,cl	SD, CD	1	
Asclepias linaria	Pine-Leaf Milkweed	S	SD, CD	2	
Asclepias subulata	Desert Milkweed	A	SD	2	(sh)
Aster bigelovii	Aster	an	SD	1	(t)
Aster tanacetifolius	Aster	an	SD, CD	1	(t)
Atriplex canescens	Four-Wing Saltbush	S	SD, CD	1	
Atriplex lentiformis	Quail Bush	S	SD	1	
Atriplex lentiformis breweri	Brewer Saltbush	S	SD	1-2	
~~Atriplex nummularia~~	~~Old Man Saltbush~~	~~S~~	~~Australia~~	~~1~~	
Atriplex polycarpa	Desert Saltbush	S	SD	1	
~~Atriplex semibaccata~~	~~Australian Saltbush~~	~~S~~	~~Australia~~	~~2~~	
~~Baccharis sarothroides (male plants only)~~	~~Desert Broom~~	~~S,I~~	~~SD~~	~~1-2~~	
~~Baccharis sarothroides `Centennial'~~	~~Centennial~~	~~S,Ge~~	~~SD~~	~~2-3~~	
Bahia absinthifolia	Desert Daisy	p,cl	SD	2	
Baileya multiradiata	Desert Marigold	p,cl*	SD, CD	1-2	
Berberis harrisoniana	Barberry	S	SD	3	
Berberis trifoliata	Agritos	S	SD	3	
Bothriochloa barbinodis	Cane Beardgrass	Gr,cl	SD, CD	1	
~~Bougainvillea spp.~~	~~Bougainvillea~~	~~V,S,cl~~	~~Brazil~~	~~3~~	~~(t)~~
Bouteloua chondrosioides	Sprucetop Grama	Gr	SD, CD	2	
Bouteloua curtipendula	Sideoats Grama	Gr,cl	SD, CD	2	
Bouteloua eriopoda	Black Grama	Gr,cl	SD	3	
Bouteloua gracilis	Blue Grama	Gr	SD, CD	2	
Bouteloua hirsuta	Hairy Grama	Gr	SD	2	
Bouteloua rothrockii	Rothrock Grama	Gr	SD, CD	1	
~~Brachychiton populneus~~	~~Bottle Tree~~	~~T~~	~~Australia~~	~~2-3~~	
Brahea (Erythea) armata	Mexican Blue Palm	T	SD	2-3	
Buchloe dactyloides	Buffalo Grass	Gr	CD	2-3	
Buddleia marrubifolia	Wooly Butterfly Bush	S,cl	CD	2-3	
Caesalpinia (Poinciana) mexicana,	Mexican Bird of Paradise (yellow)	S,cl*	CD	2	

BOTANICAL NAME	COMMON NAME	STATUS	ORIGIN	NEEDS	HARDY
~~Caesalpinia (Poinciana) gilliesii~~	~~Yellow Bird of Paradise~~	~~S,cl*~~	~~Argentina~~	~~1-2~~	
~~Caesalpinia pulcherrima~~	~~Red Bird of Paradise~~	~~S,cl*~~	~~Caribbean~~	~~3~~	~~(sh)~~
Calliandra californica	Red Fairy Duster, Baja Fairy Duster	S,cl	SD	2-3	
Calliandra eriophylla	Fairy Duster, False Mesquite	S,cl	SD	1	
Calliandra peninsularis	Red Calliandra, Baja Fairy Duster	S,cl	SD	2-3	(sh)
~~Callistemon citrinus~~	~~Lemon Bottlebrush~~	~~T,S,cl~~	~~Australia~~	~~3~~	~~(sh)~~
Calylophus hartwegii	Calylophus	Gc,cl	CD	3	
Campsis radicans	Common Trumpet Creeper	V,cl	SD, CD	2-3	
Carnegiea gigantea	Saguaro	C	SD	1	
~~Carpobrotus edulis~~	~~Ice Plant~~	~~Gc,Sc,cl,~~	~~Africa~~	~~3~~	~~(t)~~
~~Cassia artemisioides~~	~~Wormwood Senna, Feathery Cassia~~	~~S,cl~~	~~Australia~~	~~2-3~~	~~(sh)~~
~~Cassia nemophila (eremophila)~~	~~Green Cassia~~	~~S,cl~~	~~Australia~~	~~2~~	
~~Cassia phyllodinea~~	~~Silvery Cassia~~	~~S,cl~~	~~Australia~~	~~2-3~~	
~~Casuarina cunninghamiana~~	~~Australian Pine~~	~~T~~	~~Australia~~	~~3~~	
~~Casuarina stricta~~	~~Coast Beefwood~~	~~T~~	~~Australia~~	~~2-3~~	
Cathostecum erectum	False Grama	Gr,cl	SD	1	
Celtis pallida	Spiny or Desert Hackberry	S	SD, CD	1-2	
Celtis reticulata	Netleaf or Western Hackberry	T	SD, CD	2	
~~Centaurea cineraria~~	~~Dusty Miller~~	~~p,cl~~	~~Mediterranean~~	~~3~~	
Cephalophyllum `Red Spike'	Red Spike Ice Plant	Gc,Sc,cl		2	
~~Ceratonia siliqua~~	~~Carob, St. John's Bread Tree~~	~~T~~	~~Mediterranean~~	~~3~~	~~(sh)~~
Cercidium floridum	Blue Palo Verde	T,cl	SD	2-3	
Cercidium microphyllum	Littleleaf or Foothill Palo Verde	T,cl	SD	1	
Cercidium praecox	Palo Brea	T,cl	SD	2	(sh)
Cercidium sonorae	Sonoran Palo Verde	T,cl	SD	1-2	
Cercis canadensis var. mexicana	Mexican Redbud	T,S	CD	3	
~~Cereus peruvianus 'Monstrosus'~~	~~Peruvian Cereus~~	~~C~~	~~South America~~	~~1-2~~	~~(sh)~~
~~Chamaerops humilis~~	~~Mediterranean Fan Palm~~	~~T~~	~~Spain~~	~~2-3~~	
Chilopsis linearis	Desert Willow	T,S,cl	SD, CD	2-3	

BOTANICAL NAME	COMMON NAME	STATUS	ORIGIN	NEEDS	HARDY
~~Cissus incisa~~	~~Desert Grape Ivy~~	~~V,I~~	~~CD~~	~~1-2~~	
Cissus trifoliata	Desert Grape Ivy	V	SD	1-2	
Condalia warnockii var. kearneyana	Condalia	S	SD, CD	1	
~~Convolvulus cneorum~~	~~Bush Morning Glory~~	~~S,Gc,cl*~~	~~Mediterranean~~	~~1-2~~	
~~Convolvulus mauritanicus~~	~~Ground Morning Glory~~	~~Gc,cl~~	~~Africa~~	~~3~~	~~(sh)~~
Cordia boissieri	Anacahuita, Texas Olive	T,S,cl	CD	2-3	(sh)
Cordia parvifolia	Littleleaf Cordia	S,cl	SD, CD	1-2	
~~Cortaderia selloana~~	~~Pampas Grass~~	~~Gr~~	~~Argentina~~	~~3~~	
Cupressus arizonica	Arizona Cypress	T	SD, CD	2	
Cupressus glabra	Smooth Bark Cypress	T	SD	2-3	
~~Dalbergia sissoo~~	~~Rosewood~~	~~T~~	~~India~~	~~3~~	~~(sh)~~
Dalea bicolor var. argyrea	Silver Dalea	S	SD	2-3	
Dalea frutescens	Black Dalea	S,cl	CD	2-3	
Dalea greggii	Trailing Indigo Bush	Gc	CD	2-3	
Dalea pulchra	Indigo Bush	S,cl	SD	2-3	
Dalea versicolor var. sessilis	Indigo Bush, Dalea	S,cl	SD	3	
Dasylirion acrotriche	Green Desert Spoon	A	CD	1	
Dasylirion wheeleri	Sotol, Desert Spoon	A	SD, CD	1	
Datura wrightii	Sacred Datura	Gc,p,cl*	SD	3	(sh)
~~Digitaria californica~~	~~Arizona Cottontop~~	~~Gr~~	~~SD, CD~~	~~1~~	
~~Dimorphotheca sinuata~~	~~African Daisy, Cape Marigold~~	~~an,cl~~	~~South Africa~~	~~4~~	
Dodonaea viscosa	Hopbush	S	SD, CD	1-2	(sh)
Dyssodia acerosa	Dogweed	Gc,p,cl,SD,CD	SD, CD	2-3	
~~Dyssodia pentachaeta~~	~~Dyssodia~~	~~Gc,an,p,cl~~	~~SD,CD~~	~~2-3~~	
Echinocactus grusonii	Golden Barrel	C,cl	SD	1-2	
Echinocereus spp.	Hedgehog, Rainbow Cactus	C,cl	SD, CD	1	
~~Echinopsis spp.~~	~~Easter Lily, Sea Urchin Cactus~~	~~C,cl~~	~~So. America~~	~~1~~	
Encelia californica	California Brittlebush (green)	S,cl	SD	1-2	(sh)
Encelia farinosa	Brittlebush	S,cl	SD	1-2	(sh)
Ephedra nevadensis	Ephedra	S	SD	3	
~~Eragrostis intermedia~~	~~Plains lovegrass~~	~~Gr~~	~~SD, CD~~	~~1~~	
~~Eremophila decipiens~~	~~Emu Bush~~	~~S,cl~~	~~Australia~~	~~1~~	

BOTANICAL NAME	COMMON NAME	STATUS	ORIGIN	NEEDS	HARDY
Erioneuron pulchellus	Fluffgrass	Gr	SD, CD	1	
Eschscholtzia californica	California Poppy	an,cl	SD	2-3	
Eschscholtzia mexicana	Mexican Gold Poppy	an,cl	SD	3	
~~Eucalyptus camaldulensis~~	~~Red River Gum~~	~~T~~	~~Australia~~	~~2~~	
~~Eucalyptus campaspe~~	~~Silver Gimlet~~	~~T~~	~~Australia~~	~~2-3~~	~~(sh)~~
~~Eucalyptus formanii~~	~~Eucalyptus~~	~~T~~	~~Australia~~	~~2~~	
~~Eucalyptus leucoxylon (rosea)~~	~~White Iron Bark~~	~~T,cl~~	~~Australia~~	~~2~~	
~~Eucalyptus microtheca~~	~~Tiny Capsule Eucalyptus~~	~~T~~	~~Australia~~	~~1-2~~	
~~Eucalyptus polyanthemos~~	~~Silver Dollar Gum~~	~~T~~	~~Australia~~	~~2~~	
~~Eucalyptus rudis~~	~~Desert Gum~~	~~T~~	~~Australia~~	~~2~~	
~~Eucalyptus spathulata~~	~~Swamp Mallee~~	~~T~~	~~Australia~~	~~3~~	
Euphorbia antisyphilitica	Wax Plant, Candelilla	S	CD	1	
Euphorbia myrsinites	Euphorbia	Gc		2	
~~Euphorbia rigida (biglandulosa)~~	~~Gopher Plant~~	~~A,Sc,cl* Africa~~	~~Africa~~	~~2~~	
~~Feijoa sellowiana~~	~~Pineapple Guava~~	~~T,S,cl~~	~~So. America~~	~~3~~	
Ferocactus spp.	Barrel Cactus	C,cl	SD, CD	1	
Fouquieria splendens	Ocotillo	A,cl	SD, CD	1	
Gaillardia pulchella	Fire Wheel, Blanket Flower	an,cl	CD	3	
~~Gazania rigens `Copper King'~~	~~Copper King Gazania~~	~~Gc,cl~~	~~Africa~~	~~3-4~~	
~~Gazania rigens~~	~~Treasure Flower Gazania~~	~~Gc,cl~~	~~Africa~~	~~3-4~~	
~~Gazania rigens leucolaena~~	~~Trailing Gazania~~	~~Gc,cl~~	~~Africa~~	~~3-4~~	~~(t)~~
~~Geoffreya (Gourleia) decorticans~~	~~Chilean Palo Verde~~	~~T,cl~~	~~So. America~~	~~1~~	
Gossypium harknessii	Gossypium	S,cl	SD	2	(t)
Haplopappus (Ericameria) laricifolius	Turpentine Bush	S,cl	SD, CD	1	
Hesperaloe funifera	Giant Hesperaloe	A	CD	1-2	
Hesperaloe parviflora	Red Yucca, Red Flowered Hesperaloe	A,cl	CD	1-2	
Hetropogon contortus	Tanglehead	Gr	SD	3	
Hibiscus coulteri	Yellow Hibiscus, Coulter's Hibiscus	S	SD, CD	2	
Hilaria berlangeri	Curly Mesquite	Gr	SD, CD	2	
Hilaria mutica	Tobosa Grass	Gr	SD, CD	1	
Hilaria rigida	Big Galleta Grass	Gr	SD, CD	2	

BOTANICAL NAME	COMMON NAME	STATUS	ORIGIN	NEEDS	HARDY
Hyptis emoryi	Desert Lavendar	S	SD	3	(sh)
Jatropha cardiophylla	Limberbush	S	SD	1	
Jatropha dioica	Jatropha	S,cl	CD	1	(t)
~~Juniperus chinensis~~	~~Juniper (many culitvars)~~	~~T,S~~	~~Asia~~	~~3~~	
Juniperus deppeana	Alligator Bark Juniper	T	SD, CD	3	
~~Juniperus sabina `Arcadia'~~	~~Arcadia Juniper~~	~~S~~		~~3~~	
Justicia (Beloperone) californica	Chuparosa	S,cl	SD	2-3	
Justicia candicans	Red Jacobinia	S,cl	SD	3	(sh)
Justicia spicigera	Mexican Honeysuckle, Firecracker Bush	S,cl	SD	3	(sh)
Lantana camara	Bush Lantana (many cultivars)	S,cl*	No. America	3-4	(t)
Lantana montevidensis	Trailing Lantana	Gc,cl* S. Am.	So. America	3-4	(t)
Larrea tridentata (divaricata)	Creosote Bush, Greasewood	S,cl	SD, CD	1	
Leptochloa dubia	Green Sprangle-Top	Gr	CD	3	
Leucaena retusa	Golden Leadball	T,S,cl	CD	1-2	
Leucophyllum spp.	Texas Ranger (all cultivars)	S,cl	CD	2	
~~Linum grandiflorum `Rubrum'~~	~~Scarlet Flax~~	~~Gc,an,cl~~		~~3~~	
Linum lewisii	Blue Flax	an,cl	SD, CD	3	
Lupinus arizonicus	Lupine	an,cl	SD	1	
Lupinus sparsiflorus	Desert Lupine	an,cl	SD	1	
Lupinus succulentus	Arroyo Lupine	an,cl	SD	1	
Lycium exsertum	Lycium	S	SD	1	
Lycium fremontii	Wolfberry	S	SD	1	
Lysiloma thornberi	Feather Tree	T,S	SD	2-3	(sh)
Macfadyena unguis-cati	Cat's Claw Vine	V,cl	America	2-3	
~~Malephora crocea~~	~~Croceum, Ice Plant~~	~~Gc,Sc,cl~~		~~2-3~~	
Mamillaria spp.	Mamillaria Cactus	C,cl	SD, CD	1-2	
Mascagnia lilacina	Lavender Orchid Vine	V,cl	CD	2-3	
Mascagnia macroptera	Yellow Orchid Vine	V,cl	SD, CD	2-3	(sh)
Maytenus phyllanthoides	Mangle Dulce	S	SD, CD	2	

BOTANICAL NAME	COMMON NAME	STATUS	ORIGIN	NEEDS	HARDY
Melampodium leucanthum	Blackfoot Daisy	Gc,p,cl SD,CD	SD, CD	2	
Merremia aurea	Yellow Merremia	V,cl	SD	2-3	(t)
Mimosa dysocarpa	Velvetpod	S,cl	SD	2	
Muhlenbergia dumosa	Bush Muhlenbergia, Bamboo Muhly	Gr	SD	3-4	
Muhlenbergia emersleyi	Bullgrass	Gr,cl	SD	1	
Muhlenbergia porteri	Bush Muhly	Gr,cl	SD, CD	1	
Muhlenbergia rigens	Deer Grass	Gr	SD	3	
Muhlenbergia rigida	'Nashville' TM	Gr,cl	SD	3	
~~Myoporum parvifolium~~	~~Myoporum~~	~~Gc~~	~~Australia~~	~~3~~	
~~Myrtus communis~~	~~True Myrtle, Roman Myrtle~~	~~S~~	~~Mediterranean~~	~~3~~	
~~Myrtus communis `Boetica'~~	~~Twisted Myrtle~~	~~S#~~	~~Mediterranean~~	~~3~~	
~~Myrtus communis `Compact~~	~~Dwarf Myrtle~~	~~S~~	~~Mediterranean~~	~~3~~	
~~Nandina domestica~~	~~Heavenly Bamboo (many cultivars)~~	~~S,cl~~		~~3~~	
~~Nerium oleander~~	~~Oleander (many cultivars)~~	~~S,cl*~~	~~Asia~~	~~2-3~~	
Nolina bigelovii	Beargrass	A	SD	1-2	
Nolina matapensis	Tree Beargrass	A,T	SD	1-2	
Nolina microcarpa	Beargrass	A	SD	1-2	
Nolina parryi	Parry's Beargrass	A	SD	1-2	
Oenothera berlandieri (speciosa childsii)	Mexican Evening Primrose	Gc,cl	CD	3	
Oenothera caespitosa	Tufted Evening Primrose	p,cl	SD	2-3	
Oenothera stubbei	Chihuahuan Primrose, Baja Primrose	Gc,cl	CD	2-3	
~~Olea europaea `Swan Hill'~~	~~Swan Hill Olive~~	~~T~~	~~Mediterranean~~	~~3~~	
Olneya tesota	Desert Ironwood, Tesota	T	SD, CD	1	(sh)
Opuntia spp.	Prickly Pear, Cholla	C	SD, CD	1	
Oryzopsis hymenoides	Indian Ricegrass	Gr	SD, CD	3	
~~Osteospermum fruticosum~~	~~Trailing African Daisy~~	~~Gc,cl~~	~~Africa~~	3-4	(sh)
Pappophorum mucronulatum	Pappusgrass	Gr	SD	1	
~~Parkinsonia aculeata~~	~~Mexican Palo Verde~~	~~T,I,cl~~	~~SD, CD~~	~~1-2~~	

BOTANICAL NAME	COMMON NAME	STATUS	ORIGIN	NEEDS	HARDY
Passiflora foetida	Passion Flower	V	SD	3	(sh)
Pedilanthus macrocarpus	Slipper Flower	A,Sc,cl*	SD	2	
~~Pennisetum setaceum `Cupreum'~~	~~Purple Fountain Grass~~	~~Gr~~	~~Africa~~	~~1-2~~	
Penstemon baccharifolius	Cutleaf Penstemon	p,cl	CD	1	
Penstemon barbatus	Beardtongue Penstemon	p,cl	SD, CD	1	
Penstemon eatoni	Eaton's Penstemon	p,cl	SD	1	
Penstemon parryi	Parry Penstemon	p,cl	SD	1	
Penstemon pseudospectabilis	Canyon Penstemon, Mohave Beardtongue	p,cl	SD	1	
Penstemon superbus	Superb Penstemon	p,cl	CD	1	
~~Pentzia incana~~	~~Karoo Bush~~	~~Gc~~	~~Africa~~	~~1-2~~	
Phacelia campanularia	Desert Canterbury Bells	an,cl	SD	2-3	
Phacelia tanacetifolia	Tansy Phacelia	an,cl	SD	2-3	
~~Phoenix canariensis~~	~~Canary Island Date Palm~~	~~T~~		~~3~~	
~~Phoenix dactylifera~~	~~Date Palm~~	~~T~~	~~Asia~~	~~3~~	
~~Phyla nodiflora~~	~~Lippia~~	~~Gc,cl~~		~~3-4~~	
~~Pinus edulis~~	~~Piñon Nut Pine~~	~~T~~		~~2-3~~	
~~Pinus eldarica~~	~~Afghan Pine~~	~~T#~~	~~Asia~~	~~2~~	
~~Pinus halepensis~~	~~Aleppo Pine~~	~~T~~	~~Mediterranean~~	~~2~~	
~~Pinus monophylla~~	~~Singleleaf Piñon Pine~~	~~T~~	~~Mojave~~	~~2~~	
~~Pinus pinea~~	~~Italian Stone Pine~~	~~T~~	~~Mediterranean~~	~~2-3~~	
~~Pinus roxburghii~~	~~Chir Pine~~	~~T~~	~~Asia~~	~~3~~	
~~Pistacia atlantica~~	~~Mt. Atlas Pistache~~	~~T~~	~~Africa~~	~~2~~	
~~Pistacia chinensis~~	~~Chinese Pistache~~	~~T,cl~~	~~Asia~~	~~3~~	
~~Pistacia terebinthus x integerrima~~	~~Pistache hybrid terebinthus x integerrima~~	~~T,cl~~		~~3~~	
~~Pistacia vera~~	~~Pistachio~~	~~T~~	~~Asia~~	~~2-3~~	
Pithecellobium flexicaule	Texas Ebony	T	CD	2	(sh)
Pithecellobium mexicanum	Mexican Ebony	T	SD	3	
Pithecellobium pallens	Tenaza	T	CD	2	(sh)
~~Pittosporum phillyraeoides~~	~~Willow Pittosporum~~	~~T~~	~~Australia~~	~~2~~	
Plantago spp.	Indian Wheat	an	SD, CD	1-2	

BOTANICAL NAME	COMMON NAME	STATUS	ORIGIN	NEEDS	HARDY
Prosopis (So. Am. hybrid)	Thornless Mesquite (So. Am. hybrid)	T#	So. America	2	
~~Prosopis alba~~	~~Argentine Mesquite~~	~~T#~~	~~So. America~~	~~2~~	
~~Prosopis chilensis~~	~~Chilean Mesquite~~	~~T#~~	~~So. America~~	~~2~~	
Prosopis glandulosa glandulosa	Honey or Texas Mesquite	T#	CD	2	
Prosopis pubescens	Screwbean Mesquite	T	SD, CD	2	
Prosopis velutina	Velvet Mesquite	T#	SD	2	
Psilostrophe cooperi	Paper Flower	p,cl	SD, CD	2	
~~Punica granatum~~	~~Pomegranate~~	~~S,T,cl~~	~~India~~	~~2-3~~	
~~Pyracantha (red berried types)~~	~~Pyracantha (many cultivars)~~	~~S,cl~~		~~3~~	
Quercus arizonica	Arizona White Oak	T	SD, CD	3	
Quercus emoryi	Emory Oak	T	SD, CD	3	
~~Quercus ilex~~	~~Holly Oak~~	~~T~~		~~3~~	
~~Quercus suber~~	~~Cork Oak~~	~~T*~~	~~Mediterranean~~	~~2~~	
~~Quercus virginiana 'Heritage'~~	~~Heritage Live Oak~~	~~T~~	~~SE U.S.A.~~	~~3~~	
~~Rhus lancea~~	~~African Sumac~~	~~T,I~~	~~Africa~~	~~2~~	
Rhus microphylla	Littleleaf Sumac	S,cl	CD	2	
Rhus ovata	Sugar Bush, Sugar Sumac	S	SD	2	
Rhus virens	Evergreen Sumac	S,cl	CD	2	
~~Rosa banksiae~~	~~Lady Banks Rose, Tombstone Rose~~	~~S,Gc,V~~		~~3~~	
~~Rosmarinus officinalis~~	~~Bush Rosemary~~	~~S,cl~~	~~Mediterranean~~	~~2-3~~	
~~Rosmarinus officinalis 'Prostratus'~~	~~Dwarf or Trailing Rosemary~~	~~Gc,cl~~	~~Mediterranean~~	~~2-3~~	
Ruellia californica	Ruellia	S,cl	SD	3	(t)
Ruellia peninsularis	Ruellia	S,cl	SD	3	(t)
~~Ruschia uncinatus~~	~~Ruschia~~	~~Sc,Gc~~		~~2~~	
Salvia chamaedryoides	Blue Sage	S,p,cl	CD	2-3	
Salvia clevelandii	Cleveland Sage	S,cl		3	
Salvia columbariae	Chia	an,cl	SD	3	
Salvia farinacea	Mealy Blue Sage	S,cl	CD	3-4	
Salvia greggii	Texas Red Salvia, Autumn Sage	S,cl	CD	2-3	
Salvia mohavensis	Mohave Sage	S,cl	SD	2	
Sambucus mexicana	Mexican Elderberry	T	SD, CD	2	
~~Santolina chamaecyparissus~~	~~Lavendar Cotton~~	~~S,Gc~~	~~Mediterranean~~	~~2-3~~	

BOTANICAL NAME	COMMON NAME	STATUS	ORIGIN	NEEDS	HARDY
~~Santolina virens~~	~~Green Santolina~~	~~Gc,S,cl Medit.~~	~~Mediterranean~~	~~3-4~~	
Sapindus saponaria	Soapberry	T*	SD, CD	3-4	
~~Schinus molle~~	~~California Pepper Tree~~	~~T~~	~~So. America~~	~~2-3~~	
~~Senecio cineraria~~	~~Dusty Miller, Silver Plant~~	~~p,cl*~~		~~3~~	
Senna covesii	Desert Senna	p,cl	SD	1-2	
Senna lindheimeriana	Senna	S	CD	4	(sh)
Senna wislizenii	Cassia, Shrubby Senna	S,p,cl	SD, CD	2	
~~Sesuvium verrucosum~~	~~Sea Purslane, Ice Plant~~	~~Gc~~	~~Africa~~	~~2~~	~~(t)~~
Setaria macrostachya	Plains Bristle Grass	Gr	SD, CD	3	
Simmondsia chinensis	Jojoba, Goat Nut	S	SD	1-2	
Sophora secundiflora	Mescal Bean, Texas Mountain Laurel	S,T,cl*	CD	2-3	
Sphaeralcea spp.	Globe-Mallow	p,cl	SD, CD	1	
Sporobolus airoides	Alkali Sacaton	Gr	SD, CD	3	
Sporobolus contractus	Spike Dropseed	Gr	SD, CD	1	
Sporobolus cryptandrus	Sand Drops	Gr	SD, CD	3	
Sporobolus flexuosus	Mesa Dropseed	Gr	SD, CD	2	
Sporobolus wrightii	Sacaton	Gr	SD, CD	1	
Stenocereus (Lemaireocereus) thurberi	Organ Pipe Cactus	C	SD	1	
Stipa neomexicana	New Mexico Feathergrass	Gr	SD, CD	2	
Tagetes lemmoni	Mountain Marigold	p,cl	SD	3-4	
~~Tamarix aphylla~~	~~Athel Tree, Tamarisk~~	~~T~~	~~Asia~~	~~1~~	
~~Tamarix parviflora or chinensis~~	~~Spring Flowering Salt Cedar~~	~~T,S,I~~	~~Asia~~	~~2~~	
Tecoma stans var. angustata	Trumpet-Bush	S,cl	SD, CD	2-3	(sh)
~~Tecomaria capensis~~	~~Cape Honeysuckle~~	~~S,cl~~	~~Africa~~	~~4~~	~~(sh)~~
~~Teucrium chamaedrys (prostratum)~~	~~Prostrate Germander~~	~~Gc,p~~	~~Mediterranean~~	~~2-3~~	
~~Teucrium fruticans~~	~~Bush Germander~~	~~S~~		~~3~~	
Trucklers crinita	Two-feather Trichloris	Gr	SD, CD	2	
Trichocereus spp.	Trichocerius Cactus	C		1-2	
Tridens muticus	Slim Tridens	Gr	SD, CD	2	

BOTANICAL NAME	COMMON NAME	STATUS	ORIGIN	NEEDS	HARDY
Ungnadia speciosa	Mexican Buckeye	T,cl	CD	3	
Vauquelinia californica	Arizona Rosewood	S,T#	SD	2	
Verbena gooddingii	Goodding Verbena	p,cl	SD	3-4	
~~Verbena peruviana~~	~~Peruvian Verbena~~	~~p,cl~~	~~So. America~~	~~4~~	
~~Verbena tenuisecta (pulchella)~~	~~Moss Verbena, Fineleaf Verbena~~	~~p,cl~~	~~So. America~~	~~3~~	
Verbesina encelioides	Crown Beard	an,cl	SD, CD	2	
Viguiera deltoidea	Golden Eye	p,cl	SD	2	
~~Vitex agnus castus~~	~~Chaste Tree, Monk's Pepper~~	~~T,S,cl~~		~~2~~	
~~Washingtonia filifera~~	~~California Fan Palm~~	~~T~~	~~SD~~	~~2~~	
~~Washingtonia robusta~~	~~Mexican Fan Palm~~	~~T~~	~~SD~~	~~2-3~~	~~(sh)~~
~~Xylosma congestum~~	~~Xylosma~~	~~T,S~~	~~China~~	~~3-4~~	
Yucca aloifolia	Spanish Bayonet Yucca	A	SD	1	
Yucca baccata	Banana Yucca	A	SD, CD	1	
Yucca brevifolia	Joshua Tree	A	CD	1	
Yucca carnerosana	Giant Dagger Yucca	A	CD	1	
Yucca elata	Soaptree Yucca	A	SD, CD	1	
Yucca glauca	Small Soapweed Yucca	Sc	U.S.A.	1	
Yucca recurvifolia (pendula)	Pendulous or Curveleaf Yucca	A	U.S.A.	2	
Yucca rigida	Blue Dagger Yucca	A,cl	CD	1	
Yucca rostrata	Beaked Yucca	A	CD	1	
Yucca schottii	Mountain Yucca	Sc	SD	1	
Yucca treculeana	Tree Yucca	A	CD	1	
Yucca whipplei	Our Lord's Candle	A	SD	1	
Zauschneria californica	Hummingbird Trumpet	Gc,cl	SD	3	
Zinnia acerosa	Desert Zinnia	p,cl	SD, CD	1	
Zinnia grandiflora	Rocky Mountain Zinnia	p,cl	CD	2	
~~Zizyphus jujuba~~	~~Chinese Date~~	~~T,I~~	~~Asia~~	~~2~~	

List Sorted Alphabetically by Botanical Name

EXHIBIT E

LEGAL DESCRIPTION

THE LAND REFERRED TO HEREIN BELOW IS SITUATED IN THE COUNTY OF PIMA, STATE OF ARIZONA, AND IS DESCRIBED AS FOLLOWS:

Blocks 1, 2 and 3, SILVERBELL RIDGE ESTATES, according to plat recorded in Sequence No. 20182500098, records of Pima County, Arizona.

APN: 214-04-1170, 214-04-1180 and 114-04-1190

Council-Regular Meeting **A2**

Meeting Date: 11/19/2024

To: Mayor and Council

Submitted For: Jason Angell, Development Services Director

From: Dustin Ward, Development Engineering Division Manager

Date: November 19, 2024

Strategic Plan Focus Area:
Not Applicable

Subject: Ordinance No. 2024.025: Relating to Land Development, adopting the Town of Marana Drainage Manual (Jason Angell)

Resolution No. 2024-103: Relating to Land Development, declaring as a public record filed with the Town Clerk the Town of Marana Drainage Manual adopted by Ordinance No. 2024.025 (Jason Angell)

Discussion:

The Town of Marana (Town) has prepared this Drainage Manual for the civil engineering and floodplain management community designing improvements within the Town limits. Historically, the Town has relied on regional standards and methods in the hydrology/hydraulic discipline that mainly originated in the City of Tucson and Pima County. The core purpose of this manual is to compile the Town's policies by taking into consideration the historically used regional standards and methods, but modifying standards to be more reflective of Marana's topography and culture.

With the Town's growth over the last several years, staff have observed that there is a need to position the Town so that we are not reliant on other jurisdictions for drainage standards. Creating the Town of Marana Drainage Manual will allow the Town to decide how we will require drainage to be designed. This will also position us to guide development in a direction that allows us to protect our residents, foster town growth, provide consistency within the developments, and maintain our relationships with the development community.

The current drainage design practices across the Town have been inconsistent in terms of the methods used while constant in their approach to design. The Drainage Manual will set the standards, making the designs consistent with the developments. It will also provide guidance to new developers who are developing within the Town. The manual, as developed, has pulled together the relevant design standards from jurisdictions within the region that staff have determined to align with the Town's master plan. As part of the development of the Drainage Manual, Town staff worked with SAHBA and the engineers within the development community to get feedback on the manual. We evaluated all the feedback received for the impact on the residents, staff, and the community; we incorporated the suggestions that were in the Town's best interest.

Staff Recommendation:

Staff recommends adopting the Town of Marana Drainage Manual as the Town standard for drainage development.

Suggested Motion:

I move to adopt Ordinance No. 2024.025, adopting the Town of Marana Drainage Manual, and Resolution No. 2024-103, declaring the Drainage Manual as a public record filed with the Town Clerk.

Attachments

Ordinance No. 2024.025
Resolution No. 2024-103
Exhibit A - Drainage Manual

MARANA ORDINANCE NO. 2024.025

RELATING TO LAND DEVELOPMENT; ADOPTING THE TOWN OF MARANA DRAINAGE MANUAL

WHEREAS A.R.S. §48-3610 authorizes an incorporated city or town to assume floodplain management powers and duties within its area of jurisdiction; and

WHEREAS the Town of Marana has assumed floodplain management powers and duties within its area of jurisdiction via the adoption of Marana Town Code Chapter 17-15 "Floodplain and Erosion Hazard Management Code" to promote the public health, safety and general welfare of its citizens; and

WHEREAS Town staff has promulgated the Town of Marana Drainage Manual, providing general commercial and residential development regulations for developing properties within the Town of Marana; and

WHEREAS the Mayor and Council find that the approval of the proposed Town of Marana Drainage Manual is in the best interest of the residents and businesses of the Town of Marana.

NOW, THEREFORE, BE IT ORDAINED by the Mayor and Council of the Town of Marana as follows:

SECTION 1**.** The Town of Marana Drainage Manual, one paper copy and one electronic copy of which are on file in the office of the Town Clerk, which was made a public record by and attached as Exhibit A to Resolution No. 2024-103 of the Town of Marana, Arizona, is hereby referred to, adopted and made a part of this ordinance as if fully set out here.

SECTION 2. Violation of the Town of Marana Drainage Manual shall be treated in the same manner as a violation of the Town of Marana Land Development Code, as set forth in Marana Town Code Chapter 17-3 "Administration and Enforcement."

SECTION 3. The Marana Town Council hereby authorizes the Town Engineer to administratively update and revise the Town of Marana Drainage Manual from time to time as needed due to changes to the Marana Town Code and other Town standards or regulations, or when necessary based on sound engineering judgment consistent with accepted practices, as long as the administrative changes do not alter the general purpose or intent of the Drainage Manual.

SECTION 4. The various town officers and employees are authorized and directed to perform all acts necessary or desirable to give effect to this ordinance.

SECTION 5. All ordinances, resolutions, or motions and parts of ordinances, resolutions, or motions of the Council in conflict with the provisions of this ordinance are hereby repealed, effective as of the effective date of this ordinance.

SECTION 6. If any section, subsection, sentence, clause, phrase or portion of this ordinance is for any reason held to be invalid or unconstitutional by the decision of any court of competent jurisdiction, the decision shall not affect the validity of the remaining portions of this ordinance.

SECTION 7. This ordinance is effective on the 31st day after its adoption.

PASSED AND ADOPTED by the Mayor and Council of the Town of Marana, Arizona, this 19th day of November, 2024.

_____
Mayor Ed Honea

ATTEST:

_____
David L. Udall, Town Clerk

APPROVED AS TO FORM:

_____
Jane Fairall, Town Attorney

MARANA RESOLUTION NO. 2024-103

RELATING TO LAND DEVELOPMENT; DECLARING AS A PUBLIC RECORD FILED WITH THE TOWN CLERK THE TOWN OF MARANA DRAINAGE MANUAL ADOPTED BY ORDINANCE NO. 2024.025

BE IT RESOLVED BY THE MAYOR AND COUNCIL OF THE TOWN OF MARANA, ARIZONA, that the Town of Marana Drainage Manual adopted by Marana Ordinance No. 2024.025, a copy of which is attached to and incorporated in this resolution as Exhibit A and one paper copy and one electronic copy of which are on file in the office of the Town Clerk, are hereby declared to be a public record and ordered to remain on file with the Town Clerk.

PASSED AND ADOPTED BY THE MAYOR AND COUNCIL OF THE TOWN OF MARANA, ARIZONA, this 19th day of November, 2024.

_____
Mayor Ed Honea

ATTEST:

_____
David L. Udall, Town Clerk

APPROVED AS TO FORM:

_____
Jane Fairall, Town Attorney

MARANA AZ



TOWN OF MARANA
DRAINAGE MANUAL

SEPTEMBER 2024

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1. Introduction and Purpose

1.1 Introduction

The Town of Marana (Town) has prepared this manual for the civil engineering and floodplain management community that is designing improvements within the Town limits. This shall apply to public and private improvements. Historically, the Town has relied on regional standards and methods in the hydrology/hydraulic discipline that mainly originated in the City of Tucson and Pima County. The Town prepared its own Subdivision Street Standards Manual for the first time in 2004 and has since updated that manual a total of two (2) times. This experience of having standards specific to the Town, compiled and referenced all in one location, has been very helpful to not only Town Staff but to the end users of the manuals: planners and engineers.

The purpose of this manual is to compile the Town's policy by consolidating the historically used regional standards and methods but modifying standards to be more reflective of Marana's topography and culture. New methods and requirements for specific situations that are applicable within the Town Limits are also included. The standards in this manual are guidelines, which will be criteria for approval of submittals. However, it is recognized that there are situations for which these standards may not be applicable. In these cases, and in cases of conflict or contradiction, sound engineering judgment consistent with accepted practice shall be used and in some cases approval in writing by the Town Engineer will be necessary.

Those portions of these standards prepared by the Pima County Regional Flood Control District (District) or the City of Tucson have been included herein as public domain information. It should be noted that this manual is adopting those standards from other agencies as they were at the time of publishing of this manual. Future changes to policy and methodology are not automatically incorporated into this manual.

1.2 Purpose

The Town has grown substantially in area and population since first incorporating in 1977 and the growth has been subject to standards and policies through development processes that have been implemented and adapted as the town has grown. The Town is developing this drainage manual to manage the future growth of the Town with a single point of reference for drainage policy. This manual seeks to accomplish the following:

- Compile drainage policies that currently exist in multiple references.
- Establish policies that are appropriate to the Town's topography and culture.
- Provide consistency for the development community, the public, and the Town.
- Provide clarity to the development and engineering community of what to expect during the review and approval process.
- A more consistent/efficient review and approval process.
- A better final design that aims to keep the public safe from flooding for an established set of criteria that is achievable and cost-effective.
- A design that acknowledges the maintenance costs of improvements and attempts to minimize undue maintenance for both publicly and privately owned infrastructure.

1.3 Applicability

These standards should be applied to development, both commercial and residential, and public works improvements when no such overriding standards, agreements and conditions apply. In the future, there could be overlapping of these standards with the Marana Town Code, Chapter 17-15 Floodplain and Erosion Hazard Management Code (Ordinance) and in those cases, the more restrictive of the two will take priority.

2. Documentation Requirements

Drainage submittals supporting improvements and developments will need to meet minimum content standards in accordance with the size and complexity of the project. The types of drainage support documents and specific requirements are detailed in this section.

2.1 Drainage Statement

A drainage statement is an appropriate supporting document when the project is five (5) acres or less and meets all of the following conditions:

- Detention/Retention is not required.
- No hydrologic or hydraulic modeling is required.

Prior to pursuing or scoping a Drainage Statement as the supporting documentation for a project, consult with the Town to determine if this is acceptable. A Drainage Statement may be appropriate for developments covered by an approved Master Drainage Report under the condition that Detention/Retention was handled regionally and within the spine infrastructure of the development. There are other scenarios where a drainage statement may be appropriate when the density of development and subsequent drainage complexity does not require a report. See Appendix A for Drainage Statement Format.

2.2 Drainage Report

A drainage report is an appropriate supporting document for public infrastructure projects that may affect drainage and those private development projects that exceed the thresholds for a drainage statement. Drainage reports are appropriate for the following:

- Subdivisions with single family residential land-use.
- Commercial, Industrial and Institutional Developments that are single owner – non-phased improvements.
- Public infrastructure projects.
- Private utility projects.

See Appendix A for Drainage Report Format.

2.3 Master Drainage Report

A master drainage report (MDR) is an appropriate supporting document for master planned developments, phased developments, and any platted subdivisions (residential or commercial) with Blocks that are created for future development. The MDR is approved in perpetuity by virtue of the development review process. MDRs may become obsolete, non-conforming, or not in-step with the owner's/Town's vision for the area. At such time the MDR must be revised and entitled the "Revised" MDR and make reference to former MDR approval. Reasons for revising the MDR include, but are not limited to the following:

- Change in federal flood hazard zone designation
- Change in land-use of the property

- Change in hydrology methodology (runoff method, rainfall, etc.)
- Change in drainage concept

2.3.1 Master Drainage Concept

The master drainage concept (MDC) must address the spine infrastructure drainage, regional detention, and block to block drainage concept. This drainage concept addresses the potential runoff of the entire block and its ultimate destination in the MDC. Blocks that do not drain into spine infrastructure must establish flow types, amounts across block boundaries. Flow types across block boundaries can be divided into three (3) categories:

- Sheet flow – downstream block must account for future sheet flow from upstream developed block
- Dispersed flow – downstream block must account for at least 2 or more locations of flow from the upstream block
- Concentrated flow – downstream block need only account for one concentrated inflow from the upstream block

Blocks that develop first shall establish the location of flow acceptance and discharge and post-developed blocks shall adhere and accept those locations. The concept of individual block detention/retention over regional detention must be approved in writing by the Town Engineer.

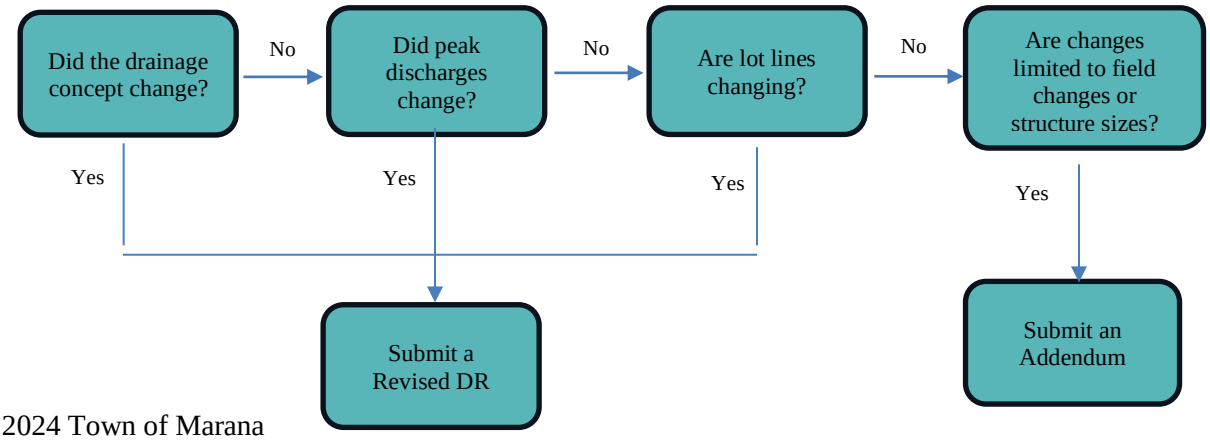
See Appendix A for Master Drainage Report Format

2.4 Technical Data Support Notebook

The Technical Data Support Notebook (SDTSDN) is a nationally accepted report format for documenting large scale hydrologic and hydraulic analyses with the intent to establish flood risk inundation. This format is required for supporting a Conditional Letter of Map Revision (CLOMR) and Letter of Map Revision (LOMR). A regionally accepted format for the DDTSDN has been published by Arizona Department of Water Resources as State Standard SS1. Attention should be given to projects that overlap municipal boundaries that multiple community concurrence forms may be required. See MT-2 form instructions.

2.5 Revisions

Revisions are for the purpose of revising or adding to approved reports. A report that is not yet approved by the town cannot have a revision or addendum to it. Revisions or refinements to a drainage concept may need to be documented in a re-submittal during the development review process. The decision matrix for submitting a revision (Revised Drainage Report) versus an addendum is laid out in the flow chart below:



3. Regulatory Requirements

3.1 Floodplain and Erosion Hazard Management Code

Chapter 17-15 of Marana Town Code is entitled Floodplain and Erosion Hazard Management Code and was approved by Ordinance 2015.021. This section of the Town Code shall hereafter in this document be referred to as the "Ordinance." In the future, there could be overlapping of these standards with the Ordinance and in those cases, the more restrictive of the two will take priority.

3.2 Northwest Policy

The Northwest Policy is hereby incorporated into the Drainage Manual and will now be the home for future modifications and updates. The Northwest Policy was first introduced in December of 2000 for the purpose of addressing the development of the area of the Town Limits which are largely devoid of drainage conveyance mechanisms either natural or improved. The boundary in which the Northwest Policy shall be administered is shown on Figure 1, NW Policy Area Map. Accordingly, the Town adopted the following requirements for this region:

3.2.1 Sheet Flow

Any offsite sheet flow intercepted by a project shall be passed through the project, onsite, or shall be accommodated via an approved alternative facility. Simply elevating a project out of a sheet-flow area without regard to the displaced floodwaters will not suffice. The Town may require flow corridors to be dedicated to provide conveyance of offsite flow in sheet flow areas.

3.2.2 Insufficient Receiving Waters

Projects lacking sufficient improved or natural receiving waters into which stormwater runoff may be discharged shall be required to retain 100% of all on-site runoff volume generated during the design storm. The design storm shall be a 100-year, 1-hr storm, followed by a 10-year, 1-hr storm. These storms shall be applied assuming a lag of 24 hours between (This is important for calculating drain time). Drain time must be 36 hours or less and the clock begins at the end of the 10-year storm. The volume of runoff to be retained shall be computed using the applicable equation excerpted below. An emergency overflow weir, which may discharge to an existing public street, shall be provided as an element of any onsite retention facility.

Equation 3.1 $$V_{post-rp} = \frac{C_{w-rp}\, P_{1-rp}\, A}{12}$$

Where:

A	=	Watershed area
C_{w-rp}	=	Weighted runoff coefficient for the return period, dimensionless
P_{1-rp}	=	1-hour rainfall depth for the return period, inches
$V_{post-rp}$	=	Runoff volume for the return period, acre feet

3.2.3 Ponding Restrictions

Ponded water in basins shall be in conformance with Section 6.3 of this manual, "Basin Depth and Perimeter Safety Requirements."

Drywells are the most common disposal method used to meet drain time requirements. Drywell and Infiltration Trench requirements are discussed in Sections 6.1.1 and 6.1.2 respectively.

3.3 Excavations next to Flood Control Infrastructure

Recognizing the inherent hazard of potentially unstable slopes from deep excavations upon public infrastructure due to failure mechanisms such as seepage, rilling, and headcutting, the Town has generated a standard for safe setback to public infrastructure and neighboring property for all new sand and gravel operations that are permitted within the town limits.
Without additional geotechnical analysis supporting stability of excavations, the following setbacks from property lines shall be adhered to under the following conditions:

3.31 Upstream of Avra Valley Road

1. Maximum excavation slope shall be 1:1
2. Top of slope (as first permitted) shall be setback:
    a. No closer than 100 feet for 25-50-foot depth excavation
    b. No closer than 200 feet for 50-100-foot depth excavation
3. Excavations deeper than 75 feet shall first install piezometers in the area between effluent flow and excavation to evaluate presence of lateral groundwater flow. A slope failure analysis due to saturation will be required at time of submittal.
4. Final reclaimed slopes shall be no steeper than 3:1

3.32 Downstream of Avra Valley Road

1. Maximum excavation slope shall be 1:1
2. Top of slope (as first permitted) shall be setback:
    a. No closer than 150 feet for 25-75-foot depth excavation
    b. No closer than 300 feet for 75-150-foot depth excavation
3. Excavations deeper than 125 feet shall first install piezometers in the area between effluent flow and excavation to evaluate presence of lateral groundwater flow. A slope failure analysis due to saturation will be required at time of submittal.
4. Final reclaimed slopes shall be no steeper than 3:1

3.33 Additional Geotechnical Analysis

Minimum setback to property line/public infrastructure shall be 100-feet when supported by additional geotechnical analysis, including:

- Appropriate characterization of soils on slope and in between property line/public infrastructure to a depth greater than ultimate excavation depth
- When setbacks are proposed which do not provide for sufficient distance to achieve a reclaimed 3:1 slope, a statement that slopes are stable and will not create a hazard to adjacent personal property or public infrastructure must be made under the seal of a registered professional engineer in the State of Arizona.
- A slope failure analysis will be required for any setbacks proposed that are less than standard minimums published above.

Additional restrictions on excavations outlined in the Ordinance shall remain and be full in force.

4. Hydrology

The Town uses a combination of rainfall runoff methodology to quantify peak discharges within the town limits that depends on purpose of the discharge quantity, the location of the project and the size of the watershed. One distinction in terms of location within Town Limits is the Tortolita Fan which comprises a good portion of the Marana Town Limits. Because the Tortolita Fan area is unique geomorphologically and is subject to unconsolidated sheet flow, distributary flow, and active alluvial channel formation, the method for rainfall runoff requires a rain on grid analysis using finite difference methodology. The remainder of the Town Limits should utilize the Pima County Hydrology Methodology. Both methodologies are discussed in detail below.

4.1 Tortolita Alluvial Fan Study (TAFS) Area

Figure 2, TAFS Area is provided to show the region that is covered by the Town's TAFS model. The TAFS model uses two software programs: HEC-1 and FLO-2D. This modeling effort was approved by FEMA for flood hazard mapping use. The study area has two model scenarios to address rainfall aerial reduction: Regional and Non-regional. Refer to References to download the models.

Regional: Rainfall aerial reduction factor was based on the watershed size of the entire TAFS area (±165 square miles). The regional model was approved by FEMA for floodplain mapping in the TAFS area. Non-regional: Rainfall aerial reduction factors were based on the watershed size of each major watershed (total 10 major watersheds, with varying watershed size in the range of 7.8 ~ 24.8 square miles (measured by extending major watersheds to Interstate 10). The non-regional model is intended to be used by the Town for development projects

The size of the TAFS area necessitates aerial reduction for accurate flood risk; without aerial reduction the regional discharges would be exaggerated. However, a scenario was executed and entitled "non-regional" which applies aerial reduction at the sub-basin level instead of at the watershed scale. This non-regional scenario was approved for determining design discharges for areas within the fan.

When preparing a Letter of Map Change (LOMC) through FEMA to address changes to flood boundaries within the TAFS area, the revision should utilize hydrology from the regional model. When preparing a development submittal (commercial or residential) and the purpose is to support the plats, development plans and improvement plans for drainage design and accommodation of offsite flows, the Drainage Report should utilize non-regional hydrologic results for offsite hydrology. Non-regional results can come from a non-regional FLO-2D run. The consultant needs to use sound engineering judgement in selecting the offsite hydrology method. Pima County methodology, specifically use of PC-Hydro software, is very conservative and is an accepted method for design hydrology on the fan (See Section 4.2).

Exceptions within the TAFS Area:

- Onsite hydrology within TAFS shall be prepared using PC-Hydro software and methodology.
- Regional FLO-2D model results are not permitted for design discharges.
- Locations on the fan where the FLO-2D does not show flow accumulation and clearly has contributing watershed upstream of planned development must be accounted for with a PC-Hydro runoff calculation.

Regional FLO-2D model results shall only be used for FEMA purposes. Design discharges shall be either the Non-regional FLO-2D model value or other design discharge specified by the Town. Both regional and non-regional FLO-2D models will be provided by the Town with a public information request.

4.2 Areas outside of TAFS

Projects located outside of the TAFS boundary should use Pima County Hydrology Methodology as published in TECH-015. One exception to TECH-015 is that Marana will accept use of PC-Hydro on watersheds up to 10 square miles or times of concentration up to 180 minutes for design purposes only. Rainfall shall use NOAA Atlas 14 (or latest published Atlas) mean point precipitation frequency estimates. If PC-Hydro is used it defaults to Upper 90% point precipitation estimates. The Town will accept manual input of the mean rainfall estimate into the PC-Hydro web application under the following conditions:

- The report shall clearly state that the decision was made to use mean rainfall values.
- The plotted PC-Hydro results sheets shall be clearly marked that they were conducted with mean rainfall data and not Upper 90%.
- A plot of NOAA Atlas 14 rainfall depths showing mean rainfall depths shall be provided.

FEMA remapping projects outside of TAFS should use a rainfall runoff method acceptable to FEMA that is as accurate as possible and verified to published frequency estimates and/or within the confidence intervals of regional regression estimates.

4.3 Regulatory Discharges

The Town has published regulatory and design discharges for certain watercourses. The discharges can be found in the Ordinance Section 17-15-11 Appendix 1.

4.4 Previously Approved Discharges

In addition to Section 4.3 published discharges, the town has authority to direct the use of other design discharges that may have been approved with other projects. Consult with the Town about other discharges that may be affecting the project in question.

4.5 Accepted Software Programs

The Town will accept the following software programs for hydrology in accordance with Section 4.2:

- FLO-2D Pro versions. In the TAFS area, only FLO-2D Pro [Build No. 17.08.17] will be allowed due to other FLO-2D Pro versions having issues with the combined Green-Ampt and SCS curve number method, which was utilized in the TAFS models.
- PC-Hydro 7.4
- HEC-1 allowed for generational projects that have been prepared using HEC-1.
- HEC-HMS for new projects

4.6 Hydrologic Parameters

For projects that use Pima County Hydrology Methodology, parameter selection is defined in the PC-Hydro 7.4 Users Manual embedded in the web application. Soils are not populated automatically, so when choosing soil coverage use PimaMaps-SDCP. Toggle on the Geology Layer and then the Hydrologic Soils Group – NRCS layer.

For projects that use FLO-2D user shall utilize:

- TAFS modeling parameters for projects located in the TAFS area.
- Outside the TAFS area, Pima County's Criteria for Two-Dimensional Modeling Technical Policy (TECH-033) shall be used.

5. Hydraulics

Hydraulic methodology originates from multiple sources that have been accepted by the Town. The most robust source on hydraulics is the Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona (City Manual) (1998) prepared by Simon, Li and Associates, Inc. for the City of Tucson. The City Manual is widely accepted in Southern Arizona and adjacent jurisdictions for drainage design methodology. The following sections make any clarifications or specific departures from the City Manual standards.

5.1 Open Channel Design

It is the preference of the Town to preserve existing natural channels with a natural bottom. If the channel bottom cannot be maintained as natural, then a justification must be provided within the report. Open Channel design methodology is discussed in Chapter 8 of the City Manual (See Appendix B). What follows are some clarifications and/or supplemental information to those standards:

- Sheet flow areas, specifically in the Northwest Area, may require some corridors for offsite generated drainage conveyance. Do not assume that upstream development will retain pass-through flow.
- Sheet flow in areas upstream of residential developments or habitable structures shall be collected following the Collector Channels standards in Chapter 8 of the City Manual. Sheet flow in areas upstream of other projects such as linear roadways may be collected in collector channels designed per alternative capacity and freeboard criteria as approved on a project-specific basis by the Town Engineer. Collector channels should be fully-lined with a material that is resistant to erosion and provides a means to remove sediment to restore constructed grades.
- Constructed channel slopes in the Northwest Marana area (only) may be as flat as 0.0015 ft/ft
- When a project runs adjacent to one of the future Marana Drainage Master Plan channel alignments on Barnett Rd, Marana Rd, or CMID 10.5 canal the Town may require construction or dedication of right-of-way for the future channel.
- CMID Canals shall not be considered as providing flood conveyance capacity.
- Open Channels shall be designed with non-regional discharges.

Acceptable methods for calculating water surface elevations/capacity of channels includes normal depth calculations for those channels/watercourses that do not have the presence of structures/ineffective flow areas that would create backwater. If the watercourse is regulatory (>50 cfs) and has culvert crossings, then it needs to be evaluated with a steady flow direct step backwater model that also has internal drainage structure calculations rather than simple normal depth calculations.

Acceptable software includes Federal Highway's Hydraulic Toolbox and other proprietary software for calculating normal depth. For backwater applications, it is recommended to use the latest available version of HEC-RAS.

5.2 Cross-Drainage

The goal of cross-drainage design will be to achieve all-weather access. On-site roadways shall be designed to convey the 100-year discharge under the roadway. Off-site public roadways will continue to be a challenge until the Town's Master Drainage Plan is implemented. Because of sheet-flow from the TAFS area and large expanses of the Town limits inundated by the Santa Cruz River, there will need to be exceptions until regional flood control improvements go in. As a matter of interpretation and consistency with other adjacent jurisdictions, a development provides all-weather access when it connects to an

existing public collector or arterial roadway despite whether the Town or County maintained collector roadway provides all-weather access along its entire length. An on-site all-weather at-grade crossing may be considered if it can be demonstrated that a dry-crossing is not feasible, that it conforms to Section 9.3 of the *Marana Streets and Subdivision Standards* and that is has attained prior approval by the Town before it is included in a development package.

5.2.1 Culverts

Culvert analysis shall follow FHWA's *Hydraulic Design Series (HDS) No. 5 (2012)*. Software based on HDS No. 5 methodology is acceptable for calculating hydraulic results.

Culvert headwater shall be designed to be a minimum of six inches below the hinge point of roadway for newly designed on-site roadways.

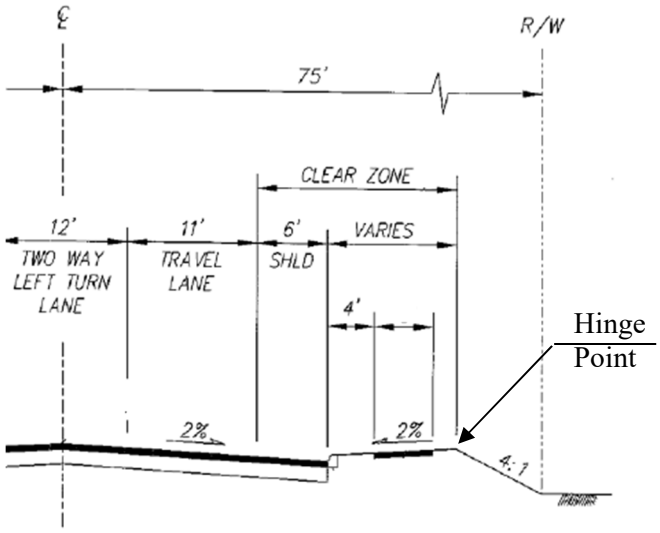


Figure 1 - Partial Roadway Cross Section

Off-site public roadway improvements cross-drainage design criteria shall be determined by the Town on a case-by-case basis.

Inlet and outlet treatment for culverts shall be required and be appropriate for the design of the road. Pipe ends projecting from slope are acceptable in local rural road applications only. Mitered culvert ends are acceptable only on slopes 2:1 and steeper; surrounding slopes must be armored with erosion protection.

Additional provisions for inlet and outlet treatment may be required based on *Roadside Design Guide* (AASHTO). Barricade railing shall be provided at the top of culvert headwalls when distance between established walkway and back of headwall is less than 5-feet.

Drop inlets used to accommodate cover over a cross-culvert must be evaluated in both inlet control and weir control and use the highest calculated headwater. Drop inlets must also provide a minimum of 7-feet from the face of the culvert to the toe of the drop slope to accommodate maintenance equipment. One side of the drop inlet shall be traversable to a piece of tracked equipment. Traversable is defined as a 3:1 slope that can support the weight of a 950G loader or equivalent.

5.2.2 Bridges

Bridges shall be analyzed using a direct step backwater model in a sub-critical regime with the goal to get the most conservative water surface elevation (WSEL) on the upstream side of the bridge face in a 1-dimensional environment. Refer to HEC-RAS *Hydraulic Reference Manual* Section 7.1 for bridge modeling considerations.

Freeboard at bridges shall conform to the guidance in *Guidelines for Establishing Scour and Freeboard for Bridges in Pima County (2012)*. Bridge Scour is addressed in Section 5.5. If the bridge falls in a 2-Dimensional flow environment, it is recommended to schedule a meeting with the Town to discuss the design approach. There could be occasions where a low-flow bridge is acceptable, and those occasions will be reviewed on a case-by-case basis.

5.3 Storm Drain Design

This section is included for describing policy and methodology of hydraulics in storm drain trunklines and laterals. Inlet design capacity will be discussed in Section 5.4, Pavement Drainage. Hydraulic grade line (HGL) calculations should be performed on the trunkline and associated junctions and manholes along the trunkline beginning at the downstream terminus and calculating in the upstream direction. See City Manual Section 10.8 for instructions on HGL calculations. StormCAD and other proprietary software may be appropriate for performing these calculations.

5.3.1 Trunklines

5.3.1.1 Private Systems

Storm drain systems on developed sites that are not in public right-of-way will be maintained by the owner or property owners association. Sites that have a sediment yield shall follow design criteria for public systems. Sites that are determined to be clear-water conditions may follow the guidelines below:

- Minimum trunkline slope may be 0.1% for smooth interior pipes.
- Pipe materials other than reinforced concrete pipe may be used provided the manufacturers recommendations for cover are followed and documented in the drainage report.
- Pipe segments may match at the invert although preference would be to match soffits.
- Pipe diameter or aggregate cross-sectional flow area must increase in the downstream direction.
- Design event can be less than 100-year event if it is demonstrated that the combination of surface and sub-surface flow for the 100-year event is conveyed safely to downstream destination and adjacent habitable structures are elevated appropriately.
- If pipe system is used for supplemental storage volume, then pipes must be designed to be water tight. Furthermore, pipes must also meet basin drain time requirements.

5.3.1.2 Public Systems

Storm drain systems within public right-of-way are maintained by the Town and therefore must meet the following requirements:

- Pipe material shall be rubber gasket reinforced concrete pipe (RGRCP).
- Minimum trunkline slope may be 0.25% if velocity conditions are met.
- Velocity in pipe shall not be less than 3 fps.
- Velocity in trunkline must be maintained or increased in the downstream direction. Decreased velocity will subject the pipe to deposition of sediment.
- Minimum pipe diameter is 24-inches for smooth interior pipes.
- Pipes segments shall match at the inside top of pipe in the downstream direction.
- HGL shall be designed to stay below finished grade and 6-inches below inlets and manholes.

The Town Engineer may allow manhole rims to be bolted down in rare cases when the 6-inch separation cannot be achieved.

- Trunklines shall be designed for the 100-year event.

5.3.2 Laterals

The following requirements shall apply to laterals of both public and private systems:

- Laterals slope may not exceed 10% and should not be less than 0.5%
- Laterals shall connect to trunkline at no greater than 90-degrees.
- Laterals on public systems shall not be smaller than 18-inches.
- HGL at upstream terminus of lateral shall be at least 6-inches below gutter grade or grate elevation for the 100-year event.
- Cover over pipe shall be in accordance with manufacturer's recommendations.

5.4 Pavement Drainage

Subdivision and Commercial Developments shall follow the guidelines in Section 9.0 of the Subdivision Streets Standards. Additional stipulations have been added below:

- Parking may be proposed with ponding areas (including within flood hazard zones) provided that the flooding depth does not exceed 1-foot during the 100-year event.
- Parking areas subject to flooding from a regulatory watercourse must be signed to warn vehicle owners of such risk.
- Arterial Streets and multi-laned curbed roadways shall provide at least one dry lane (10-feet) in each direction during a 10-year storm event.
- Cross-slopes may flatten to zero on local roads to accommodate transverse grates which extend from curb to curb. Cross-slopes must immediately transition back to the design cross-slope(s) in accordance with AASHTO guidance on transition lengths on either side of the transverse grate.
- Curbs may transition from 4-inch roll/5-inch wedge curb to 6-inch vertical for curb inlets and scuppers. Transition must happen abruptly and not impact driveway access.
- Maximum depth in roadway shall be 1-foot at any point, provided it is contained in the right-of-way or is discharged through a controlled structure into a facility with capacity to receive the peak flow. Depth shall be measured at the gutter/base of curb going upward irrespective of inlet depression.
- Inlet capacity calculations should follow procedures in the City Manual Section 10.6.
- Inlet clogging factors can be found in the City Manual Section 10.6.9.
- When sidewalk is present, a curb inlet shall be provided to take the 10-year flow under the sidewalk.
- Overtopping of sidewalks during the 100-year may be allowed provided that the entire length of susceptible overtopping area is protected from erosion.
- Depressed curb, where no sidewalk is provided, may be longer than 10-feet provided post barricades are provided at 5-foot (center to center) but in no case shall be longer than 20-feet.

With the prevalence of transverse grate inlets that extend across the entire road, the City Manual may be appropriate for inlet capacity calculations; however, when curved vane grates are utilized it is recommended to use the capacity calculations within the FHWA's Hydraulic Toolbox, which is a publicly available software. Other proprietary inlet performance charts may be accepted on a case-by-case basis by the Town.

Offsite public roadways pavement drainage design shall follow guidelines in the 4th Edition of the *Pima County Roadway Design Manual (2013)*.

It is the position of the Town that discharge from the street via scuppers to the surface is more desirable than the addition of storm-drain to the Town's infrastructure inventory. Use of public storm drain must be accompanied with a demonstration that it is the best alternative for conveyance of stormwater.

5.5 Scour

There are three scenarios that need scour analysis: 1) Bridge Design; 2) Outfall Scour; and 3) Riverine Scour. Bridge design shall follow the *Guidelines for Establishing Scour and Freeboard for Bridges in Pima County (2012)*.

The latter two scenarios should follow methodology in the City Manual, Chapter 6. When determining a design scour depth on the Santa Cruz River an additional 5-feet shall be added to the design toe-down to account for continuous presence of effluent and the entrenching created by the long-term presence of clear water.

A headcut on the Santa Cruz River continues to migrate towards Marana from Pinal County. For future regional flood control improvements or new bridges over the Santa Cruz River, the propagation of the headcut upstream should be considered in design of features with design life greater than 25-years.

5.6 Erosion Mitigation

For practical purposes most natural undisturbed washes can be considered to be at equilibrium. Once washes are modified or graded, they are susceptible to changes in equilibrium and must be treated as unstable. Grade control shall be provided on earthen channels/bottoms that have design slopes steeper than the equilibrium slope. See Section 6.9 of the City Manual for the procedure on channel grade control.

Erosion potential is also required to be evaluated and mitigated at outlets of drainage structures. There is guidance in Section VI, *Drainage and Channel Design Standards for Local Drainage (1984)* for scour protection at culvert outlets.

Sheet flow areas are not typically environments for erosion; however, newly placed fill and earthen embankment are usually susceptible to erosion even during sheet flooding. To mitigate erosion of fill pads, follow the guidance in *Pima County Technical Policy, TECH-006 Erosion Protection of Fill Pads in Regulatory Floodplains*.

The test for susceptibility to erosion on a fluvial watercourse is to determine what the lateral migration limits are. Erosion Hazard Setbacks (EHS) are calculated for potential migration areas and any improvements within those limits are susceptible. The Ordinance restricts uses within the EHS and if a project needs to mitigate the erosion hazard to reclaim the use of that property, erosion mitigation in the form of bank protection should be installed to eliminate the potential of lateral migration. Bank protection design should follow the guidance in Section 8.5 of the City Manual.

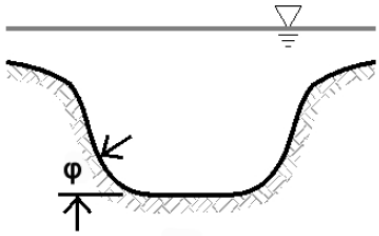
Rock rip-rap is one alternative for bank protection. The effectiveness of dumped rock rip-rap is dependent upon a satisfactory gradation that allows the rock to be laid without significant voids. Voids in rip-rap layers due to homogenous sized rock can induce undermining, sloughing and failure as fine sediments are washed out from behind the layer because of too much porosity. There are two steps to appropriately size rip-rap for use as bank protection: 1) Calculate the D_{50} (the rock diameter that at which 50% passes in a sieve analysis); 2) Calculate the gradation of rip-rap.

5.6.1 Calculating Rip-rap D_{50}

The rip-rap d_{50} can be calculated using the Isbash equation for a straight reach of channel.

The equation (as adapted from Maricopa County) is as follows:

$$d_{50} = \frac{0.0191 V_a^2}{\cos\varphi}\left(\frac{\gamma_w}{\gamma_s - \gamma_w}\right)$$



With:

d_{50} = the median diameter (ft),
V_a = average velocity (ft/s)
γ_s = specific weight of stone (lb/ft3) = assumed 165 lb/ft^3
γ_w = specific weight of water (lb/ft3) = 62.4 lb/ft^3
φ = bank angle (degrees), see figure above

Minimum D_{50} in all applications is 6-inches. Rip-rap sizing methodology other than the Ishbash equation may be proposed within the drainage report. Refer to the Maricopa County manual for rip-rap sizing guidance in situations where curved reaches are present.

5.6.2 Calculating the Rip-rap Gradation

Rip-rap gradation limits should be specified in drainage reports and on construction documents where rip-rap is to be installed. Limits are meant to be for visual inspection of a mock-up prior to installation of rip-rap. The three-point gradation (adapted from HEC-11) below should be satisfactory in most applications for bank protection:

Stone Size Range (ft)	Stone Weight Range (lb)	Percent of Gradation Smaller Than
1.5 D_{50} to 1.7 D_{50}	3.0 W_{50} to 5.0 W_{50}	100
1.0 D_{50} to 1.15 D_{50}	1.0 W_{50} to 1.5 W_{50}	50
0.4 D_{50} to 0.6 D_{50}	0.1 W_{50} to 0.2 W_{50}	15

5.7 Sedimentation

The Town's concern with sedimentation exists where infrastructure can get plugged with sediment due to abrupt changes in sediment carrying capacity. The areas where this is most likely to happen is at cross-drainage structures of public roadways and storm drain systems. To prevent this, cross-drainage culverts should be designed to transport the sediment delivered to them. The City Manual Section 11.5 has a metric which gives indication of a sedimentation problem, referred to as the Sediment-transport ratio. The ratio compares sediment transport in the approach channel to the sediment transport capacity of the culvert.

It is not desirable to collect off-site, sediment laden flow into a closed storm-drain system. Storm drain systems should be limited to collect clear water from developed areas that do not have a sediment yield. In the event a closed system must convey flow from a watershed with sediment yield, a sediment trap should be sized and installed at the inlet.

Section 5.3.1.2 of this manual provides criteria for storm-drains to ensure they don't create an environment for deposition.

6. Detention/Retention

6.1 Design Standards for Stormwater Detention and Retention (2015)

The Town has adopted the *Design Standards for Stormwater Detention and Retention (2015)* (DSSDR). The standards and procedures within shall apply to those areas outside of the Northwest Policy Area. See Figure 1. Areas within the Northwest Policy Area should reference Section 3.2 of this manual.

6.1.1 Dry Well Design Requirements and Procedures

The Northwest Drainage policy requires the total retention of the 100 year, 1-hour storm followed by a 10 year, 1-hour storm. Although the policy does not specify, there is an expected lag of 24 hours between the storms. The retention basins associated with this storage are required to drain within 36 hours after the end of the 10-year storm. Drywells are the most common method of draining these basins. The calculations of basin size needs and well-injection rates must conform to these requirements. More conservative designs are encouraged. These requirements are based upon the DSSDR, the Northwest Policy, Arizona Department of Environmental Quality Drywell Guidance Manual (ADEQ), and empirical experience from existing projects in Northwest Marana:

1. The maximum drywell well-injection rate to be used for design is nominally 0.5 cubic feet per second (cfs). With specific geotechnical recommendations, the well-injection rate may be increased up to 0.6 cfs. The well-injection rate must be multiplied by a 0.5 de-rating factor for determining the number of drywells needed.
2. The basin must at a minimum totally contain the 100-year, 1 hour storm. Since these basins rely on infiltration as their means of draining, no outflow rate may be considered during the volume design of the basin.
3. Prior to introduction of the 10-year, 1 hour storm, the Town of Marana allows a credit to reduce the amount of stored volume in the basin from the original 100-year storm. This credit is half the aged drywell drain rate over the 24-hour lag period.

   Ex: 0.25 cfs/well * 0.5 * 3600 sec/hr* 24 hours/ 43560 = 0.25 acre-ft/well

4. After drywell credit is applied, the 10-year, 1 hour storm volume is added to the basin. The basin must contain this new volume plus the prior volume less the credit. This final basin volume cannot be lower than the volume calculated in number 2 above (total containment of the 100-year, 1 hour storm).

$$100\,\text{yr} - \text{credit} + 10\ \text{year} \geq 100\ \text{year for volume requirement}$$

5. The de-rated well-injection rate, while not allowed to be considered for volume requirements, can be used immediately in the calculations for determining if the basin will drain in 36 hours after the final ten-year storm.

6. Other key factors to be considered for basin design:
    a. Ponding depth maximum is 3.0 feet (Section 6.3)
    b. Backwater is allowed into drainage channels and parking areas but not onto streets.
    c. Basin floors may not be designed totally flat. They must be designed with positive drainage to the drywells – 0.5% minimum.
    d. Multiple Drywells should be spaced a minimum of 100 feet apart from center to center. (ADEQ)
    e. Drywell grates should be 24-inch cast iron with raised letters "STORMWATER ONLY". (ADEQ)
    f. Drywell grates should be a minimum of 6 inches above the bottom of landscaped retention basins (ADEQ).
7. During construction, a minimum of 1 well per basin must be tested for verification of flow rate at or above the original design. If the wells do not flow as designed, redesign is necessary, and more wells may be needed.
8. Drywells must be protected from silt infiltration during construction. Any and every drywell known to have been compromised during construction will have to be cleaned and tested prior to closeout of permitting.
9. Drywells must be registered with ADEQ prior to closeout of permitting.

6.1.2 Infiltration Trenches

Alternative methods for disposing of stormwater into the subsurface will be evaluated on a case-by-case basis. Drain time requirements will continue to drive the viability of subsurface disposal and a separate study prepared by a registered geotechnical engineer or hydrogeologist must accompany the construction plans and include at a minimum:

- Design percolation rate of stormwater into subsurface
- Native percolation rates of soils beneath the alternative structure
- Potential for fine sediments to clog the porous material.
- Annual inspection checklist
- Means to maintain the alternative structure.
- Certified statement by a registered professional engineer in the State of Arizona that the structure complies with ADEQ regulations.

6.2 Town of Marana Exceptions to the DSSDR

- Redevelopment of a property shall assume an existing impervious percentage equivalent to its last use prior to demolition of the site.
- First Flush Retention is not required in the Northwest Policy Area.
- The Town has issued its own Balanced and Critical Basin Map (Section 6.4) and will update that from time to time. All updates to that map will be automatically incorporated into the drainage manual.
- The minimum freeboard on detention basins (between maximum water surface and top of impoundment) in all cases will be 6-inches. This freeboard shall apply to Northwest Policy area as well.

6.3 Basin Depth and Perimeter Safety Requirements

Recognizing that ponded water under the right conditions can be a hazard and an environment for insect breeding, to deter the public and protect the pedestrian from potential hazards associated with ponded water, precautions should be taken when certain physical criteria are met.
Specific safety requirements are dependent upon land use and the size of development as follows:

6.3.1 Single Subdivision

1. Maximum ponding depth of 3 feet.
2. Barricade railing must be provided when both of the following occur:
    a. Ponding depth exceeds 2 feet
    b. Side slope is steeper than 4:1 (H:V)
3. If a minimum of 5 feet of refuge does not exist between the top of slope and back of pedestrian way and condition 2(b) is exceeded, then barricade railing must be provided.
4. Railing, at least 42 inches high, must extend along all portions of the basin accessible to pedestrians via a constructed walkway, the railing should terminate in a manner that protects the public from the hazard.

6.3.2 Master-Planned Subdivisions (with regional detention/retention) and Commercial Developments

1. In no case will ponding exceed 6 feet, unless approved by the Town Engineer (3 feet when a full retention system is employed).
2. Barricade railing must be provided when both of the following occur:
    a. Ponding depth exceeds 2 feet
    b. Side slope is steeper than 4:1 (H:V)
3. If a minimum of 5 feet of refuge does not exist between top of slope and back of pedestrian way, then barricade railing must be provided.
4. Railing, at least 42 inches high, must extend along all portions of the basin accessible to pedestrians via a constructed walkway, the railing should terminate in a manner that protects the public from the hazard.
    a. For commercial applications the railing should be provided along the basin edges that have the potential for employee foot traffic if the 5 feet refuge is not provided.
5. When ponding depth exceeds 3 feet and the side slope is steeper than 4:1, the entire basin perimeter must be secured with non-penetrable fencing.

This standard applies to all areas of the Town of Marana. Master-planned subdivisions that do not provide regional detention must follow the Single Subdivision requirements**.**

6.4 Critical Basin Map

All watersheds within the Town Boundary are designated Balanced Basins unless it has been determined to be a Critical Basin. See Figure 3, Balanced and Critical Basins Map. Future revisions to the Balanced and Critical Basins Map will be automatically incorporated into the Drainage Manual.

6.5 In-lieu Fee Process

Any request to waive the detention requirements shall come in writing in the form of a waiver request letter to the Town Engineer. The process for requesting a waiver should follow the guidance in Section 9 of the DSSDR.

Upon approval of the waiver request, an in-lieu fee calculation sheet will be provided to the applicant. The in-lieu fee calculation will require the following:

- Total required peak detention volume to meet the appropriate balanced or critical designation.
- Total required first flush retention volume.
- The area of land required with volume distributed over 3-feet in depth.
- A sample In-lieu calculation can be downloaded here.

7. Dedication of Drainage Right of Way

Constructed channels that are dedicated to the public must be labeled as public drainageway on a subdivision plat or via separate instrument. Minimum 16-foot maintenance access shall be provided on each side of the channel. Projects adjacent to regional watercourses shall dedicate 50-feet measured from the front of bank protection. Consult the Town prior to proposing dedication to the public.

8. Maintenance

Improved Channels with side slopes steeper than 6:1 must be equipped with maintenance ramps for both private common areas and public rights of way. Access for maintenance on fully lined channels shall be designed to support the loads of the following equipment:

- 10 CY dump truck
- 950G Loader or equivalent

Ramps shall be a minimum of 10 feet wide and fall in the downstream direction. Ramps shall be cut-out of the bank to prevent loss of conveyance. When roadways bisect the channels and the culverts structures are not big enough for access, ramps shall be designed on the downstream side of each crossing.

Detention Basins must be inspected on an annual basis. A maintenance checklist shall be submitted within the Drainage Report. A sample channel/basin maintenance plan is provided in Appendix A

9. Storm Water Requirements

Storm water regulations exist for the purpose of monitoring water quality and are governed by the Arizona Department of Water Quality under the Arizona Pollution Discharge Elimination System (AZPDES) program. Marana is a Small MS4 General Permit area and must comply with requirements of the AZPDES program. Requirements to comply with the Town of Marana Stormwater division are separate and unique and can be found in the Marana Town Code Chapter 17-16, Stormwater Management.

10. References

TAFS model (Click to access Models)

Town of Marana. *Subdivision Street Standards Manual*. 2020

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Federal Highway Administration. *Design of Riprap Revetment* (Hydraulic Engineering Circular No. 11). 1989

U.S. Army Corps of Engineers. Hydrologic Engineering Center. HEC-RAS (River Analysis System). *Hydraulic Reference Manual*.

11. Glossary

AASHTO: Abbreviation for the American Association of State Highway and Transportation Officials.

AERIAL REDUCTION FACTOR: The ratio of mean precipitation depth over a watershed resulting from a storm to the maximum point depth of the storm.

ALL WEATHER ACCESS: Access considered traversable by normal passenger vehicles, defined as a permanent, durable material with adequate protection against scour and erosion and having a depth of water no more than 12 inches above the roadway surface during a Base Flood. Asphalt, Concrete, and traffic rated pavers are considered durable surfaces. All other surfaces must be approved by the Town Engineer. See also the Floodplain and Erosion Hazard Management Code, Chapter 17-15 of the Town Code.

ALLUVIAL CHANNEL: Water channels made up of loose sediments. The loose sedimentary materials are known as alluvium. The banks of the channel are subjected to erosion, or wearing away, by fast running water.

ADEQ: Abbreviation for Arizona Department of Environmental Quality.

ADWR: Abbreviation for Arizona Department of Water Resources

AZPDES: Abbreviation for Arizona Pollution Discharge Elimination System

AT-GRADE CROSSING: A depression or vertical sag in the roadway designed to allow drainage to cross "at-grade" without using culverts.

BACKWATER: The effect tailwater has upon upstream flow. Backwater can also refer to the calculations that are performed to compute water-surface profiles in an open channel.

CMID CANALS: Cortaro- Marana Irrigation District Canals that provide irrigation water to more than 10,000 acres of farmland.

CONDITIONAL LETTER OF MAP REVISION (CLOMR): Federal Emergency Management Agency's (FEMA's) comment on a proposed project that would affect the hydrologic or hydraulic characteristics of a flooding source. A CLOMR does not revise the current National Flood Hazard Layer (NFHL).

CURB INLET: An inlet which captures street drainage and discharges through the curb. This can consist of a sidewalk scupper or catch basin.

DEPRESSED CURB: This drainage mechanism occurs when the curb is transitioned from full height curb to flowline of the road or parking area and can also be referred to as a curb cut for the purpose of taking flow off pavement without the use of a curb inlet.

DRY WELL: An engineered hole with a grated inlet designed to dispose of floodwaters through a process of passive infiltration of floodwaters into the vadose zone (ie., the unsaturated sediments commonly found above the water table).

DSSRR: Abbreviation for Design Standards for Stormwater Detention and Retention (2015)

EROSION HAZARD SETBACK (EHS): The minimum horizontal distance from the top of bank or the floodplain limit, whichever is closest to the centerline of the primary channel or outside channels in a multiple channel watercourse.

FEDERAL HIGHWAY ASSOCIATION (FHWA) HYDRAULIC TOOLBOX: A stand-alone suite of calculators that perform routine hydrologic and hydraulic analysis and design computations.

FEMA: Abbreviation for Federal Emergency Management Agency

FLO-2D: A two-dimensional flood routing model that can simulate rainfall-runoff.

HEC-1: A watershed computer program designed to simulate the surface runoff response of a river basin to precipitation by representing the basin as an interconnected system of hydrologic and hydraulic components.

HEC-HMS: Hydrologic modeling system designed to simulate the complete hydrologic processes of dendritic watershed systems.

HEC-RAS: One- and two-dimensional simulation software used in computation fluid dynamics to model the hydraulics of water flow through natural rivers and other channels.

HYDRAULIC DESIGN SERIES (HDS) NO. 5 (2012): Combines culvert design information previously contained in Hydraulic Engineering Circulars (HEC) No. 5, No. 10, and No. 13 with hydrologic, storage routing, and special culvert design information.

HYDRAULIC GRADE LINE (HGL): A line which represents the static head plus pressure head of flowing water.

INFILTRATION TRENCH: Rock-filled trench designed for the purpose of temporarily storing runoff, and then subsequently disposing of runoff within the sub-surface through the process of infiltration.

LETTER OF MAP CHANGE (LOMC): A general term used to refer to the several types of revisions and amendments to FEMA maps that can be accomplished by letter.

LETTER OF MAP REVISION (LOMR): FEMA's official modification to an effective Flood Insurance Rate Map (FIRM). LOMRs can result in a physical change to the existing regulatory floodway, the effective Base Flood Elevations (BFEs), or the Special Flood Hazard Area (SFHA).

LOW FLOW BRIDGE: a bridge which does not convey the standard 1% chance flow event with freeboard and typically has overtopping during the less frequent events. Low Flow Bridges may not meet the all-weather access requirement.

MS4 GENERAL PERMIT: Authorizes the discharge of storm water from small Municipal

Separate Storm Sewer Systems provided that the permittee complies with the requirements set forth in the permit.

NATURAL: Undeveloped; existed, undisturbed, prior to development of the site.

NORTHWEST POLICY: Town policy that describes the requirements for total site retention and allowances for drywells within the Northwest Policy area shown on Figure 1.

PC-HYDRO: The official modeling method for hydrology to be submitted to Pima County Regional Flood Control District and accepted by the Town of Marana.

RECLAIMED SLOPE: Restored slope after excavation.

RETENTION BASIN: A facility which stores surface runoff but is not provided with a positive outlet. No flow is discharged directly into a downstream watercourse from a retention basin but may be drained into the subsurface by infiltration.

RILLING: A pattern of narrow, vertical troughs formed in relatively steep earthen embankments by floodwaters cascading down the embankment.

SETBACK: The minimum horizontal distance between a structure and a channel, stream, wash, watercourse, or detention basin. A channel setback is measured from the top edge of the highest channel bank or from the edge of the 100-year water-surface elevation, whichever is closer to the channel centerline.

SINGLE SUBDIVISION: A subdivision which is comprised of lots that is platted without a master plan and can be built without regional/spine infrastructure.

TAFS: Abbreviation for the Tortolita Alluvial Fan Study

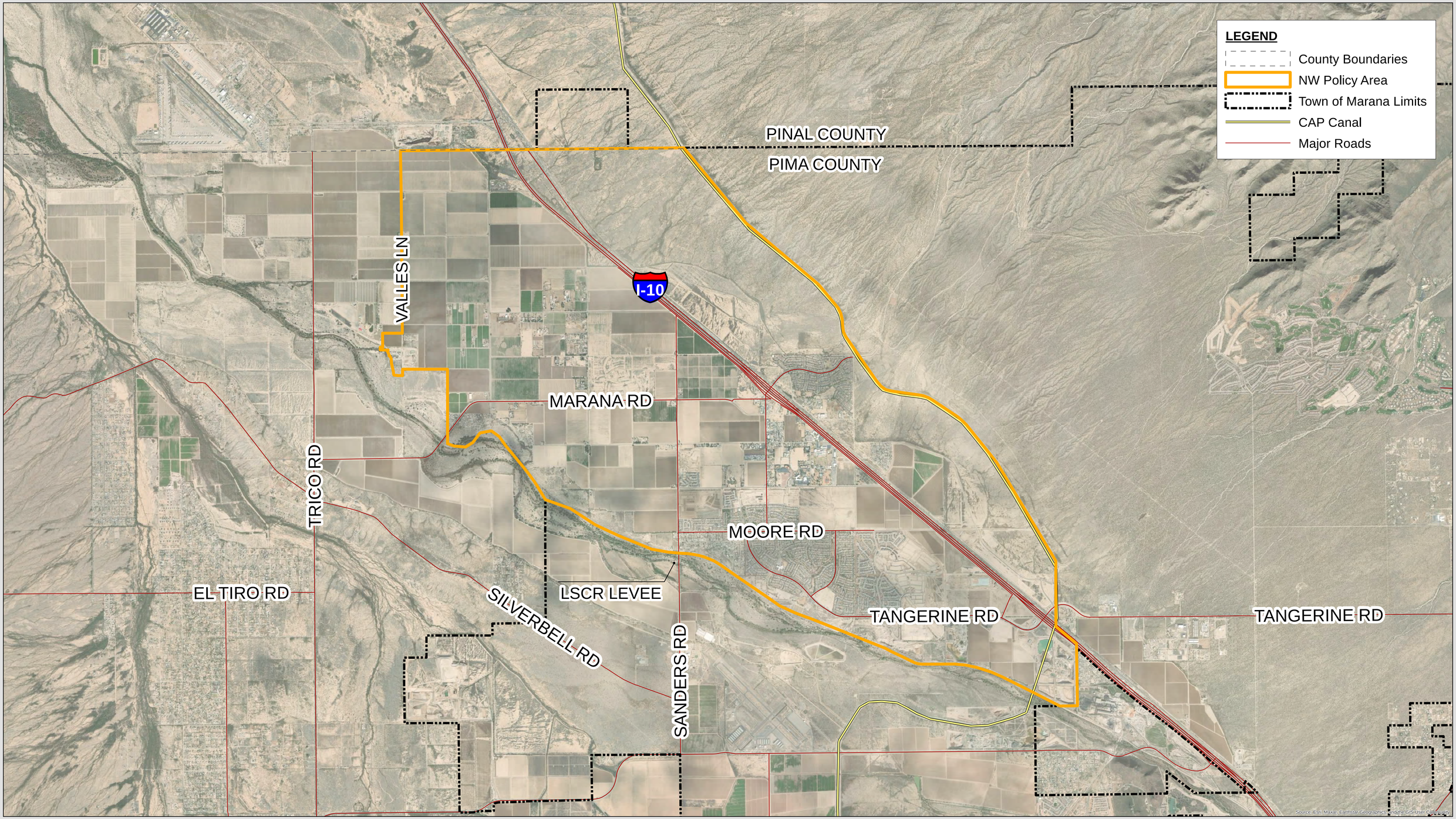
TECH-015: Pima County Regional Flood Control District Technical Policy describing acceptable methods for determining peak discharges.

TECH-033: Pima County Regional Flood Control District Technical Policy describing the criteria for two-dimensional modeling.

TOWN: Town of Marana, a political subdivision of the State of Arizona.

UNCONSOLIDATED SHEET FLOW: Shallow, unconcentrated and irregular flow along a plane.

FIGURES



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Town of Marana
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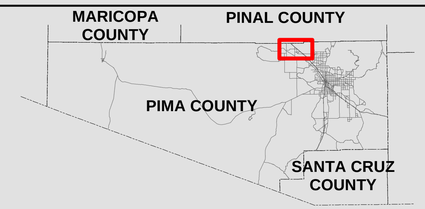
AUGUST 2024

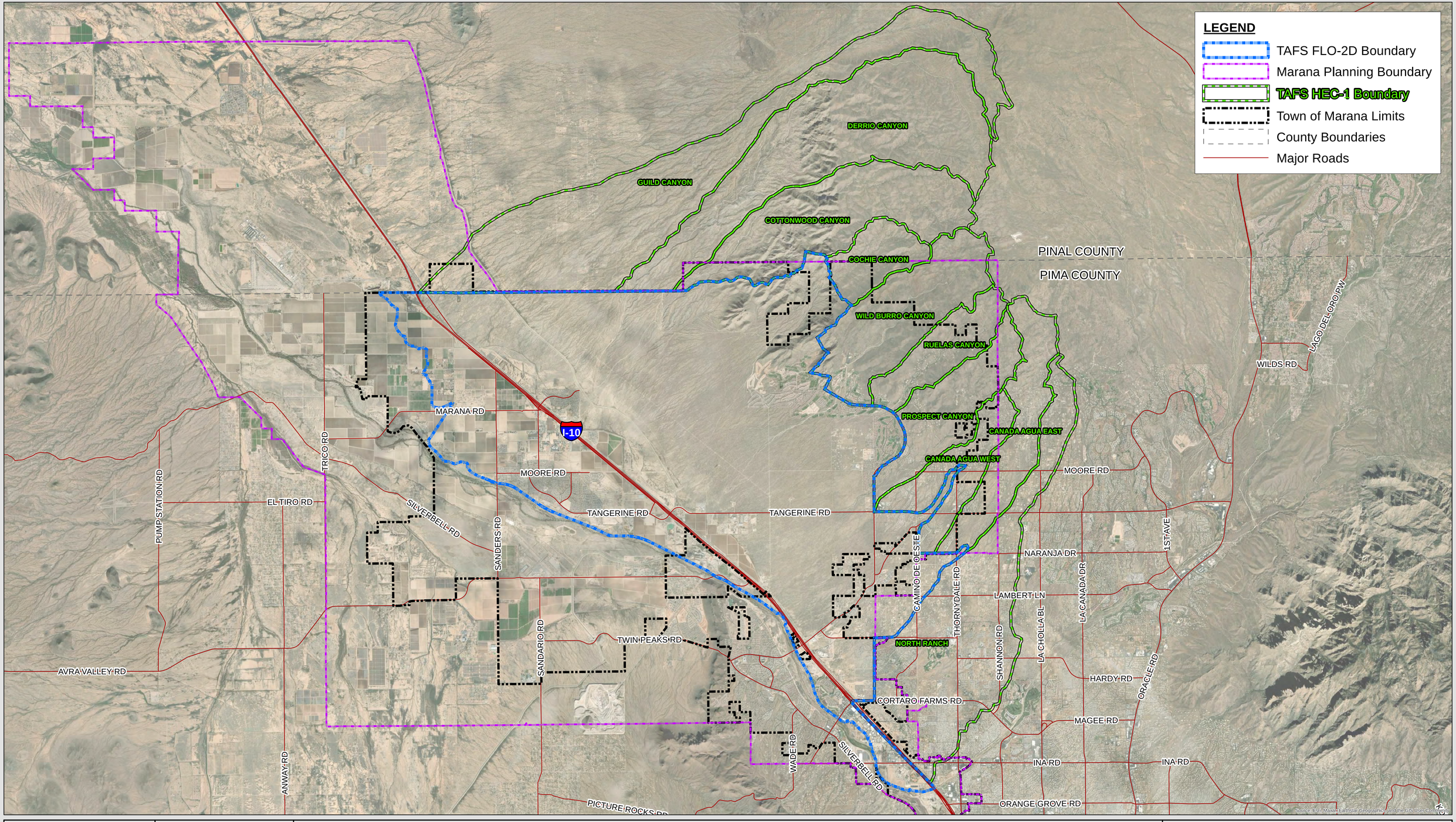
FIGURE 1, NW POLICY AREA MAP

TOWN OF MARANA DRAINAGE MANUAL

0 0.5 1 2 3 Miles

1 Inch = 0.5 Mile





MARANA AZ

Town of Marana
11555 West Civic Center Drive
Marana, Arizona 85653
(520) 382-1999

N
W E
S

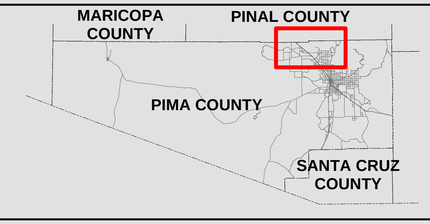
August 2024

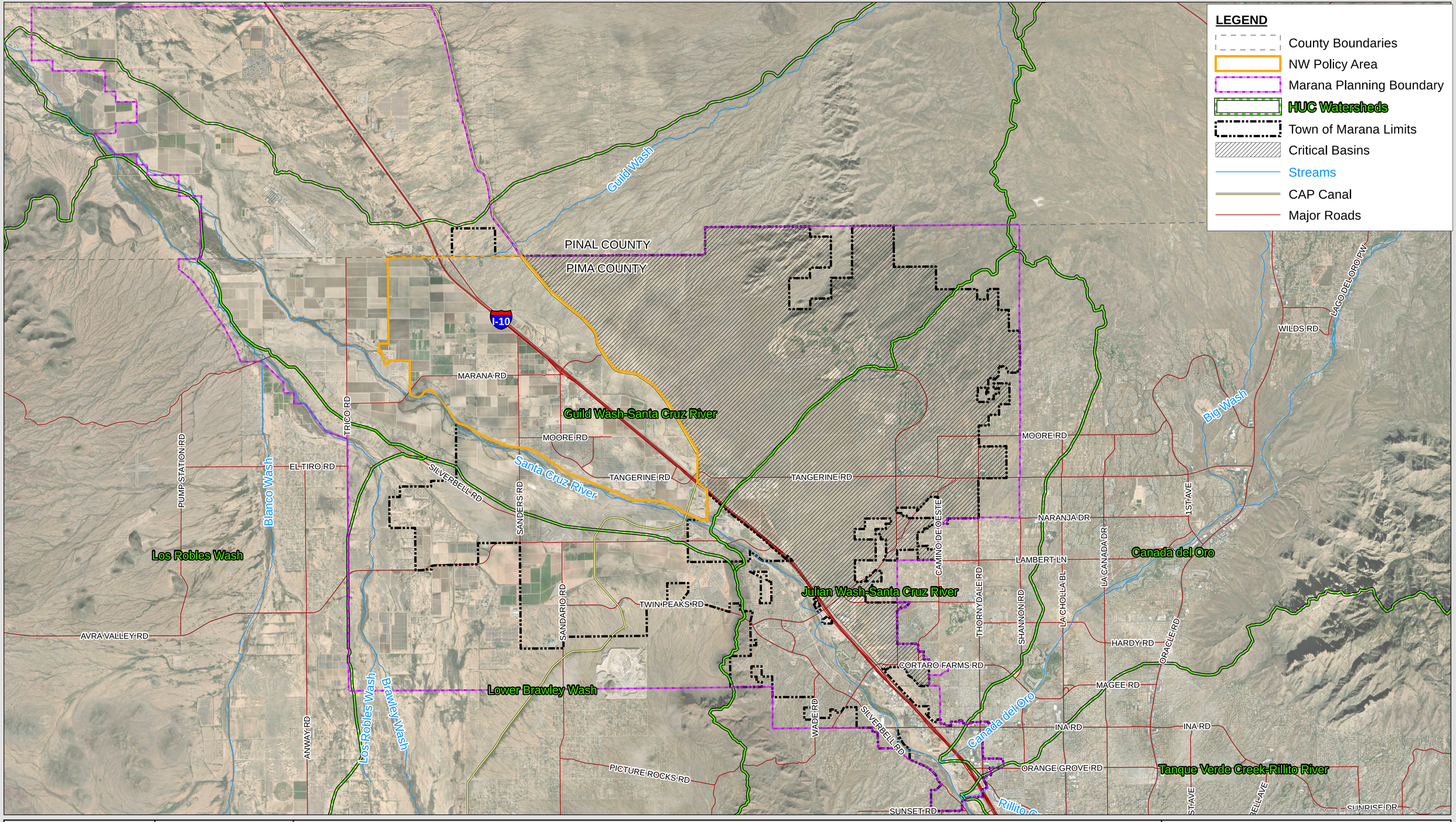
FIGURE 2, TAFS AREA

TOWN OF MARANA DRAINAGE MANUAL

0 1 2 4 6 Miles

1 Inch = 1 Mile





MARANA AZ
Town of Marana
11555 West Civic Center Drive
Marana, Arizona 85653
(520) 382-1999

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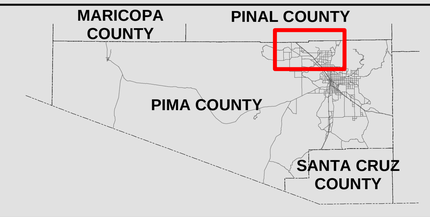
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FIGURE 3, BALANCED & CRITICAL BASINS MAP

TOWN OF MARANA DRAINAGE MANUAL

0 1 2 4 6 Miles

1 Inch = 1 Mile



APPENDIX A

Report Formats/Maintenance Checklist

Drainage Statement Outline

- Project Description
- Project Location
- Prior Studies
- Floodplain Status
    - Local Regulatory
    - Federal
- Methodology/Parameter Selection
- Hydrology & Hydraulics
    - Offsite Drainage
    - Onsite Existing Conditions
    - Onsite Proposed Conditions
- Erosion Mitigation
- Sediment Deposition Mitigation
- Clean Water Act Compliance
- Conclusion

Drainage Report Outline

- Cover
- Table of Contents
- Project Description
- Project Location
- Prior Studies
- Floodplain Status
    - Local Regulatory
    - Federal
- Methodology/Parameter Selection
- Hydrology & Hydraulics
    - Offsite Drainage
    - Onsite Existing Conditions
    - Onsite Proposed Conditions
- Detention/Retention
- Erosion Mitigation
- Sediment Deposition Mitigation
- Clean Water Act Compliance
- Conclusion

Master Drainage Report Outline

- Cover
- Table of Contents
- Master Plan Description
- Master Plan Location
- Prior Studies
- Floodplain Status
    - Local Regulatory
    - Federal
- Methodology/Parameter Selection
- Hydrology & Hydraulics
    - Offsite Drainage
    - Onsite Existing Conditions
- Master Drainage Concept
    - Block Drainage Plan
    - Regional Detention/Retention
    - Spine Drainage Infrastructure
    - Erosion Mitigation
    - Sediment Deposition Mitigation
- Phasing/Interim Drainage Requirements
- Clean Water Act Compliance
- Conclusion

Private Drainage Improvement Inspection and Maintenance Checklist

Date:		Project Name/Location:
Inspector:	Title:	Affiliation:
Type of Inspection: ☐ Annual ☐ After a Significant Storm Event		

General Requirements

- Improvements shall be maintained to perform as designed for the life of the project and shall not be converted to a different use without a Floodplain Use Permit. A Floodplain Use Permit is not required for maintenance activities.
- Improvements shall be inspected annually and after significant storm events.
- The purpose of the inspection is to evaluate whether as-built characteristics are maintained.

Component	Inspection Item	Requires Maintenance	If maintenance is required, describe corrective action
Inlet	As-built grades and elevations	☐	
	Presence of obstructions	☐	
	Evidence of material damage	☐	
Outlet	As-built grades and elevations	☐	
	Presence of obstructions	☐	
	Evidence of material damage	☐	
Earthen Slopes	As-built grades and elevations	☐	
	Invasive non-native plants	☐	
	Slope treatment	☐	
Retaining walls	As-built grades and elevations	☐	
	Presence of damage or instability	☐	
	Drainage function	☐	
Depth	As-built grades and elevations	☐	
	Sediment accumulation >10% of design volume	☐	
Basin/Channel Floor	As-built grades and elevations	☐	
	Presence of ponding	☐	
	Evidence of oil, grease, chemicals or trash	☐	
	Presence of invasive non-native plants	☐	

Private Drainage Improvement Inspection and Maintenance Checklist (Continued)

Date:	Project Name/Location:

Component	Inspection Item	Requires Maintenance	If maintenance is required, describe corrective action
Perimeter Wall	As-built grades and elevations	☐	
	Presence of damage or instability	☐	
	Drainage function	☐	
Security Barrier	Presence of damage or instability	☐	
Access	Presence of obstruction	☐	
Landscaping	Presence of overgrown vegetation	☐	
	Presence of invasive non-native plants	☐	
	Damage to basin due to landscape elements	☐	
Pump	Alarm System	☐	
	Presence of obstruction	☐	
	As-built specifications	☐	
Dry/Rock Well	Presence of sediment and/or standing water for more than 36-hours	☐	
Armored Slopes	Cracking	☐	
	Sloughing	☐	
	As-built grades and elevations	☐	
Toe Down	Exposed	☐	
	Buried/not visible	☐	
Sediment Deposition	As-built grades and elevations	☐	
	Aggradation ongoing	☐	
	Only at specific locations	☐	

APPENDIX B

Excerpts from Other Manuals

On watersheds larger than one square mile, the guidelines cited above may result in overdesign. The design of sediment basins on these watersheds is a more complicated procedure, involving total watershed sediment yield and channel sediment-transport capacity over a range of discharges. Total watershed sediment yield can be estimated by such methods as the Modified Universal Soil Loss Equation (Williams, 1975; and Williams and Berndt, 1977), the Pacific Southwest Inter-Agency Committee (PSIAC) Method (Pacific Southwest Inter-Agency Committee, 1968), the Flaxman Method (Flaxman, 1972), the SCS Method (U.S. Soil Conservation Service, 1971), the Dendy/ Bolton Method (Dendy and Bolton, 1976), and the Renard Method (Renard, 1972). A publication by Renard and Stone (1981) contains a detailed discussion and comparison of some of these methods.

The equations for watershed sediment yield which are listed above do not readily distinguish between sediment production that would be classified as wash load and sediment production that would be classified as bed load. Wash load particles are so small that they would generally remain in suspension as the water passes through the detention basin. Therefore, the wash load is not generally to be considered in sediment basin design. An estimate of wash load, as compared to bed load estimated from equations for total watershed sediment yield, can be made by taking samples of the topsoil throughout the watershed.

Total watershed sediment production may not be an entirely accurate estimate of the amount of sediment that would be delivered to a certain point, because there is sediment storage within the watershed system. Sediment-volume estimates must therefore also consider the sediment-transport capacity of the channel. A detailed discussion of this type of analysis will not be presented here. However, the reader is referred to publications by the U.S. Army Corps of Engineers (1977), Simons, Li & Associates (1982, 1985), the American Society of Civil Engineers (1977), Simons and Senturk (1977), and Zeller and Fullerton (1983) for more detailed information about performing such analyses.

6.9 Equilibrium Slopes within Constructed Channels

Given a fixed size distribution of sediments, the sediment-transport capacity of a stream is dependent primarily upon flow velocity and depth. Within the City of Tucson, transport of all particle sizes of bed material increases, as flow velocity increases, at a rate proportional to approximately the third to fifth power of the velocity. Correspondingly, transport of sediment particles composed of bed material generally decreases as depth increases, while transport increases with decreased depth. However, flow velocity is by far the more important variable.

For purposes of analysis and design, most natural, undisturbed channels in the Tucson area can be assumed to be at or near a state of dynamic equilibrium with regard to sediment transport. This means that, for a given reach of the channel, the sediment-transport capacity of the channel, over the long term, is more or less equal to the sediment supply. The channel bed slope is therefore "stable."

When channelization occurs, the channel top width is often narrowed, and channel roughness is normally decreased. The result is an increase in velocity and depth, with

a corresponding increase in sediment-transport capacity. Sediment-transport capacity then exceeds the sediment supply; and, if the bed is composed of sediment that can be transported, the deficiency will be made up from bed material--causing the channel to degrade. Another factor that contributes to this degradation is upstream urbanization. Urbanization increases flood peaks, which also lead to higher flow velocities and depths. Urbanization also reduces the watershed sediment supply, and increases the frequency of runoff. The result of all these occurrences is that channel bed degradation will occur until the channel slope is flat enough to cause the sediment-transport rate to be equal to the incoming sediment supply. This slope then becomes the new, "stable," equilibrium slope. Streambed degradation can threaten underground improvements, bank-protection toe-downs, culverts, and other hydraulic structures that are within and/or that cross the channel. Grade-control structures, or lining of the channel bed, are usually required in order to prevent damage caused by streambed degradation.

The equilibrium slope for a channel which has an upstream sediment supply that is considered to be essentially zero (e.g., a channel located within a highly urbanized watershed) can be computed from:

$$S_{eq} = \left(\frac{1.45n}{q^{0.11}} \right)^2 \qquad \textbf{(6.25)}$$

Where:

S_{eq} = Equilibrium slope after urbanization, in feet per foot;
n = Manning's roughness coefficient; and,
q = Channel unit discharge, in cubic feet per second per foot.

For use with Equation 6.25, channel unit discharge is defined as the channel discharge divided by the channel bottom width. Use of this equation will produce the flattest slope that can be reasonably expected to transport sediment within channels located in the Tucson area. The discharge associated with a 10-year flood is normally chosen when computing the unit discharge for use in Equation 6.25.

For lesser degrees of urbanization, the equilibrium slope is computed from Equation 6.26, which is a generalization of the theoretically derived sediment-transport relationships for sandbed channels developed by Zeller and Fullerton (1983):

$$S_{eq} = \left(\left[\frac{n_u}{n_n} \right]^2 \left[\frac{Q_{u,10}}{Q_{n,10}} \right]^{-1.1} \left[\frac{b_u}{b_n} \right]^{0.4} (1-R_s)^{0.7} \right) S_n \qquad \textbf{(6.26)}$$

Where:

n_u = Manning's roughness coefficient for an urban channel;
n_n = Manning's roughness coefficient for a natural or existing channel;
$Q_{u,10}$ = Ten-year discharge, under urbanized conditions, in cubic feet per second;
$Q_{n,10}$ = Ten-year or bank-full discharge (whichever is less), under natural conditions, in cubic feet per second;
b_u = Bottom width of channel, under urbanized conditions, in feet;
b_n = Bottom width of channel, under natural conditions, in feet;
R_s = Reduction factor for sediment supply. This factor is usually assumed to be equal to the ratio of the impervious area to the total area of the upstream watershed (i.e., $0.0 \leq R_s \leq 1.0$); and,
S_n = Natural or existing channel slope, in feet per foot.

The roughness coefficients for natural and urbanized channel beds are often very nearly the same, so the term in which these coefficients appear in Equation 6.26 can usually be assumed equal to the value 1.0. However, from time to time exceptions to this assumption may occur. For instance, when the existing channel is a wide, flat, sheetflow watercourse; and the proposed channel is a narrow, sand-bed channel, n_u will ordinarily not be equal to n_n.

For moderately urbanized to highly urbanized watersheds, the equilibrium slope should be computed by using both Equation 6.25 and Equation 6.26. The steeper of the two computed slopes should then be used for design. The reason for this is that Equation 6.26 can sometimes produce slope values that are too flat to generate reasonable sediment-transport rates for maintenance of channel stability, when impervious cover within a watershed is very high.

Equation 6.26 should be used with caution within the City of Tucson. An underlying assumption of this equation is that the existing or natural channel is itself in equilibrium. This is not always true in the City, because most channels have undergone alteration. If there is any question as to whether or not the existing channel is in equilibrium, it is best to try and determine through old (pre-development) aerial photographs and topography what the channel characteristics were in its original, undisturbed (i.e., natural) state. In the absence of historical information about the original channel, an examination may be made of existing stable channels in the area to help estimate what the channel in question may have looked like before urbanization.

Equation 6.26 can be used for more than merely the quantification of streambed degradation. It can also be used to determine whether aggradation will occur when a channel is widened beyond existing or natural conditions. Another application would be to use it to design a stable channel cross-section in lieu of installing grade-control structures to otherwise control degradation of the channel bed.

6.10 Spacing and Depth of Grade-Control Structures

If the equilibrium slope of a channel, as determined by use of either Equation 6.25 or Equation 6.26, is flatter than the design slope, grade-control structures may be needed to limit degradation from exceeding a certain depth at any point along the channel. Grade-control structures, sometimes called "cut-off walls" or "check dams," are non-erodible vertical barriers in the channel that prevent the channel bed from degrading at a point located immediately upstream of where they are located. After the channel bed has reached equilibrium, the bed elevation immediately upstream of the grade-control structure is at the design elevation. Downstream of the grade-control structure, the bed is at an "equilibrium" elevation that is lower than the design elevation. For most channels, the design of grade-control structures is an iterative process, involving drop height, reach length, and depth of scour downstream of the drop.

Once a drop height is chosen, the reach length, or spacing, between adjacent structures can be computed from:

$$L_r = \frac{h}{S_{ib} - S_{eq}} \qquad (6.27)$$

Where:

L_r = Reach length, or spacing, between adjacent grade-control structures, in feet;
h = Drop height downstream of the grade-control structure, in feet;
S_{ib} = Initial channel bed slope, in feet per foot; and,
S_{eq} = Channelized equilibrium bed slope, in feet per foot.

If the initial and final bed slopes are approximately the same, the distance between grade-control structures will be very large. Under these circumstances, such structures may not be required.

Normally, the drop height downstream of a grade-control structure which consists of poured concrete without reinforcements shall not exceed two feet; and preferably should be only one foot, where feasible. For economical and technical reasons, grade-control structures should be spaced no closer together than twelve times the local scour depth below the grade-control structures, as computed by the use of either Equation 6.13 or Equation 6.14.

The total height of a cut-off wall or a grade-control structure (D_{cw}), from top to toe, shall not be less than the drop height plus the computed depth of scour below the wall or structure (see Figure 6.6). The depth of scour below grade-control structures should be computed according to the guidelines presented in Section 6.6.6 of this Manual. For a one-foot-wide, unreinforced concrete cut-off wall, if structural calculations support same, the maximum allowable height of a cut-off wall, from top to toe, can be six feet. If the depth of scour plus the drop height is greater than six feet, the drop shall be considered to be too great for unreinforced concrete cut-off walls, unless a structural analysis can demonstrate otherwise, and the spacing between

the cut-off walls must be reduced. The example which follows (i.e., Example 6.1), illustrates the recommended procedure for cut-off wall design.

There will be many design situations, especially when unit discharges are high, where a cut-off wall with a hegith of six feet, from top to toe, is not sufficient. In such cases, a reinforced concrete cut-off wall that has a height greater than six feet, from top to toe, may be used, provided that a structural analysis is submitted showing that the proposed cut-off wall will be structurally stable. If a structural analysis is submitted and approved, the maximum drop height of two feet will no longer apply.

Grade-control structures for large discharges need not necessarily be vertical on the downstream side. For structural stability, a triangular or wedge-shaped soil-cement grade-control structure is recommended for use on regional watercourses. However, for hydraulic reasons, the use of any grade-control structure with a face flatter than I:1 on the downstream side shall not be permitted without prior written approval from the City Engineer.

EXAMPLE 6.1: SPACING AND DEPTH OF GRADE-CONTROL STRUCTURES

A channel in a highly urbanized watershed is to be built to contain the 100-year-flood discharge. The sides of the channel are to be of shotcrete, the bottom of earth.

Channel characteristics are as follows:

Bottom Width	= 20 feet
Design Slope	= 0.006 feet/foot
Side Slopes	= 1:1
Manning's "n"	= 0.022

Hydraulic characteristics are as follows:

Q_{100} = 700 cfs	Q_{10} = 350 cfs
Y_{100} = 3.1 feet	Y_{10} = 2.1 feet
V_{100} = 9.7 fps	V_{10} = 7.7 fps
q_{100} = 35.0 cfs/foot	q_{10} = 17.5 cfs/foot

Because the watershed is highly urbanized, Equation 6.25 will be used to compute the equilibrium slope. Therefore:

$$S_{eq} = \left[\frac{1.45\ (0.022)}{(17.5)^{0.11}} \right]^2 = 0.0005 \text{ feet/foot.}$$

Assume a two-foot drop height. From Equation 6.27, the spacing between grade-control structures should be:

$$L_r = \frac{2.0}{(0.006)-(0.0005)} = 364 \text{ feet.}$$

The grade-control structure will be submerged. Using Equation 6.14 yields:

$$Z_{lss} = 0.581(q_{100})^{0.667}(h/Y_{100})^{0.411}[1-(h/Y_{100})]^{-0.118};$$

$$q_{100} = 35.0 \text{ cfs;}$$

$$Z_{lss} = 0.581\ (35.0)^{0.667}\ (0.645)^{0.411}\ (0.355)^{-0.118}; \text{ so,}$$

$$Z_{lss} = 5.9 \text{ feet.}$$

Therefore, the total height of the grade-control structure, from top to toe, should be 5.9 feet *plus* the two-foot drop height; or, 7.9 feet (round to 8.0 feet).

However, it is desirable to keep the total vertical dimension of the grade-control structure, from top to toe, equal to or less than six feet. Therefore, a smaller drop height should be used.

Using a drop height of one foot yields:

$$L_r = \frac{1.0}{(0.006)-(0.0005)} = 182 \text{ feet.}$$

$$Z_{lss} = 0.581\ (35.0)^{0.667}\ (0.323)^{0.411}(0.677)^{-0.118}; \text{ so,}$$

$$Z_{lss} = 4.10 \text{ feet (round to 4.0 ft).}$$

Since, in this example, the ultimate drop height at the downstream side of a grade-control structure will be set at one foot, cut-off walls with a height of five feet, from top to toe, could be placed at approximately 180-foot intervals along the bottom of the channel to serve as grade-control structures in order to limit long-term bed degradation to a maximum of one foot anywhere along the subject channel.

CHAPTER VI: EROSION AND SEDIMENTATION

6.1 Introduction

The hydrology and hydraulics of floodwaters are not the only concern of floodplain-management administrators and/or drainage design engineers who work in arid or semi-arid environments which contain alluvial rivers such as those that exist both within and around the City of Tucson, Arizona. The transport of sediment by floodwaters is also a major concern because of the potential for rapid bank erosion and changes in channel bed elevations. Bank erosion can often be so severe that it causes much more damage than inundation by floodwaters. Aggradation or degradation of the channel bed can rapidly change flood limits, or cause bank protection and other channel improvements to fail over a very short period of time.

The study of fluvial geomorphology and the analysis of sediment transport are usually undertaken in an attempt to quantify the broad effects of erosion and sedimentation and the impacts of sediment-transport capacity upon channel morphology. Sediment-transport analysis is a relatively specialized field of study. Predictions based upon its application are often expensive to produce, and can be highly variable in nature. Therefore, as an aid to the user, this chapter of the Manual presents some design and predictive guidelines that can be used within the City of Tucson in the absence of a more detailed sediment-transport analysis.

6.2 Purpose

The purpose of this chapter is to provide guidelines for the estimation of erosion, sedimentation, and channel bed scour when designing drainage channels and hydraulic structures which are to be located within the City of Tucson. These design guidelines and procedures are to be used when normal design situations are encountered. Deviations from these guidelines may occur, provided that the user has experience in sediment-transport technology; and provided that the deviation is technically justified, through detailed sediment-transport analysis, to the satisfaction of the City Engineer.

6.3 Fluvial Geomorphology

The study of fluvial geomorphology normally involves analyses which encompass entire drainage systems. This is so because the response of an individual channel to change within a watershed can often have an effect upon the entire drainage system. Conversely, the fluvial system, as a whole, will ultimately dictate the response of an individual channel to overall change within a watershed. Rarely is it possible to understand the fluvial processes which occur within even a short reach of an alluvial channel in isolation from its upstream and downstream system controls.

The fluvial system is generally divided into three zones (Schumm, 1977). Zone 1 is characterized as the drainage basin, watershed, or source area for sediment. This is the area from which water and sediment are derived. Storage of sediment is not significant in this zone. Zone 2 is characterized as the transport zone; where, for a stable channel, sediment input can equal sediment output. For those reaches where the sediment-transport capacity exceeds the upstream supply, it can be assumed that the sediment deficit will be made up out of the channel bed or banks. Channel bed

degradation or erosion of channel banks will be the result. Zone 3 is characterized as the sediment sink or area of deposition.

Obviously, the division between these three zones is indiscrete. Each zone has characteristics of the other two, which are subordinate to the primary characteristic of the zone. Zone 2 is of major concern to the hydraulic and river-control engineer, and to geomorphologists concerned primarily with river-channel morphology. It is this zone with which this chapter deals.

6.3.1 Channel Morphology

Sediment and water moving through alluvial channels are the independent variables that determine the size, shape, and pattern of the channel. Numerous empirical relations have been developed that relate channel morphology to water and sediment discharge.

6.3.1.1 Hydraulic Geometry of Alluvial Channels

As a general rule, the greater the quantity of water that moves through a channel, the larger is the cross-sectional area of that channel. Preceded by numerous studies of canal morphology and stability, Leliavsky (1955) and Leopold and Maddock (1953) demonstrated that, for most rivers, the water surface width, T, and depth, Y, increase with mean-annual discharge, Q_a, in a downstream direction such that:

$$T = k_1 Q_a^b \tag{6.1}$$

and,

$$Y = k_2 Q_a^c \tag{6.2}$$

Both the coefficients and exponents of Equations 6.1 and 6.2 (i.e., the "k_1," "k_2," "b," and "c" values) are different for each river and, when data from a number of rivers are plotted against discharge, the scatter covers an entire log cycle. For a given discharge, there is an order of magnitude range of width and depth. Therefore, other variables apparently influence the hydraulic geometry of channels as well.

6.3.1.2 Influence of Sediment Load

A primary variable which significantly controls river morphology is sediment load. Bed-material load is defined as that part of the stream's sediment load that consists of sediment sizes comprising a significant part of the streambed. The other component of total sediment load is wash load, which is part of the total load not significantly represented in the bed. In and around the Tucson area, wash load is generally composed of sediments smaller than sand (i.e., smaller than about 0.06 mm to 0.07 mm). Wash load is held in suspension by the turbulence of the flowing water, and therefore is transported at the same velocity as the water. Bed-material load is composed of sands and larger sediments, and therefore is generally transported at an average velocity less than the velocity of flowing water.

From an analysis of data from regime canals, Lacey (1930) concluded that the wetted perimeter of a channel is directly dependent upon discharge; but that channel shape reflects sediment size. It is also generally recognized that coarse sediment produces channels with high width/depth ratios, while fine sediment produces channels with narrow and deep cross sections.

In addition to the size of the transported sediment, relative amounts of bed-material load and wash load significantly influence the morphology of sand-bed streams. Large bed-material loads are associated with wide channels, and large wash loads are associated with narrow widths.

The type of sediment load is considered to be a more important control on stable channel shape than the total quantity of sediment transported through a channel. For example, in one channel a certain quantity of bed-material load may exert the dominant control if it is the total load, whereas in another channel the same amount of bed-material load may exert much less influence on channel shape because it is only a small part of the total sediment load (i.e., wash load and bed-material load). Therefore, when load and discharge are constant, an increase in the quantity of bed-material load will cause an increase in channel width, and a corresponding increase in the width/depth ratio. This phenomenon is probably related to the high gradient and velocity of flow generally associated with large bed-material loads.

In summary, for alluvial channels which occur in the Tucson area, the type and amount of sediment load exerts a major control on their shape. Therefore, for a single channel under the ideal assumption of a constant discharge and a fixed amount of wash load, a change in bed-material load would be reflected by a change in both the shape and gradient of the channel.

6.4 Sediment-Transport Theory

Sediment particles are transported by flowing water in one or more of the following ways: (1) surface creep, (2) saltation, and (3) suspension. Surface creep is the rolling or sliding of particles along the bed. Saltation (jumping) is the cycle of motion above the bed, with resting periods on the bed. Suspension involves the sediment particle being supported by the water during its entire motion. Sediments transported by surface creep, sliding, rolling, and saltation are referred to as bed load, and those transported by suspension are called suspended load. The suspended load consists of sands, silts, and clays. Total sediment load is defined as the sum of the bed load and suspended load. Generally, the amount of bed load transported by a large river is on the order of five to twenty-five percent of the suspended load. Although the amount of bed load may be relatively small compared with total sediment load, it is important because it shapes the bed, influences channel stability, determines the form of bed roughness, and affects various other hydraulic factors as well.

As presented earlier, the total sediment load in a channel can be more simply defined as the sum of bed-material load and wash load; where the bed-material load is the sum of bed load and suspended bed-material load, representing that part of the total sediment discharge which is composed of grain sizes found in the bed; and the wash load is that part of the sediment discharge which is composed of particle sizes

finer than those found in appreciable quantities in the bed (Simons and Senturk, 1977). The presence of wash load can increase bank stability, reduce seepage, and increase bed-material transport. Wash load can be easily transported in large quantities by the stream, but is usually limited by availability from the watershed. The bed-material load is more difficult for the stream to move, and is normally limited in quantity by the transport capacity of the channel. Figure 6.1 summarizes the various definitions of the components of sediment load, and their contribution to total sediment load.

There is no clear size distinction between wash load and bed-material load. As a rule of thumb for the Tucson area, it should be assumed that the size of bed-material particles is equal to or larger than 0.0625 mm, which is the division point between sand and silt. The sediment load consisting of grains smaller than this size is then considered as wash load. It is generally assumed that most of the wash load is transported through the system by stream flow, and that little wash load is deposited on or in the stream bed. Wash load deposited with coarse material is usually only a very small fraction of the total bed material within the channel.

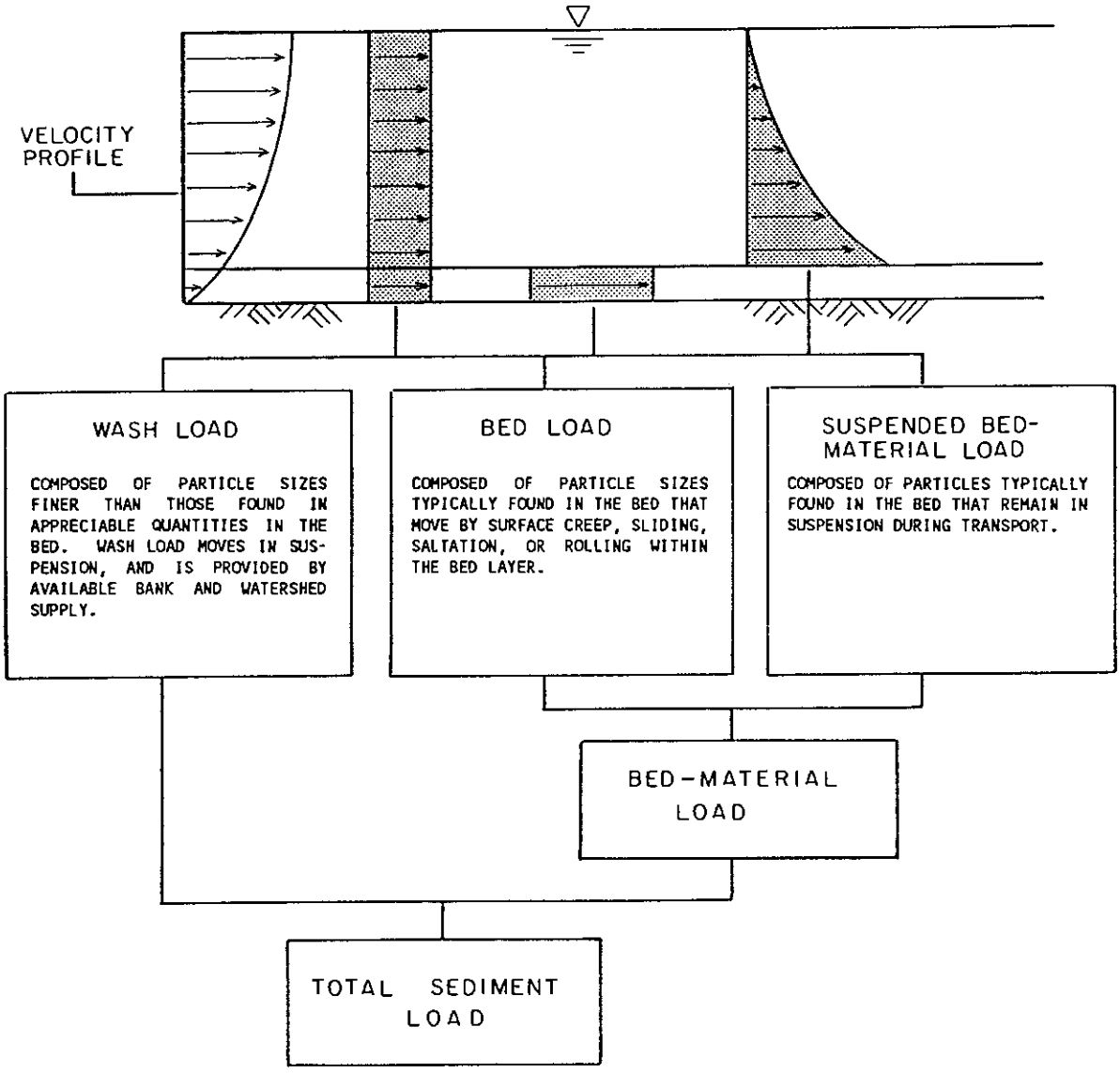
The amount of material transported, eroded, or deposited in an alluvial channel is a function of both the sediment supply and the sediment-transport capacity of the channel. Sediment supply includes the quality and quantity of sediment brought to a given reach. Sediment-transport capacity is a function of the size of bed material, flow rate, and geometric and hydraulic properties of the channel. Generally, the single most important factor determining sediment-transport capacity is flow velocity. Additionally, since sediment-transport capacity is generally proportional to the third to fifth power of the velocity, small changes in velocity can cause large changes in sediment-transport capacity (Simons, Li & Associates, 1982, 1985). Either the sediment supply or sediment-transport capacity may limit the actual sediment-transport rate in a given reach.

6.5 Sediment Routing

Supported by qualitative and quantitative analysis, a detailed evaluation of the fluvial-system response can be made based upon mathematical-modeling concepts. A mathematical model is simply a quantitative expression of the physical processes. The mathematical processes governing watershed and river responses are complicated. Computer programs can provide a means of assessing the many parameters of these complex processes within a fluvial system. There are several computer models available which are applicable to this region. For information on where to obtain these models, the user should contact the City Engineer.

6.5.1 Simplified Sediment Modeling

After evaluating the hydraulic conditions of the river by water-routing programs such as the U.S. Army Corps of Engineers HEC-2 program, the sediment-transporting capacity can be established. Sediment-transport equations are used to determine the sediment-transport capacity for a specific set of flow conditions. Different transport capacities can be expected for different sediment sizes. For each sediment size, the transport rate includes the transport rate of the bed load and the transport rate of the suspended bed-material load.



NOTE:

THE TERM "SUSPENDED LOAD" IS USED WHEN REFERRING TO THE SUM OF THE "WASH LOAD" AND "SUSPENDED BED-MATERIAL LOAD" COMPONENTS. THEREFORE, AN ALTERNATE DEFINITION OF TOTAL SEDIMENT LOAD IS THE SUM OF THE SUSPENDED LOAD AND BED LOAD.

FIGURE 6.1
DEFINITION OF SEDIMENT-LOAD COMPONENTS

One modeling method uses hydraulic conditions from a rigid-boundary model such as HEC-2, or an equivalent program, and computes sediment transport based upon the Meyer-Peter, Muller bed-load equation and the Einstein suspended-load procedure for each sediment size found in the bed. The data required are the same as for HEC-2 (channel geometry, resistance, bridge constriction, etc.). Also needed are the size distribution of the bed-material and the upstream sediment supply. Using the generated hydraulic conditions, the transport capacity for each sediment size at each cross section is then determined.

Actual transport rates depend upon transport capacities as well as supply rates. The change in transport capacity between two cross sections can be used to estimate aggradation or degradation, based upon availability. For example, if sediment is in ample supply to meet the transport capacity at an upstream cross section but at the next cross section downstream the transport capacity is only one-half as much, then the other one-half of the sediment passing the upstream cross section must be deposited between the upper and lower cross sections. This comparison of transport capacities continues reach by reach and size fraction by size fraction through the entire stream segment. The drawback to this simplified approach is that the hydraulic conditions are not readjusted, due to aggradation or degradation, at frequent time increments during the passage of the flood hydrograph. However, this technique does provide "trends" in bed-elevation changes without using more complex techniques.

6.5.2 Quasi-Dynamic Sediment Modeling

The sediment-routing model previously discussed is based upon a gradually-varied-flow backwater program which assumes a rigid-boundary system. This methodology can be extended to account for unsteady flow and alluvial-channel boundaries without going to a fully unsteady water and sediment-routing model.

The quasi-dynamic sediment model uses the same gradually-varied-flow backwater program for hydraulic computations. However, the flow is assumed constant for a given time increment Δt. A flow event, either short-term or long-term, can be broken into a number of time increments, each with a different flow rate, but during each increment the flow is considered steady.

To account for a non-rigid or alluvial boundary, when a predetermined volume of sediment is either deposited on or eroded from the streambed, the cross section is recomputed in the following manner.

Sediment aggradation or degradation within a reach for a given time period is ΔV_s = (sediment supply - sediment transport) x BF, where ΔV_s is the change in sediment volume in the reach and BF is a bulking factor. The change in sediment volume is assumed to be uniformly distributed throughout the reach. Change in area for each cross section is determined by a weighting factor based upon the conveyance in adjacent segments of the cross sections. The changes in elevation are used to generate a new HEC-2 data file for the next time period. Therefore, during any given time period the channel boundary is assumed to be rigid and the HEC-2 analysis is assumed to be valid. After evaluating the hydraulic conditions and the sediment-transport capacity, the channel boundary is modified to reflect the aggradation/

degradation changes occurring throughout the river, and to establish the new channel configuration for the next time step.

This methodology has been successfully applied to a number of practical engineering problems. It provides a feasible and relatively cost-effective approach to design problems in alluvial rivers.

6.5.3 Dynamic Mathematical Modeling

Dynamic mathematical modeling of water and sediment routing is the next level of sophistication and complexity in determining alluvial-channel changes. It involves unsteady, non-uniform flow routing for determining the hydraulic conditions to be used to calculate sediment transport, aggradation, and degradation.

Unsteady, non-uniform flow routing solves equations governing the motion of water in open channels. These equations are mathematical descriptions of the physical phenomena. The two basic principles for water routing are continuity and momentum. Continuity states that water coming into a reach is either stored in the reach or passes downstream without gaining or losing water.

The momentum principle balances the forces and accelerations acting on flowing water. Generally, the continuity and momentum equations, along with a resistance to flow equation involving Manning's n or Chezy's C, are solved numerically in finite-difference form. The results are the hydraulic variables of velocity, depth, and width for unsteady, non-uniform flow. These are then used to route sediment. Sediment movement is controlled by the shear forces acting on the bed, transport capacity of the flow, and both availability and supply. Equations used in these calculations are described in most sedimentation textbooks. To compute aggradation and degradation, the sediment-continuity equation is used.

While dynamic mathematical modeling can give excellent results, it is very complex. Fortunately, it is not often required to solve many of the more straightforward, practical problems that designers will usually encounter within the Tucson area. In fact, most aggradation and degradation problems can be solved to an acceptable degree of accuracy by the several methods previously described within this chapter of the Manual.

6.6 Depth of Scour

Scour, or lowering of a channel bed (excluding long-term aggradation/degradation), can be caused by discontinuity in the sediment-transport capacity of the flow during a runoff event (general scour); the formation of anti-dunes in the channel bed during a runoff event; transverse currents within the flow through a bend (bend scour) during a runoff event; local disturbances, such as abutments or bridge piers, during a runoff event; and the formation of a low-flow channel thalweg. The design depth of scour (*excluding* long-term aggradation/degradation, which must be added for toe-down design) is the sum of all these individual scour components, and can be expressed by:

$$Z_t = 1.3\ (Z_{gs} + 1/2Z_a + Z_{ls} + Z_{bs} + Z_{lft}) \qquad (6.3)$$

Where:

Z_t	=	Design scour depth, *excluding* long-term aggradation/degradation, in feet;
Z_{gs}	=	General scour depth, in feet;
Z_a	=	Anti-dune trough depth, in feet;
Z_{ls}	=	Local scour depth, in feet;
Z_{bs}	=	Bend scour depth, in feet;
Z_{lft}	=	Low-flow thalweg depth, in feet; and,
1.3	=	Factor of safety to account for nonuniform flow distribution.

The various equations for depth of scour which are to follow were developed strictly for use in conjunction with sand-bed channels in which the bed material is erodible to the depth specified by the applicable equations. However, this situation does not always exist in channels located within the City of Tucson. In some areas of the city, the channel has degraded to a point where the exposed bed is no longer composed of strictly unconsolidated alluvial material, but rather of consolidated hard-pan or caliche. Channel beds composed of this type of material are not freely erodible, and thus the scour equations which follow may not strictly apply. Should such conditions be encountered, a geotechnical investigation should be submitted by an Arizona Registered Professional Civil Engineer to justify the use of a lesser scour depth than would be determined from the use of Equation 6.3.

6.6.1 General Scour

As previously discussed in Section 6.5 of this Manual, the depth of general scour is best estimated by performing a detailed sediment-transport analysis using the bed grain-size distribution, hydraulic conditions, sediment-transport capacity at different stages throughout the flow event, changes in bed levels throughout the event, and the sediment supply into the reach being studied. An analysis to this level of detail is beyond the scope of this Manual. However, there are several computer models commercially available to aid in making an estimate of general scour. Unfortunately, these models are very sensitive to input, and the results are best interpreted by someone with extensive experience in the field of sediment transport. A detailed discussion of sediment-transport analysis for computing general scour can be found in "Engineering Analysis of Fluvial Systems" (Simons, Li & Associates, 1982), and "Arizona Department of Water Resources Design Manual for Engineering Analysis of Fluvial Systems" (Simons, Li & Associates, 1985).

General scour on regional watercourses should be estimated by undertaking a detailed sediment-transport study, as described above, when and where it is feasible to do so. However, such a study is not usually practical on smaller watercourses. Therefore, as an alternative to the above, on watercourses other than regional watercourses, the following equation (Zeller, 1981) should be used to predict general scour:

$$Z_{gs} = Y_{max}\left(\frac{0.0685V_m^{0.8}}{Y_h^{0.4}S_e^{0.3}} - 1\right) \quad (6.4)$$

Where:

Z_{gs} = General scour depth, in feet;
V_m = Average velocity of flow, in feet per second;
Y_{max} = Maximum depth of flow, in feet;
Y_h = Hydraulic depth of flow, in feet; and,
S_e = Energy slope (or bed slope for uniform-flow conditions), in feet per foot.

NOTE: Should Z_{gs} become negative, assume that the general-scour component is equal to zero (i.e., $Z_{gs} = 0$).

6.6.2 Anti-Dune Trough Depth

Anti-dunes are bed forms, in the shape of dunes, which move in an upstream rather than a downstream direction within the channel; hence the term "anti-dunes." They form as trains of waves that build up from a plane bed and a plane water surface. Anti-dunes can form either during transitional flow, between subcritical and supercritical flow, or during supercritical flow. The wave length is proportional to the velocity of flow. The corresponding surface waves, which are in phase with the anti-dunes, tend to break like surf when the waves reach a height approximately equal to 0.14 times the wave length. A relationship between average channel velocity, V_m, and anti-dune trough depth, Z_a, can therefore be developed (Simons, Li & Associates, 1982). This relationship is:

$$Z_a = \frac{1}{2}(0.14)\frac{2\pi V_m^2}{g} = 0.0137V_m^2 \quad (6.5)$$

A restriction on the above equation is that the anti-dune trough depth can never exceed one-half the depth of flow. Therefore, if the computed depth of Z_a obtained by using Equation 6.5 exceeds one-half of the depth of flow, the anti-dune trough depth should then be taken as equal to one-half the depth of flow. Figure 6.2 shows a definition sketch for anti-dune trough depth.

6.6.3 Low-Flow Thalweg

A low-flow thalweg is a small channel which forms within the bed of the main channel, and in which low discharges are carried. Low-flow thalwegs form when the width/depth ratio of the main channel is large. Rather than flow in a very wide, shallow state, low flows will develop a low-flow channel thalweg below the average channel bed elevation in order to provide more efficient conveyance of these discharges.

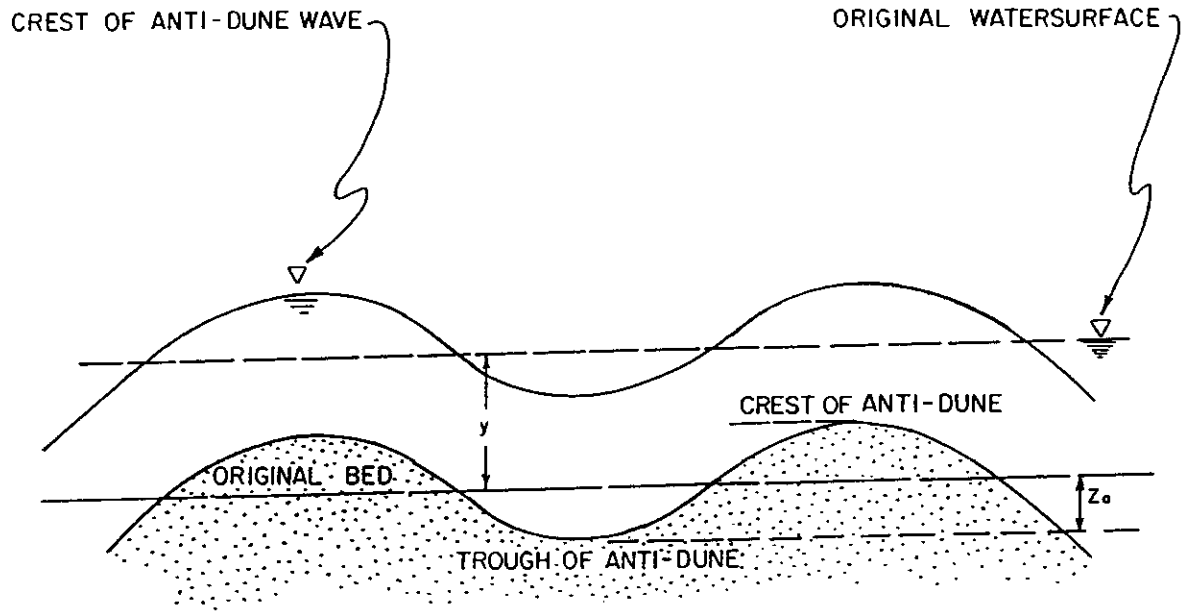


FIGURE 6.2
DEFINITION SKETCH FOR ANTI-DUNE TROUGH DEPTH

When the ratio of the flow width to the flow depth of a channel is greater than 1.15 times the average velocity of flow for the 100-year discharge, a low-flow thalweg must be included in all scour calculations. When the flow width or flow depth exceeds the top width and bank heights of the channel, use the top width and flow depth at bank-full conditions, instead of the actual flow width and flow depth. Presently, there is no known methodology for predicting low-flow thalweg depth. However, observation of channels in the Tucson area has revealed that low-flow thalwegs are normally one to two feet deep. Therefore, if a low-flow thalweg is predicted to be present, it should be assumed to be at least two feet deep within regional watercourses, and at least one foot deep within all other watercourses, unless field observations dictate otherwise.

6.6.4 Bend Scour

Bend scour normally occurs along the outside of bends, and is caused by spiral, transverse currents which form within the flow as the water moves around the bend. Presently, there is no single procedure which will consistently and accurately predict bend scour over a wide range of hydraulic conditions. However, the following relationship has been developed by Zeller (1981) for estimating bend scour in sand-bed channels based upon the assumption of the maintenance of constant stream power within the channel bend:

$$Z_{bs} = \frac{0.0685 Y_{max} V_m^{0.8}}{Y_h^{0.4} S_e^{0.3}} \left(2.1 \left[\frac{\sin^2(\alpha/2)}{\cos \alpha} \right]^{0.2} - 1 \right) \qquad (6.6)$$

Where:

Z_{bs} = Bend-scour component of total scour depth, in feet;
= 0 when $r_c/T \geq 10.0$, or $\alpha \leq 17.8°$
= computed value when $0.5 < r_c/T < 10.0$, or $17.8° < \alpha < 60°$
= computed value at $\alpha = 60°$ when $r_c/T \leq 0.5$, or $\alpha \geq 60°$

V_m = Average velocity of flow immediately upstream of bend, in feet per second;

Y_{max} = *Maximum* depth of flow immediately upstream of bend, in feet;

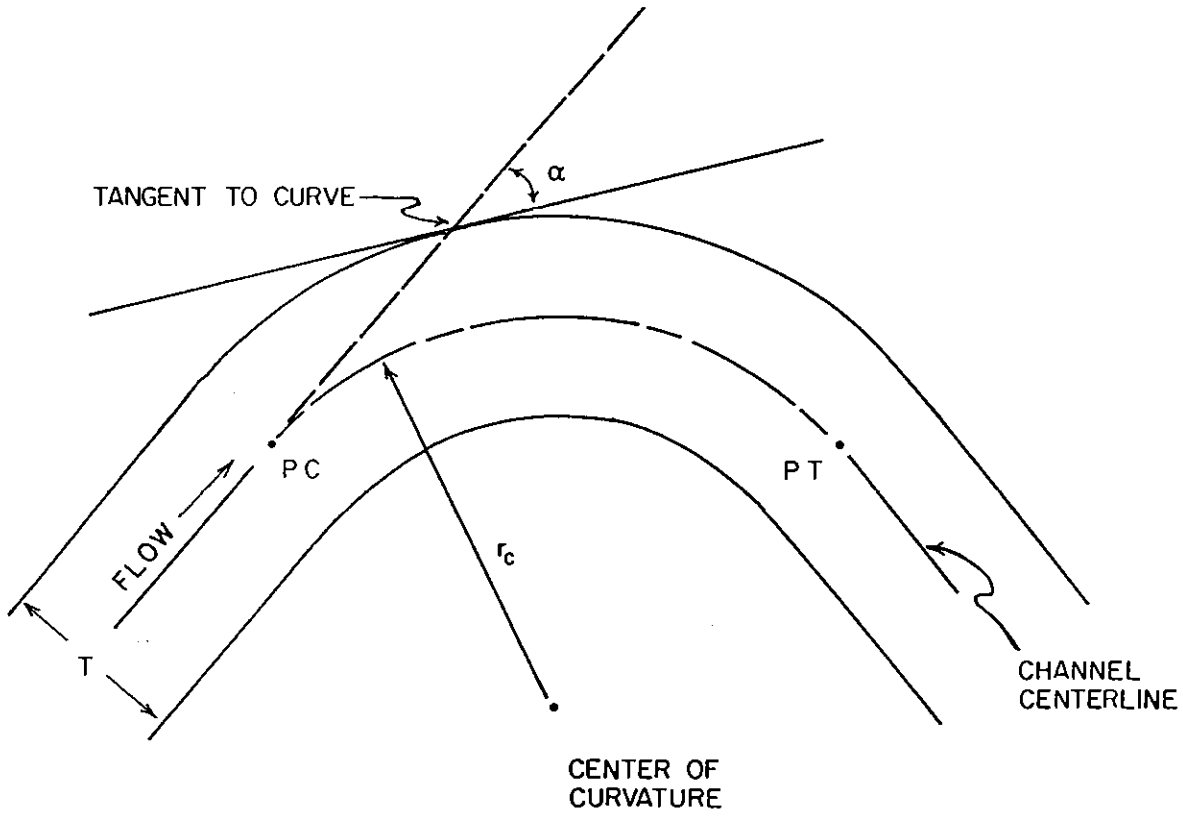
Y_h = Hydraulic depth of flow immediately upstream of bend, in feet;

S_e = Energy slope immediately upstream of bend (or bed slope for uniform-flow conditions), in feet per foot; and,

α = Angle formed by the projection of the channel centerline from the point of curvature to a point which meets a line tangent to the outer bank of the channel, in degrees (see Figure 6.3).

NOTE: Mathematically, it can be shown that, for a simple circular curve, the following relationship exists between α and the ratio of the centerline radius of curvature, r_c, to channel top width, T.

$$\frac{r_c}{T} = \frac{\cos \alpha}{4 \sin^2(\alpha/2)} \qquad (6.7)$$



PT = Downstream point of tangency to the centerline radius of curvature.
PC = Upstream point of curvature at the centerline radius of curvature.

FIGURE 6.3
ILLUSTRATION OF TERMINOLOGY FOR BEND-SCOUR CALCULATIONS

Where:

r_c = Radius of curvature along centerline of channel, in feet; and,
T = Channel top width, in feet.

If the bend deviates significantly from a simple circular curve, the curve should be divided into a series of circular curves, and the bend scour computed for each segment should be based upon the angle α applicable to that segment.

Equation 6.6 can be applied to obtain an approximation of the scour depth that can be expected in a bend during a specific water discharge. The impact that other simultaneously occurring phenomena such as sand waves, local scour, long-term degradation, etc., might have upon bend scour is not known for certain, given the present state of the art. Therefore, in order that the maximum scour in a bend not be underestimated, it is recommended that bend scour be considered as an independent channel adjustment that should be added to those adjustments computed for long-term degradation, general scour, and sand-wave troughs.

The longitudinal extent of the bend-scour component is as difficult to quantify as the vertical extent. Rozovskii (1961) developed an expression for predicting the distance from the end of a bend at which the secondary currents will have decayed to a negligible magnitude. This relationship, in a simplified form, can be expressed as:

$$x = \frac{0.6}{n} Y^{1.17} \qquad \textbf{(6.8)}$$

Where:

x = Distance from the end of channel curvature (point of tangency, PT) to the downstream point at which secondary currents have dissipated, in feet;
n = Manning's roughness coefficient;
g = Acceleration due to gravity, 32.2 ft/sec^2; and,
Y = Depth of flow (to be conservative, use maximum depth of flow, exclusive of scour, within the bend), in feet.

Equation 6.8 should be used for determining the distance downstream of a curve that secondary currents will continue to be effective in producing bend scour. As a conservative estimate of the longitudinal extent of bend scour, both through and downstream of the curve, it would be advisable to consider bend scour as commencing at the upstream point of curvature (PC), and extending a distance x (computed with Equation 6.8) beyond the downstream point of tangency (PT).

6.6.5 Local Scour

Local scour occurs whenever there is an abrupt change in the direction of flow. Abrupt changes in flow direction can be caused by obstructions to flow, such as bridge piers or abrupt contractions at bridge abutments.

VI. EROSION AND SEDIMENTATION

The depth of scour at bridge piers is highly dependent upon the shape of the pier. Figure 6.4 gives several common pier shapes. A square-nosed pier causes the deepest scour. The depth of scour caused by a square-nosed pier is computed from (Richardson et al., 1975):

$$Z_{lsp} = 2.2\, Y \left(\frac{b_p}{Y} \right)^{0.65} F_u^{0.43} \qquad (6.9)$$

Where:

Z_{lsp} = Local scour depth due to pier, in feet;
Y = Flow depth, in feet;
b_p = Pier width normal to the flow direction, in feet; and,
F_u = Upstream Froude number.

Table 6.1 can be used for computing the reduction in the depth of pier scour for the various types of piers shown in Figure 6.4.

TABLE 6.1: REDUCTION FACTORS TO BE USED WHEN APPLYING SCOUR FORMULAS FOR SQUARE-NOSED PIERS TO OTHER SHAPES

(assuming equally projected widths of piers)

Type of Pier	Reduction Factor
Square Nose	1.0
Cylinder	0.9
Round Nose	0.9
Sharp Nose	0.8
Group of Cylinders	0.9

Scour is reduced if the pier is streamlined in the direction of flow. However, many watercourses transport significant amounts of debris during large floods. Such debris can become impaled upon bridge piers, leading to an increase in the pier-width component, b_p, found in Equation 6.9. Therefore, in instances where significant debris

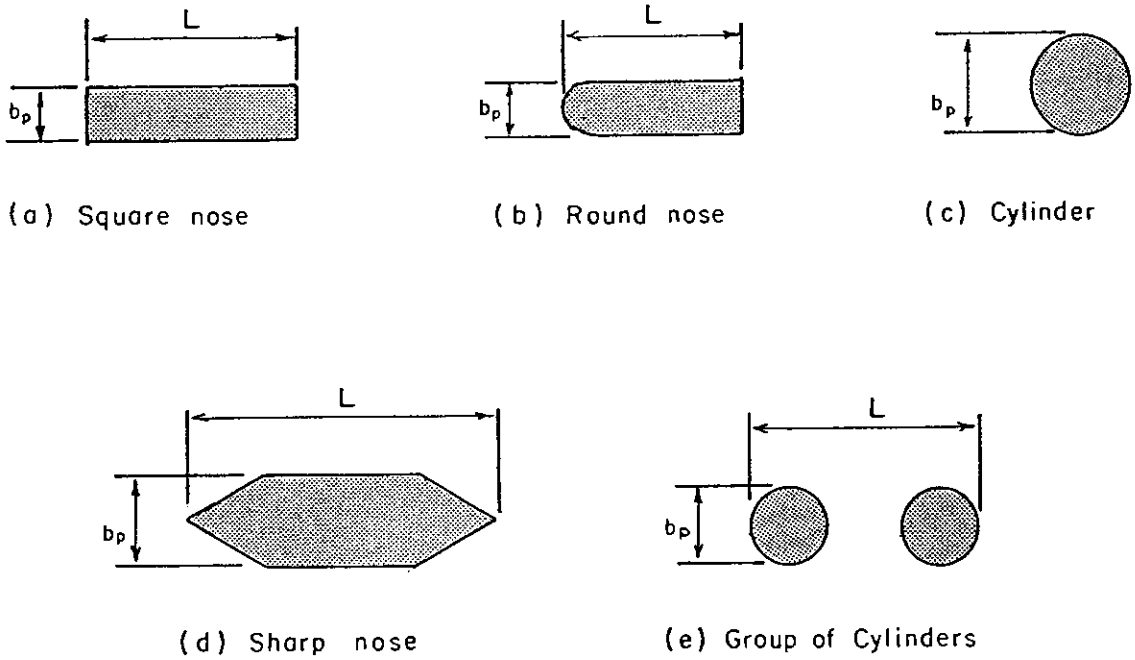


FIGURE 6.4
COMMON PIER SHAPES

transport is anticipated (e.g., within regional watercourses), b_p should be assumed equal to a width of five feet or 1.5 b_p, whichever value is greater. Additionally, pier scour will increase significantly as the direction of flow at the pier becomes more and more skewed in relationship to the pier wall. In such instances, an effective pier width, b_{pe}, can be calculated from the following equation and substituted into Equation 6.9 in lieu of b_p.

$$b_{pe} = L\sin\phi_p + b_p\cos\phi_p \quad \textbf{(6.10)}$$

Where:

b_{pe} = Effective pier width, in feet;
L = Length of pier wall, in feet;
ϕ_p = Angle of approach flow in relationship to pier wall, in degrees (ϕ_p = 0° for cylindrical piers); and,
b_p = As defined in Equation 6.9.

In Equation 6.10, b_p should incorporate any width increase due to debris, where applicable.

Local scour caused by embankments projecting into the flow, such as at bridge abutments, fill projections, and overbank levees, can be computed from the following equation:

$$Z_{lse} = 2.15\ \sin(\theta_a)\ Y \left(\frac{a_e}{Y}\right)^{0.4} F_u^{0.33} \quad \textbf{(6.11)}$$

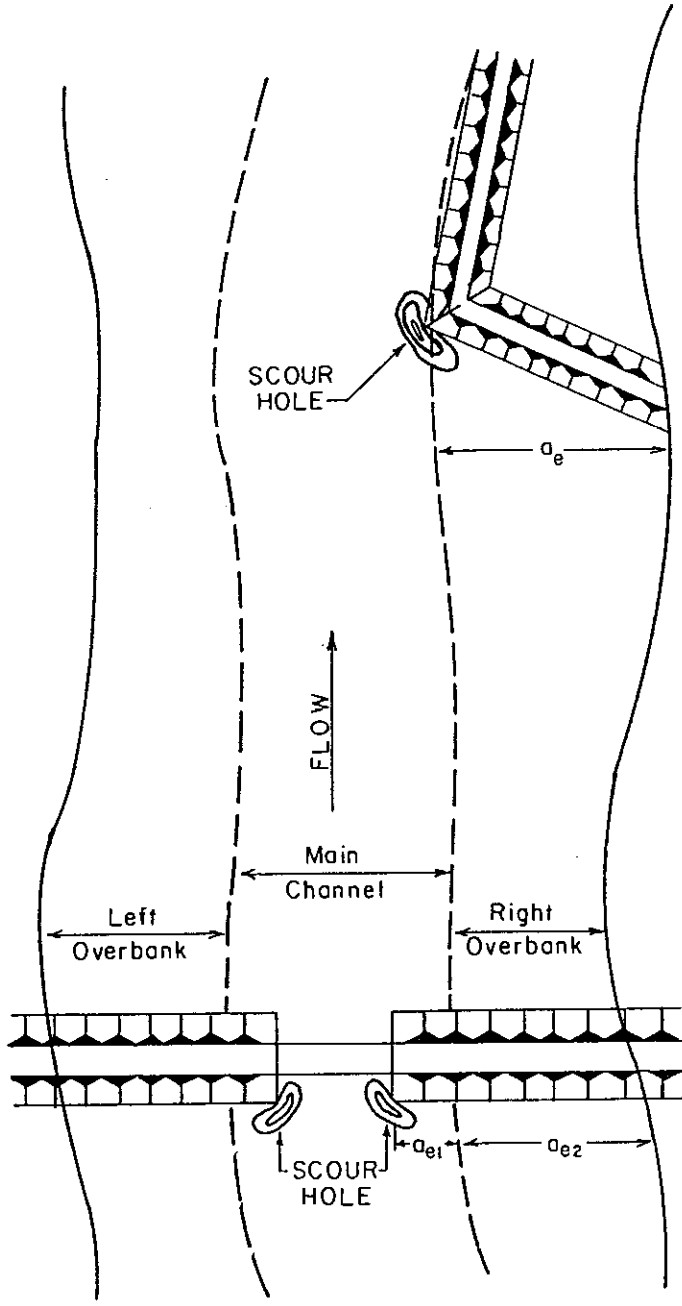
Where:

Z_{lse} = Local scour depth due to embankment, in feet;
θ_a = Slope angle of abutment face, measured from the horizontal, in degrees;
Y = Upstream normal flow depth, in feet;
a_e = Embankment or encroachment length, measured normal to the edge of the floodplain or channel bank, in feet (see Figure 6.5); and,
F_u = Upstream Froude number.

For embankments where the quantity a_e/Y is exceedingly large, such that $Z_{lse}/YF_u^{0.33} \geq 4.0$, the following equation (Richardson et al., 1975) should be used in lieu of Equation 6.11:

$$Z_{lse} = 4YF_u^{0.33} \quad \textbf{(6.12)}$$

Equations 6.11 and 6.12 are based upon relationships developed from both empirical observations and experiments in laboratory flumes. As can be seen from the formulas, the scour depth can be significantly affected by embankment length. In



CASE 1
Overbank Levee

Upstream depth of flow, Y, and Froude number should be based on hydraulic conditions for right overbank flow.

CASE 2
Bridge Embankment

Upstream depth of flow, Y, and Froude number should be based on hydraulic conditions for main channel flow when using a_{e1} and overbank flow when using a_{e2}. A comparison of scour calculations using these two definitions of embankment length is recommended.

FIGURE 6.5

DEFINITION SKETCH OF EMBANKMENT LENGTH "a_e"

practical situations, the embankment may span a wide floodplain overbank and extend partially into the main channel itself. Due to the normally large differences which exist between channel and overbank hydraulics, caution must be exercised in defining the embankment length. Figure 6.5 shows a recommended embankment length definition for different cases that might be encountered. In the situation where the embankment crosses the entire overbank and extends into the main channel, it is recommended that the scour be computed by utilizing the overbank hydraulics in combination with the embankment length a_{e2}, and that this depth of scour then be compared to the scour depth computed by utilizing the main-channel hydraulics in combination with the embankment length a_{e1}. The larger of the two values should then be used for design purposes.

6.6.6 Scour Below Channel Drops

Scour below channel drops, such as grade-control structures, is a special case of local scour. Where the drop consists of a free, unsubmerged overfall, the depth of scour below the drop (U.S. Bureau of Reclamation, 1977) shall be computed from:

$$Z_{lsf} = 1.32\, q^{0.54} H_t^{0.225} - TW \qquad (6.13)$$

Where:

Z_{lsf} = Depth of local scour due to a free-overfall drop, in feet, measured below the streambed surface downstream of the drop;
q = Discharge per unit width of the channel bottom, in cubic feet per second per foot;
H_t = Total drop in head, measured from the upstream energy grade line to the downstream energy grade line, in feet; and
TW = Tailwater elevation (downstream water-surface elevation), in feet.

Figure 6.6 shows the relationship of the parameters in Equation 6.13.

Where the drop is submerged, as will be the case for most instances involving grade-control structures placed along watercourses located within the City of Tucson, the depth of scour below the drop (Simons, Li & Associates, 1986) shall be computed from:

$$Z_{lss} = 0.581 q^{0.667} (h/Y)^{0.411} [1-(h/Y)]^{-0.118} \qquad (6.14)$$

Where:

$h/Y \leq$ 0.99; and,
Z_{lss} = Depth of local scour due to a submerged drop, in feet, measured below the streambed surface downstream of the drop;
q = Discharge per unit width of the channel bottom, in cubic feet per second per foot;
h = Drop height, in feet; and,
Y = Downstream depth of flow, in feet.

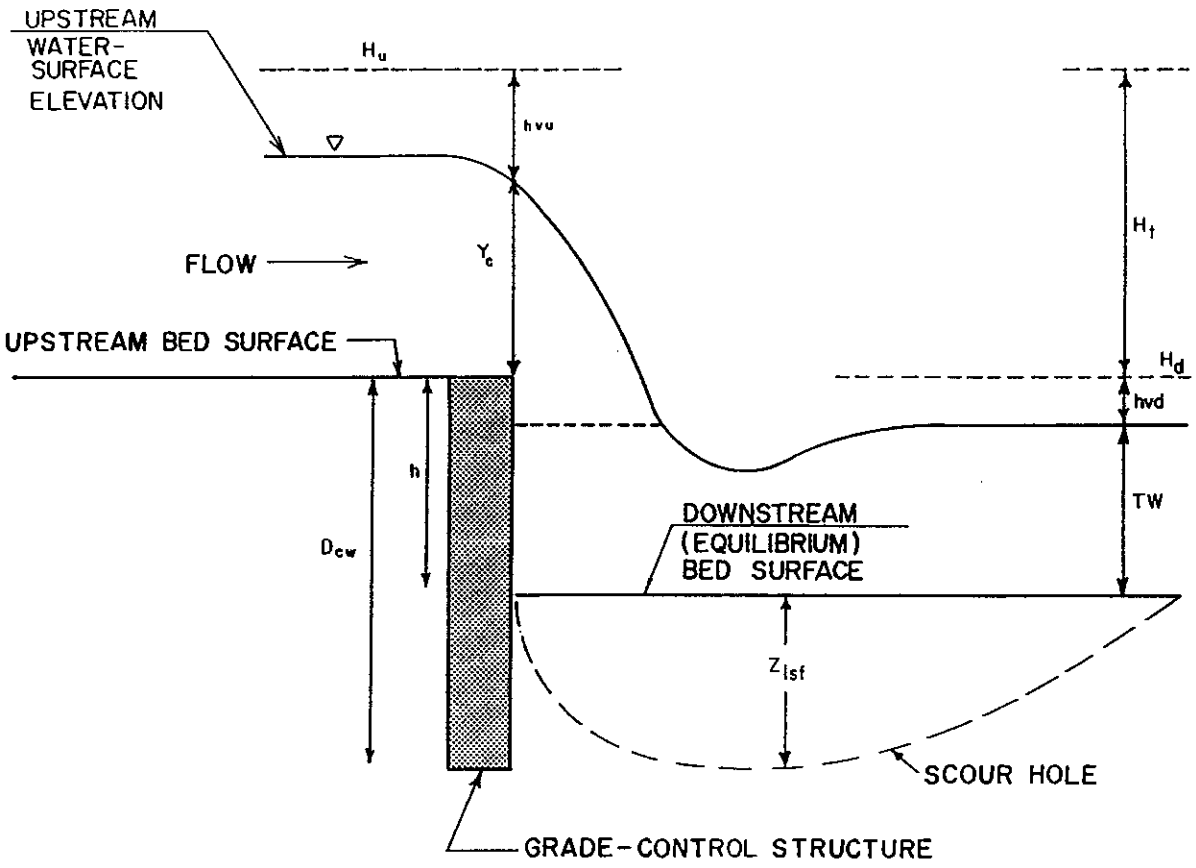


FIGURE 6.6
DEPTH OF SCOUR BELOW A FREE OVERFALL

NOTE: If $h/Y > 0.85$, the predicted scour below a channel drop should also be computed using Equation 6.13. The smaller of the two values thus computed should then be used for design purposes.

Figure 6.7 gives the relationship of the parameters in Equation 6.14.

The longitudinal extent of a scour hole created by either a free or submerged overfall is represented by the distances x_{sce} and L_s, as depicted in Figure 6.7. These dimensions are given by the equations:

$$x_{sce} = 6.0\ Z_{lsf}, \text{ or } 6.0\ Z_{lss} \quad \textbf{(6.15)}$$

$$L_s = 12.0\ Z_{lsf}, \text{ or } 12.0\ Z_{lss} \quad \textbf{(6.16)}$$

Bank protection toe-downs downstream of a grade-control structure shall extend to the computed depth of scour for a distance equal to x_{sce} beyond of the grade-control structure, as computed by Equation 6.15. They shall then taper back to the normal toe-down depth within a total distance downstream of the grade-control structure equal to L_s, as computed by Equation 6.16. Note that L_s includes x_{sce}.

In the absence of bridge piers and/or abutments, the depth of scour below grade-control structures is not added to the other scour components. Rather, the depth of scour caused by the grade-control structure is compared to the depth of scour computed by Equation 6.3, and the larger of the two values is then used for toe-down design.

6.7 Scour-Hole Geometry at Culvert Outlets

Culverts normally have less cross-sectional area available for the conveyance of flow than do the natural channels they replace. Consequently, flow velocities are increased and a potential for erosion is created at the culvert outlet. Often there is a drop at the culvert outlet, either under design conditions or as a result of outlet scour, and this further increases the possibility of outlet scour. The scour hole created at the outlet of a culvert can become large enough to threaten the culvert, the roadway, adjacent property, or other nearby improvements.

For non-cohesive soils, the dimensions of a scour hole downstream of a culvert outlet *where no drop exists* can be computed by:

$$DSG = \alpha \left[\frac{Q_r}{g^{1/2}\, D^{5/2}} \right]^{\beta} (0.09)^{\theta} \quad \textbf{(6.17)}$$

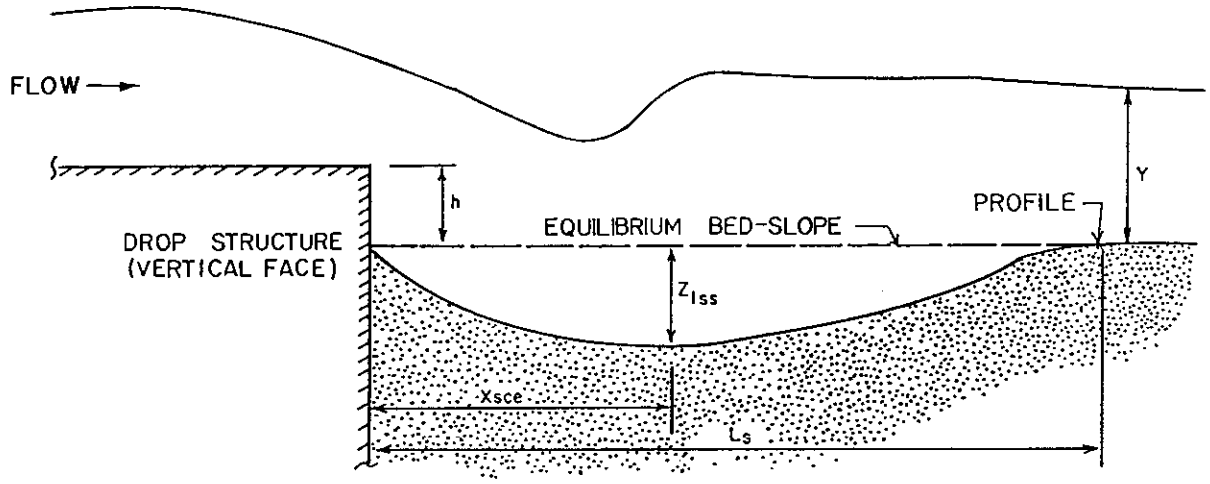


FIGURE 6.7

RELATIONSHIP OF VARIABLES IN EQUATION FOR SCOUR BELOW A SUBMERGED GRADE-CONTROL STRUCTURE

Where:

DSG = Dimensionless scour geometry = $\frac{Z_{lsc}}{D}$, $\frac{W_{sc}}{D}$, $\frac{L_{sc}}{D}$ or $\frac{V_{sc}}{D}$; and,

Z_{lsc} = Depth of scour hole below culvert, in feet;
W_{sc} = Width of scour hole below culvert, in feet;
L_{sc} = Length of scour hole below culvert, in feet;
V_{sc} = Volume of scour hole below culvert, in cubic feet;
D = Culvert diameter, in feet;
Q_r = Representative discharge, in cubic feet per second;
g = Acceleration due to gravity (32.2 ft/sec^2); and,
$\alpha,\alpha_e,\beta,\theta$ = Empirically derived coefficients (see Table 6.2).

The representative discharge is the average maximum discharge that can be expected to occur within a thirty-minute time period during the storm runoff event which is selected for design. In the City of Tucson, the design discharge is the 100-year flood. The representative discharge is calculated by:

$$Q_r = \frac{Q_{100}}{2}\left[1 + \frac{T_r - 10}{T_r}\right] \quad (6.18)$$

Where:
Q_r = Representative discharge, in cubic feet per second;
Q_{100} = 100-year peak discharge, in cubic feet per second; and,
T_r = Hydrograph rise time, in minutes (see Chapter IV, Section 4.5, of this Manual).

For either non-circular or partially-full culverts, the culvert diameter, D, should be replaced in Equation 6.17 by an equivalent depth, Y_e, where Y_e is defined as:

$$Y_e = \left[\frac{A}{2}\right]^{0.5} \quad (6.19)$$

Where:
A = Cross-sectional area of flow, in square feet.

Equation 6.18 is then modified to the following form:

TABLE 6.2A: EXPERIMENTAL COEFFICIENTS FOR SCOUR DEPTH, Z_{lsc}, AT CULVERT OUTLETS

MATERIAL	NOMINAL GRAIN SIZE D_{50} (mm)	SCOUR EQUATION	COEFFICIENTS			
			α	β	θ	α_e
Uniform Sand	0.20	6.17 or 6.20	2.72	0.375	0.10	2.79
Uniform Sand	2.0	6.17 or 6.20	1.86	0.45	0.09	1.76
Graded Sand	2.0	6.17 or 6.20	1.22	0.85	0.07	0.75
Uniform Gravel	8.0	6.17 or 6.20	1.78	0.45	0.04	1.68
Graded Gravel	8.0	6.17 or 6.20	1.49	0.50	0.03	1.33
Cohesive Sandy Clay:						
60% Sand, PI 15	0.15	6.17 or 6.20	1.86	0.57	0.10	1.53
Clay, PI 5-16	Varies	6.22 or 6.23	0.86	0.18	0.10	1.37

TABLE 6.2B: EXPERIMENTAL COEFFICIENTS FOR SCOUR WIDTH, W_{sc}, AT CULVERT OUTLETS

MATERIAL	NOMINAL GRAIN SIZE D_{50} (mm)	SCOUR EQUATION	COEFFICIENTS			
			α	β	θ	α_e
Uniform Sand	0.20	6.17 or 6.20	11.73	0.92	0.15	6.44
Uniform Sand	2.0	6.17 or 6.20	8.44	0.57	0.06	6.94
Graded Sand	2.0	6.17 or 6.20	7.25	0.76	0.06	4.78
Uniform Gravel	8.0	6.17 or 6.20	9.13	0.62	0.08	7.08
Graded Gravel	8.0	6.17 or 6.20	8.76	0.89	0.10	4.97
Cohesive Sandy Clay:						
60% Sand, PI 15	0.15	6.17 or 6.20	8.63	0.35	0.07	9.14
Clay, PI 5-16	Varies	6.22 or 6.23	3.55	0.17	0.07	5.63

TABLE 6.2C: EXPERIMENTAL COEFFICIENTS FOR SCOUR LENGTH, L_{sc}, AT CULVERT OUTLETS

MATERIAL	NOMINAL GRAIN SIZE D_{50} (mm)	SCOUR EQUATION	COEFFICIENTS			
			α	β	θ	α_e
Uniform Sand	0.20	6.17 or 6.20	16.82	0.71	0.125	11.75
Uniform Sand	2.0	6.17 or 6.20	18.28	0.51	0.17	16.10
Graded Sand	2.0	6.17 or 6.20	12.77	0.41	0.04	12.62
Uniform Gravel	8.0	6.17 or 6.20	14.36	0.95	0.12	7.61
Graded Gravel	8.0	6.17 or 6.20	13.09	0.62	0.07	10.15
Cohesive Sandy Clay:						
60% Sand, PI 15	0.15	6.17 or 6.20	15.30	0.43	0.09	14.78
Clay, PI 5-16	Varies	6.22 or 6.23	2.82	0.33	0.09	4.48

TABLE 6.2D: EXPERIMENTAL COEFFICIENTS FOR SCOUR VOLUME, V_{sc}, AT CULVERT OUTLETS

MATERIAL	NOMINAL GRAIN SIZE D_{50} (mm)	SCOUR EQUATION	COEFFICIENTS			
			α	β	θ	α_e
Uniform Sand	0.20	6.17 or 6.20	203.36	2.0	0.375	80.71
Uniform Sand	2.0	6.17 or 6.20	101.48	1.41	0.34	79.62
Graded Sand	2.0	6.17 or 6.20	36.17	2.09	0.19	12.94
Uniform Gravel	8.0	6.17 or 6.20	65.91	1.86	0.19	12.15
Graded Gravel	8.0	6.17 or 6.20	42.31	2.28	0.17	32.82
Cohesive Sandy Clay:						
60% Sand, PI 15	0.15	6.17 or 6.20	79.73	1.42	0.23	61.84
Clay, PI 5-16	Varies	6.22 or 6.23	0.62	0.93	0.23	2.48

$$DSG = \alpha_e \left(\frac{Q_r}{g^{1/2} Y_e^{5/2}} \right)^{\beta} (0.09)^{\theta} \qquad (6.20)$$

The coefficient α_e can also be found in Table 6.2.

Bed materials are classified in Table 6.2 as being either uniform or graded. Uniform materials are classified as those for which the standard deviation (σ) of the grain-size distribution is less than or equal to 1.5. The material is classified as graded if the standard deviation of the grain-size distribution is greater than 1.5. A simple formula often used for computing the standard deviation is:

$$\sigma = \left(\frac{D_{84}}{D_{16}} \right)^{0.5} \qquad (6.21)$$

Where:

D_{84} = The grain-size diameter for which 84% of the bed material consists of smaller particles; and

D_{16} = The grain-size diameter for which 16% of the bed material consists of smaller particles.

The grain-size distribution can be determined by a sieve analysis of the bed material. For planning purposes, or in the absence of a sieve analysis, bed material in the City of Tucson should be classified as graded sand, with a median diameter, D_{50}, equal to one millimeter and $\sigma = 4.0$.

If the soil at the culvert outlet is a sandy clay with a mean grain size in the range of 0.10 to 0.20 mm and a plasticity index, *PI*, of approximately 15, either Equation 6.17 or 6.20 may be used; where the coefficients for such a soil type are also given in Table 6.2.

Equations 6.17 and 6.20 are not applicable to cohesive soils, which have very different properties than the soil types described above. The potential for scour in cohesive soils is related to the critical shear stress of the soils, and is reflected by Equations 6.22 and 6.23. These equations have a wider range of applicability than do the above expressions. These equations are:

$$DSG = \alpha \left(\frac{\rho V^2}{\tau_c} \right)^{\beta} (0.09)^{\theta} \qquad (6.22)$$

For circular culverts, and

$$DSG = \alpha_e \left(\frac{\rho V^2}{\tau_c} \right)^{\beta} (0.09)^{\theta} \quad (6.23)$$

For culverts with other shapes.

Where:

$\frac{\rho V^2}{\tau_c}$ = Modified shear number;

V = Average velocity at outlet, in feet per second;
τ_c = Critical tractive shear stress, in pounds per square foot; and,
ρ = Fluid density, in slugs per cubic foot.

All other terms are as previously defined.

The critical tractive shear stress is defined as:

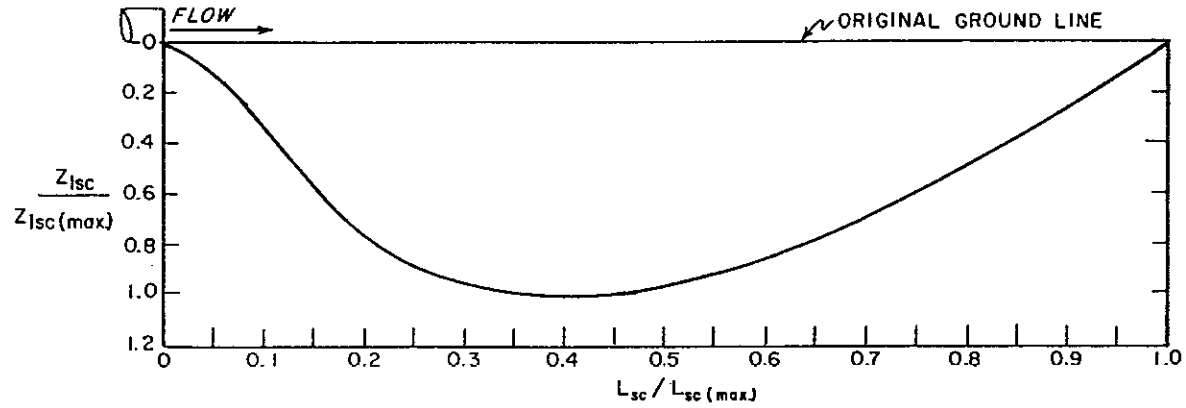
$$\tau_c = 0.0001 (S_v + 180) \tan (30 + 1.73 PI) \quad (6.24)$$

Where:
S_v = Saturated shear strength, in pounds per square inch; and,
PI = The plasticity index (limits 5-16).

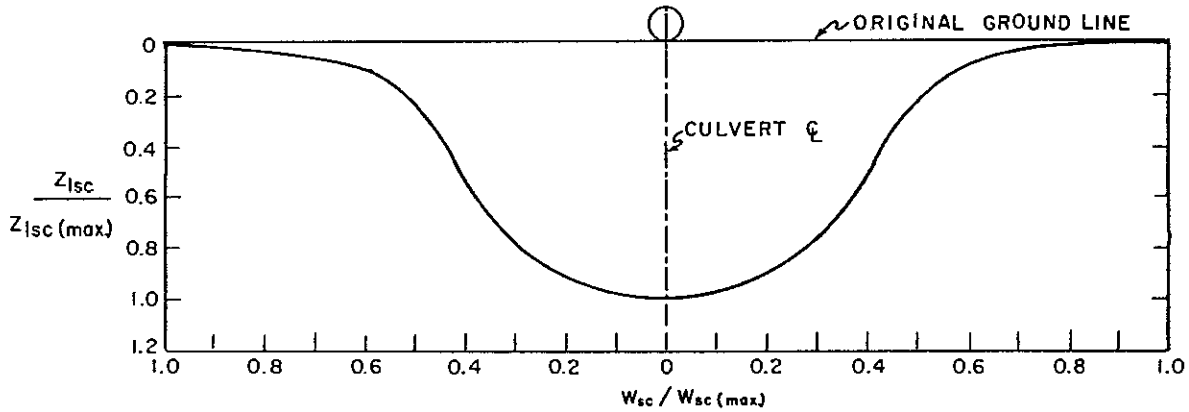
Equations 6.17 to 6.24 can therefore be used to estimate the dimensions of the scour hole that would form at the outlet of a culvert for varying types of soils. Figures 6.8 and 6.9 should be used to determine the shape of the scour hole. If the scour hole is large enough to threaten nearby improvements, adjacent property, or the culvert itself, outlet protection will be required to contain and/or prevent erosion. The user is referred to a publication by the Federal Highway Administration (1983) for further information regarding the design of culvert outlet protection.

6.8 Design of Sediment Basins

On watercourses with a potential for high sediment discharge, sediment basins may be necessary to protect detention basins, culverts, or storm drains from being filled with sediment. If it is felt that sedimentation could pose a problem for a proposed structure, basins should be built to collect and hold sediment for later removal by maintenance personnel. The design of these basins on watercourses where the upstream watershed area is one square mile, or less, shall be in accordance with the guidelines as presented within Section 3.4 of the Pima County and City of Tucson Stormwater Detention/Retention Manual (1987).

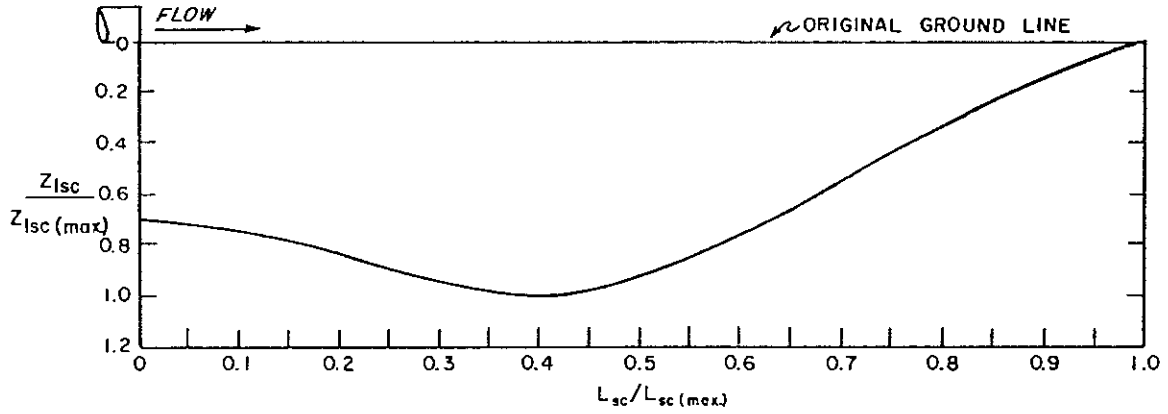


DIMENSIONLESS CENTER-LINE PROFILE

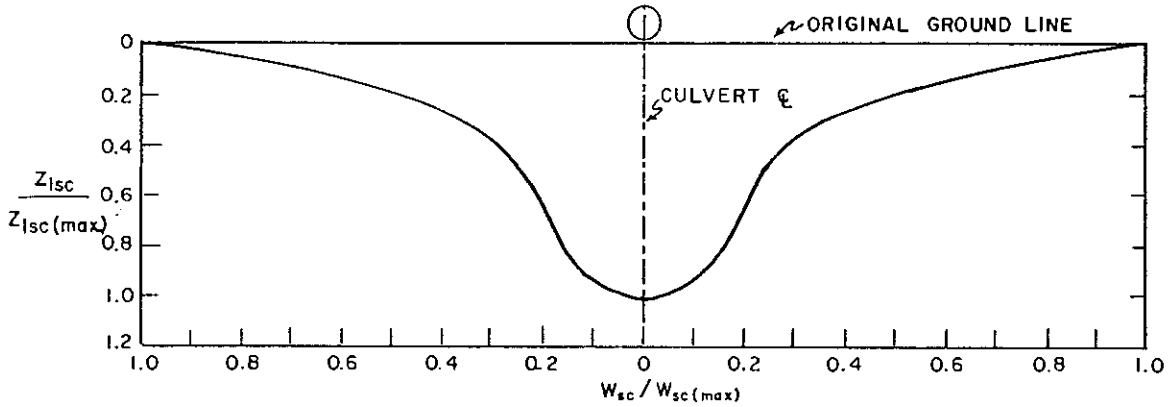


DIMENSIONLESS CROSS SECTION AT 0.4 $L_{sc(max.)}$

FIGURE 6.8
DIMENSIONLESS SCOUR-HOLE GEOMETRY
FOR MAXIMUM TAILWATER



DIMENSIONLESS CENTER-LINE PROFILE



DIMENSIONLESS CROSS SECTION AT 0.4 L_{sc}(max.)

FIGURE 6.9
DIMENSIONLESS SCOUR-HOLE GEOMETRY
FOR MINIMUM TAILWATER

On watersheds larger than one square mile, the guidelines cited above may result in overdesign. The design of sediment basins on these watersheds is a more complicated procedure, involving total watershed sediment yield and channel sediment-transport capacity over a range of discharges. Total watershed sediment yield can be estimated by such methods as the Modified Universal Soil Loss Equation (Williams, 1975; and Williams and Berndt, 1977), the Pacific Southwest Inter-Agency Committee (PSIAC) Method (Pacific Southwest Inter-Agency Committee, 1968), the Flaxman Method (Flaxman, 1972), the SCS Method (U.S. Soil Conservation Service, 1971), the Dendy/ Bolton Method (Dendy and Bolton, 1976), and the Renard Method (Renard, 1972). A publication by Renard and Stone (1981) contains a detailed discussion and comparison of some of these methods.

The equations for watershed sediment yield which are listed above do not readily distinguish between sediment production that would be classified as wash load and sediment production that would be classified as bed load. Wash load particles are so small that they would generally remain in suspension as the water passes through the detention basin. Therefore, the wash load is not generally to be considered in sediment basin design. An estimate of wash load, as compared to bed load estimated from equations for total watershed sediment yield, can be made by taking samples of the topsoil throughout the watershed.

Total watershed sediment production may not be an entirely accurate estimate of the amount of sediment that would be delivered to a certain point, because there is sediment storage within the watershed system. Sediment-volume estimates must therefore also consider the sediment-transport capacity of the channel. A detailed discussion of this type of analysis will not be presented here. However, the reader is referred to publications by the U.S. Army Corps of Engineers (1977), Simons, Li & Associates (1982, 1985), the American Society of Civil Engineers (1977), Simons and Senturk (1977), and Zeller and Fullerton (1983) for more detailed information about performing such analyses.

6.9 Equilibrium Slopes within Constructed Channels

Given a fixed size distribution of sediments, the sediment-transport capacity of a stream is dependent primarily upon flow velocity and depth. Within the City of Tucson, transport of all particle sizes of bed material increases, as flow velocity increases, at a rate proportional to approximately the third to fifth power of the velocity. Correspondingly, transport of sediment particles composed of bed material generally decreases as depth increases, while transport increases with decreased depth. However, flow velocity is by far the more important variable.

For purposes of analysis and design, most natural, undisturbed channels in the Tucson area can be assumed to be at or near a state of dynamic equilibrium with regard to sediment transport. This means that, for a given reach of the channel, the sediment-transport capacity of the channel, over the long term, is more or less equal to the sediment supply. The channel bed slope is therefore "stable."

When channelization occurs, the channel top width is often narrowed, and channel roughness is normally decreased. The result is an increase in velocity and depth, with

a corresponding increase in sediment-transport capacity. Sediment-transport capacity then exceeds the sediment supply; and, if the bed is composed of sediment that can be transported, the deficiency will be made up from bed material--causing the channel to degrade. Another factor that contributes to this degradation is upstream urbanization. Urbanization increases flood peaks, which also lead to higher flow velocities and depths. Urbanization also reduces the watershed sediment supply, and increases the frequency of runoff. The result of all these occurrences is that channel bed degradation will occur until the channel slope is flat enough to cause the sediment-transport rate to be equal to the incoming sediment supply. This slope then becomes the new, "stable," equilibrium slope. Streambed degradation can threaten underground improvements, bank-protection toe-downs, culverts, and other hydraulic structures that are within and/or that cross the channel. Grade-control structures, or lining of the channel bed, are usually required in order to prevent damage caused by streambed degradation.

The equilibrium slope for a channel which has an upstream sediment supply that is considered to be essentially zero (e.g., a channel located within a highly urbanized watershed) can be computed from:

$$S_{eq} = \left(\frac{1.45n}{q^{0.11}} \right)^2 \qquad \textbf{(6.25)}$$

Where:

S_{eq} = Equilibrium slope after urbanization, in feet per foot;
n = Manning's roughness coefficient; and,
q = Channel unit discharge, in cubic feet per second per foot.

For use with Equation 6.25, channel unit discharge is defined as the channel discharge divided by the channel bottom width. Use of this equation will produce the flattest slope that can be reasonably expected to transport sediment within channels located in the Tucson area. The discharge associated with a 10-year flood is normally chosen when computing the unit discharge for use in Equation 6.25.

For lesser degrees of urbanization, the equilibrium slope is computed from Equation 6.26, which is a generalization of the theoretically derived sediment-transport relationships for sandbed channels developed by Zeller and Fullerton (1983):

$$S_{eq} = \left(\left[\frac{n_u}{n_n} \right]^2 \left[\frac{Q_{u,10}}{Q_{n,10}} \right]^{-1.1} \left[\frac{b_u}{b_n} \right]^{0.4} (1-R_s)^{0.7} \right) S_n \qquad \textbf{(6.26)}$$

Where:

n_u = Manning's roughness coefficient for an urban channel;
n_n = Manning's roughness coefficient for a natural or existing channel;
$Q_{u,10}$ = Ten-year discharge, under urbanized conditions, in cubic feet per second;
$Q_{n,10}$ = Ten-year or bank-full discharge (whichever is less), under natural conditions, in cubic feet per second;
b_u = Bottom width of channel, under urbanized conditions, in feet;
b_n = Bottom width of channel, under natural conditions, in feet;
R_s = Reduction factor for sediment supply. This factor is usually assumed to be equal to the ratio of the impervious area to the total area of the upstream watershed (i.e., $0.0 \leq R_s \leq 1.0$); and,
S_n = Natural or existing channel slope, in feet per foot.

The roughness coefficients for natural and urbanized channel beds are often very nearly the same, so the term in which these coefficients appear in Equation 6.26 can usually be assumed equal to the value 1.0. However, from time to time exceptions to this assumption may occur. For instance, when the existing channel is a wide, flat, sheetflow watercourse; and the proposed channel is a narrow, sand-bed channel, n_u will ordinarily not be equal to n_n.

For moderately urbanized to highly urbanized watersheds, the equilibrium slope should be computed by using both Equation 6.25 and Equation 6.26. The steeper of the two computed slopes should then be used for design. The reason for this is that Equation 6.26 can sometimes produce slope values that are too flat to generate reasonable sediment-transport rates for maintenance of channel stability, when impervious cover within a watershed is very high.

Equation 6.26 should be used with caution within the City of Tucson. An underlying assumption of this equation is that the existing or natural channel is itself in equilibrium. This is not always true in the City, because most channels have undergone alteration. If there is any question as to whether or not the existing channel is in equilibrium, it is best to try and determine through old (pre-development) aerial photographs and topography what the channel characteristics were in its original, undisturbed (i.e., natural) state. In the absence of historical information about the original channel, an examination may be made of existing stable channels in the area to help estimate what the channel in question may have looked like before urbanization.

Equation 6.26 can be used for more than merely the quantification of streambed degradation. It can also be used to determine whether aggradation will occur when a channel is widened beyond existing or natural conditions. Another application would be to use it to design a stable channel cross-section in lieu of installing grade-control structures to otherwise control degradation of the channel bed.

6.10 Spacing and Depth of Grade-Control Structures

If the equilibrium slope of a channel, as determined by use of either Equation 6.25 or Equation 6.26, is flatter than the design slope, grade-control structures may be needed to limit degradation from exceeding a certain depth at any point along the channel. Grade-control structures, sometimes called "cut-off walls" or "check dams," are non-erodible vertical barriers in the channel that prevent the channel bed from degrading at a point located immediately upstream of where they are located. After the channel bed has reached equilibrium, the bed elevation immediately upstream of the grade-control structure is at the design elevation. Downstream of the grade-control structure, the bed is at an "equilibrium" elevation that is lower than the design elevation. For most channels, the design of grade-control structures is an iterative process, involving drop height, reach length, and depth of scour downstream of the drop.

Once a drop height is chosen, the reach length, or spacing, between adjacent structures can be computed from:

$$L_r = \frac{h}{S_{ib} - S_{eq}} \qquad (6.27)$$

Where:

L_r = Reach length, or spacing, between adjacent grade-control structures, in feet;
h = Drop height downstream of the grade-control structure, in feet;
S_{ib} = Initial channel bed slope, in feet per foot; and,
S_{eq} = Channelized equilibrium bed slope, in feet per foot.

If the initial and final bed slopes are approximately the same, the distance between grade-control structures will be very large. Under these circumstances, such structures may not be required.

Normally, the drop height downstream of a grade-control structure which consists of poured concrete without reinforcements shall not exceed two feet; and preferably should be only one foot, where feasible. For economical and technical reasons, grade-control structures should be spaced no closer together than twelve times the local scour depth below the grade-control structures, as computed by the use of either Equation 6.13 or Equation 6.14.

The total height of a cut-off wall or a grade-control structure (D_{cw}), from top to toe, shall not be less than the drop height plus the computed depth of scour below the wall or structure (see Figure 6.6). The depth of scour below grade-control structures should be computed according to the guidelines presented in Section 6.6.6 of this Manual. For a one-foot-wide, unreinforced concrete cut-off wall, if structural calculations support same, the maximum allowable height of a cut-off wall, from top to toe, can be six feet. If the depth of scour plus the drop height is greater than six feet, the drop shall be considered to be too great for unreinforced concrete cut-off walls, unless a structural analysis can demonstrate otherwise, and the spacing between

the cut-off walls must be reduced. The example which follows (i.e., Example 6.1), illustrates the recommended procedure for cut-off wall design.

There will be many design situations, especially when unit discharges are high, where a cut-off wall with a hegith of six feet, from top to toe, is not sufficient. In such cases, a reinforced concrete cut-off wall that has a height greater than six feet, from top to toe, may be used, provided that a structural analysis is submitted showing that the proposed cut-off wall will be structurally stable. If a structural analysis is submitted and approved, the maximum drop height of two feet will no longer apply.

Grade-control structures for large discharges need not necessarily be vertical on the downstream side. For structural stability, a triangular or wedge-shaped soil-cement grade-control structure is recommended for use on regional watercourses. However, for hydraulic reasons, the use of any grade-control structure with a face flatter than I:1 on the downstream side shall not be permitted without prior written approval from the City Engineer.

EXAMPLE 6.1: SPACING AND DEPTH OF GRADE-CONTROL STRUCTURES

A channel in a highly urbanized watershed is to be built to contain the 100-year-flood discharge. The sides of the channel are to be of shotcrete, the bottom of earth.

Channel characteristics are as follows:

Bottom Width	= 20 feet
Design Slope	= 0.006 feet/foot
Side Slopes	= 1:1
Manning's "n"	= 0.022

Hydraulic characteristics are as follows:

Q_{100} = 700 cfs	Q_{10} = 350 cfs
Y_{100} = 3.1 feet	Y_{10} = 2.1 feet
V_{100} = 9.7 fps	V_{10} = 7.7 fps
q_{100} = 35.0 cfs/foot	q_{10} = 17.5 cfs/foot

Because the watershed is highly urbanized, Equation 6.25 will be used to compute the equilibrium slope. Therefore:

$$S_{eq} = \left[\frac{1.45\ (0.022)}{(17.5)^{0.11}} \right]^2 = 0.0005 \text{ feet/foot.}$$

Assume a two-foot drop height. From Equation 6.27, the spacing between grade-control structures should be:

$$L_r = \frac{2.0}{(0.006)-(0.0005)} = 364 \text{ feet.}$$

The grade-control structure will be submerged. Using Equation 6.14 yields:

$$Z_{lss} = 0.581(q_{100})^{0.667}(h/Y_{100})^{0.411}[1-(h/Y_{100})]^{-0.118};$$

$$q_{100} = 35.0 \text{ cfs;}$$

$$Z_{lss} = 0.581\ (35.0)^{0.667}\ (0.645)^{0.411}\ (0.355)^{-0.118}; \text{ so,}$$

$$Z_{lss} = 5.9 \text{ feet.}$$

Therefore, the total height of the grade-control structure, from top to toe, should be 5.9 feet *plus* the two-foot drop height; or, 7.9 feet (round to 8.0 feet).

However, it is desirable to keep the total vertical dimension of the grade-control structure, from top to toe, equal to or less than six feet. Therefore, a smaller drop height should be used.

Using a drop height of one foot yields:

$$L_r = \frac{1.0}{(0.006)-(0.0005)} = 182 \text{ feet.}$$

$$Z_{lss} = 0.581\ (35.0)^{0.667}\ (0.323)^{0.411}(0.677)^{-0.118}; \text{ so,}$$

$$Z_{lss} = 4.10 \text{ feet (round to 4.0 ft).}$$

Since, in this example, the ultimate drop height at the downstream side of a grade-control structure will be set at one foot, cut-off walls with a height of five feet, from top to toe, could be placed at approximately 180-foot intervals along the bottom of the channel to serve as grade-control structures in order to limit long-term bed degradation to a maximum of one foot anywhere along the subject channel.

CHAPTER VIII: OPEN-CHANNEL DESIGN

8.1 Purpose

The purpose of this chapter is to (1) provide the minimum requirements for the hydraulic design of all open channels which fall within the jurisdiction of the City of Tucson (both public and private); (2) provide the additional requirements which must be met before the city will accept a channel for maintenance (public channels); and, (3) provide the design requirements for those new channels which will either be constructed near or discharge directly into natural channels. Because erosion, sedimentation, and channel-stabilization components are also an integral part of any channel design, these topics are discussed in much greater detail in Chapters VI, VII, and IX, of this Manual, respectively.

8.2 Introduction

The hydraulic design of drainage channels is not a simple procedure. For a relatively long, straight, and uniform channel, normal-depth (i.e., uniform-flow) calculations can be used to determine the discharge capacity at varying depths for a constant cross-sectional area. However, practicing engineers working in an urban environment will rarely encounter either existing conditions or design conditions where uniform-flow calculations are adequate to totally define the flow conditions associated with a given discharge. Transition sections, channel junctions or confluences, channel bends, and hydraulic structures (e.g., culverts and bridges) can create deviations from uniform-flow conditions. Therefore, the engineer must consider these deviations when designing or analyzing drainage channels.

The procedures outlined in this chapter, although not exhaustive, are sufficient for most situations that will be encountered by design engineers. The basic principles behind these design procedures are found in standard textbooks and manuals which deal exclusively with open-channel hydraulics. The design engineer is encouraged to consult the references for this chapter cited at the end of this Manual for a more complete understanding of these principles. Many of the procedures presented herein are particularly similar to those included within the referenced documents prepared by the Los Angeles Flood Control District (1973) and the U.S. Army Corps of Engineers (1970). However, where appropriate, they have been modified to account for local requirements and regulations. As with the other chapters in this Manual, the procedures outlined herein shall be adhered to unless otherwise stated in the Manual, or unless prior approval to deviate from same is obtained, in writing, from the office of the City Engineer.

8.3 Requirements for Natural Channels

Washes which traverse land designated for a proposed development may be left in their natural state provided that doing so would not be in conflict with an approved master drainage plan for the area, if one exists; and provided that the development is adequately protected from flooding and erosion. One method of developing in the vicinity of a natural wash is to keep all structures out of its 100-year floodplain, as well as its attendant erosion-hazard areas. Floodplain delineations and erosion-setback distances are discussed in Chapters V and VII of this Manual. Another

possible method of developing in the vicinity of natural washes is to utilize part of the floodplain for development, while leaving the channel in its natural state. However, this approach would involve demonstrating that (1) the encroachment would not adversely affect adjacent properties; that (2) the development would be located outside of any erosion-hazard areas which border the natural wash; and that (3) in certain key areas, as identified by the City and through the 404-permit process, the disturbance to existing riparian vegetation and habitat is minimized.

8.4 Floodplain Encroachments

Encroachments into the floodplain of a natural wash are to be analyzed according to the procedures outlined in Chapter V. The City of Tucson "Floodplain Regulations" state that the maximum allowable rise in water-surface elevation for the 100-year discharge shall be one-tenth of a foot. However, if the natural wash is small enough that the entire width of the floodplain is owned or controlled by a single entity or corporation, and there are no existing structures in the floodplain, it is possible that an exception to this rule might be granted by the City. Under these circumstances, the maximum rise in the water-surface elevation would be limited to one foot, as per Federal Emergency Management Agency guidelines. However, as with all floodplain encroachments, the development must be adequately protected from flooding and erosion, and must not violate restrictions imposed by area plans, basin-management plans, or Mayor and Council policies. At no time may an encroachment adversely affect the river's stability or adversely alter flooding conditions on other properties. Although the limit of encroachment under these circumstances is more flexible, it is still subject to review and approval by the City Floodplain Engineer. When encroachment is proposed within the floodplain of a watercourse, the City Floodplain Engineer may, at his discretion, request that a detailed study be performed to determine if a reduction in overbank flood storage will significantly affect downstream flood peaks.

When fill material is placed in an encroachment area for the purpose of creating a building pad or pads, each pad must be adequately protected against erosion. In cases where these building pads will be placed outside the limits of an erosion-hazard area, as defined in Chapter VII of this Manual, erosion protection shall be designed using the hydraulic parameters associated with the overbank flow. If the building pads will be located inside an erosion-hazard area, erosion protection shall be designed to reduce the erosion-hazard area by using the hydraulic parameters associated with the main channel. See Section 8.5.5 and Chapter VI of this Manual for information on bank-protection toe-down design.

In some cases, the City will require that the existing riparian vegetation be preserved or enhanced. Therefore, it may not be possible to alter a wash or to provide certain types of bank protection, because doing so would result in the loss of significant riparian vegetation. However if, as with most small washes, the riparian vegetation exists only along the banks of the wash, it may be possible to construct erosion protection of some type outside of this vegetation zone. The width of this zone shall be determined on a case-by-case basis, as reviewed and approved by the City Engineer.

Individual building sites may encroach into a floodplain under circumstances where the sites would be completely surrounded by floodwaters during a regulatory flood provided that (1) the general requirements of the floodplain ordinance are met; (2) the fill slopes for any building pad or pads are protected from erosion; and (3) all-weather access is provided to all building sites.

Erosion protection for the building pads shall be designed using the post-development hydraulic conditions of the overbank floodwaters in the immediate vicinity of the building site. No building shall be built within the erosion-hazard setback limit associated with the main channel, unless adequate bank protection (running the entire length of the development) is first installed to prevent lateral migration of the main channel in the direction of the development. Fill material used to elevate individual building sites must extend at least twenty-five feet away from the building in all directions, unless a study or analysis prepared by an Arizona Registered Professional Civil Engineer demonstrates that a lesser distance is acceptable or that the fill is protected from erosion. In addition, the elevation of the building pad must not be lower than the 100-year water-surface elevation. In all cases, the pad or structure must not worsen flooding on other property.

All-weather access in wide floodplains must be along an obvious, commonly used route that can be easily found by drivers of emergency vehicles who may be unfamiliar with the area. Thus, all-weather-access criteria shall apply to the entire all-weather-access route.

8.5 Constructed Channels

In many cases, the proposed density of a development will require the use of constructed channels. When such a use is permitted, constructed channels can minimize floodplain widths, thereby maximizing the developable area. However, the increased flow velocities generally associated with constructed channels often mandate that constructed channels be stabilized in order to prevent bed and/or bank erosion. Channelization and lining allows the channel alignment to be modified, to a certain degree, in order to accommodate urban development. Therefore, in most cases in the past, engineers and planners have found it easier, and more economical, to restructure a given parcel using constructed channels than to plan the development around natural channels. However, this policy of channelization has resulted in a significant reduction of riparian vegetation and habitat, as well as other adverse effects such as increased downstream flood peaks and channel erosion.

The following discussion provides the basic design criteria for the design of constructed channels. More specific and detailed information can be obtained in the published material cited in the "References and Selected Bibliographies" section found at the end of this Manual.

8.5.1 Channel Geometry

Open drainage channels shall be designed using either trapezoidal, rectangular, or compound cross sections, unless the prior approval of an alternate design is granted, in writing, by the City of Tucson Floodplain Engineer.

8.5.1.1 Side-Slopes

Side-slopes for constructed earthen or riprap channels shall be no steeper than 3:1, unless an approved soils analysis demonstrates that steeper side-slopes are stable. Side-slopes for lined channels may be steeper, depending upon the structural stability of the lining. Reinforced concrete lining may have vertical side-slopes, provided that the design is adequate to prevent failure from hydrostatic or earth pressures. Shotcrete may be placed on side-slopes as steep as 1:1, if these side-slopes are not significantly steeper than the natural angle of repose of the soil. A soil-cement lining may be placed on 1:1 side-slopes, provided it is of sufficient thickness to be structurally stable. The minimum thickness of soil cement on a 1:1 side-slope should be four feet, measured normal to its face. Where soil cement is used as slope paving, with a thickness no greater than one foot, the maximum allowable side-slope should be 4:1. Actually, for ease of construction, even flatter side-slopes (e.g., 6:1) are desirable under such circumstances.

8.5.1.2 Width

Ordinarily, the minimum bottom width of a channel must be ten feet before it will be accepted for maintenance by the City of Tucson. Occasionally, bottom widths as narrow as eight feet may be allowable in certain cases, with prior approval from the City of Tucson Floodplain Engineer. Privately maintained channels have no mandatory, minimum bottom width, except as dictated by hydraulic and/or sediment-transport considerations, as described in subsequent sections of this chapter.

The bottom width of constructed channels which lack bed and/or bank protection should not vary by more than fifteen percent between control points, such as at culverts, junctions, changes in slope, or abrupt contractions or expansions, except at the confluence of a major tributary. The purpose of this constraint is to prevent severe aggradation, degradation, or bank erosion from occurring due to sudden changes in sediment-transport rates. In addition, when channelizing a natural wash, the bottom width should be constructed so that the discharge per unit width within the engineered channel is approximately equal to the discharge per unit width of the natural channel of the wash. Typical ways to mitigate this latter constraint are (1) to line both the bottom and sides of the engineered channel, or (2) to line just the channel sides and install grade-control structures.

The bottom widths of constructed channels which have earthen bottoms should be designed to prevent the formation of an incised, meandering, low-flow channel. Theoretically, a relatively wide channel, designed to convey the 100-year discharge, would convey the more-frequent, low-flow discharges at very shallow depths, were there an equal flow distribution across the entire flow cross section. However, by the laws of nature, such an occurrence is not the case within an alluvial channel. Under such circumstances, the channel will develop a narrow, incised, low-flow channel for more efficient conveyance of these flows. This low-flow channel will often meander within the main channel, and is capable of eroding earthen banks and/or undermining bank protection along engineered channels. In order to avoid this occurrence, the channel either should be stabilized, in order to prevent the formation of an incised low-flow channel, or should be designed so that the following equation is satisfied:

$$\frac{b}{V_{p100}Y_{p100}} \leq 1.15 \qquad (8.1)$$

Where:

b = Channel bottom width, in feet;
V_{p100} = Average velocity of flow at the peak of a 100-year flood, in feet per second; and,
Y_{p100} = Maximum depth of flow at the peak of a 100-year flood, in feet.

8.5.1.3 Depth

The depth of flow in channels, where relatively steady, uniform-flow conditions exist, can be computed by an iterative solution of Manning's equation:

$$Q = \frac{1.486}{n} R^{2/3} S_f^{1/2} A \qquad (8.2)$$

Where:

Q = Discharge, in cubic feet per second;
n = Manning's roughness coefficient (see Table 8.1);
R = Hydraulic radius of flow (= A/P), in feet;
A = Cross-sectional area of flow, in square feet;
P = Wetted perimeter of flow, in feet; and,
S_f = Friction slope, in feet per foot.

The depth of flow in Equation 8.2 is implicit within the terms A and R. To solve for the depth of flow, given a known discharge, the normal procedure is to make an estimate of the depth of flow; compute A, P, and R from the channel cross-section characteristics; then solve for Q using Manning's equation. If the computed discharge is not equal to the known discharge, the depth of flow is adjusted accordingly, and the process is repeated until the computed and known discharges are sufficiently close.

Under steady, uniform-flow conditions, the friction slope is assumed equal to the channel slope. Therefore, channel slope can be used for the friction slope, when channels are designed utilizing Manning's Equation.

Uniform flow does *not* exist under most design conditions, due to disturbances caused by changes in the channel width, discharge, or slope. In addition, the presence of channel bends, transitions, junctions, or obstructions such as culverts can create conditions which lead to non-uniform flow. The effect of such disturbances can propagate far upstream, or downstream, depending upon whether or not the flow is subcritical or supercritical. Whenever there is any reason to suspect that uniform-flow conditions do not exist, the depth of flow shall be determined from backwater computations.

TABLE 8.1: MANNING'S ROUGHNESS COEFFICIENTS*

CHANNEL MATERIAL	ROUGHNESS COEFFICIENT (n)		
	Minimum	Normal	Maximum
Corrugated metal	0.021	0.025	0.030
Concrete			
1) Trowel finish	0.011	0.013	0.015
2) Float finish	0.013	0.015	0.016
3) Unfinished	0.014	0.017	0.020
4) Shotcrete, good section	0.016	0.019	0.023
5) Shotcrete, wavy section	0.018	0.022	0.025
Asphalt (use maximum value when cars are present)	0.013	0.016	0.020
Soil Cement	0.018	0.020	0.025
Riprap (bottom and sides)	--	** $n = 0.04 D_{50}^{0.167}$	--
Constructed channels with earth or sand bottom, sides of			
1) Clean earth; straight	0.018	0.022	0.025
2) Earth with grass and weeds	0.020	0.025	0.030
3) Earth with trees and shrubs	0.024	0.032	0.040
4) Shotcrete	0.018	0.022	0.025
5) Soil cement	0.022	0.025	0.028
6) Concrete	0.017	0.020	0.024
7) Dry rubble or riprap	0.023	0.033	0.036
Natural channels with sand bottom, sides of			
1) Trees and shrubs	0.025	0.035	0.045
2) Rock	0.024	0.032	0.040
Natural channel with rock bottom	0.040	0.060	0.090
Overbank Floodplains			
1) Desert brush, normal density	0.040	0.060	0.080
2) Dense vegetation	0.070	0.100	0.160

*Adapted from Chow (1959) and Aldridge and Garrett (1973).
**D_{50} in feet.

Backwater computations proceed upstream for subcritical flow and downstream for supercritical flow. A control section must be established for computations to begin. A control section is a section at a place of known water-surface elevation. Control sections can be at such places as channel confluences, culvert inlets, or at where the flow goes through critical depth. Critical depth occurs when the Froude number (F) is equal to one.

The Froude number is calculated from:

$$F = \frac{V}{(gY_h)^{1/2}} \qquad (8.3)$$

Where:

V = Average velocity of flow, in feet per second;
Y_h = Hydraulic depth of flow (area/top width), in feet; and,
g = Acceleration due to gravity = 32.2 ft/sec^2.

Equation 8.3 should be used with care whenever there is overbank flooding or variations across the cross section which cause the flow velocity to vary within the cross section. In such cases, critical depth should be estimated by the graphical method described in Section 4-4 of Chow (1959).

The hydraulic flow depth, Y_h, used in the Froude-number calculation represents the actual flow depth for a rectangular section, but represents the cross-sectional area of flow divided by the top width of flow for either trapezoidal sections or natural channel sections.

Critical depth can occur at locations where a subcritical channel slope changes to a supercritical slope, and at locations where there is an abrupt drop in the elevation of the channel bed, when subcritical flow exists upstream. Backwater calculations should proceed both upstream and downstream from critical depth at locations where a subcritical slope changes to a supercritical slope.

Backwater calculations in trapezoidal channels of uniform cross section are generally performed by the Direct Step Method. This method is easily adaptable to the computer or hand-held calculator. For those who are interested in doing these calculations manually, a very good discussion and description of the Direct Step Method can be found on page 262 of Chow (1959).

8.5.1.4 Freeboard

Freeboard is the additional depth required in a channel beyond the depth which is calculated for conveyance of the design discharge. The purpose of freeboard is to protect against hydraulic disturbances such as waves, unforseen obstructions of flow, debris, or sediment accumulation. In addition, freeboard provides a margin of safety against (1) the uncertainties which exist in the methods used to predict design discharges; and (2) floods that are larger than the design flood. The amount of

freeboard required depends upon whether the flow is supercritical or subcritical, the flow velocity, the design discharge, the consequences of overtopping, and the magnitude of flow disturbances at locations such as junctions and culverts.

The freeboard requirement for channels shall be computed from Equation 8.4, with a minimum freeboard of one foot for channels with design depths of three feet or more.

$$FB = 1/6 \left(Y_{max} + \frac{V^2}{2g} \right) \quad \textbf{(8.4)}$$

Where:

FB = Freeboard, in feet;
Y_{max} = Maximum depth of flow, in feet;
V = Average velocity of flow, in feet per second; and,
g = Acceleration due to gravity = 32.2 ft/sec^2.

The freeboard requirements described above are for uniform channel reaches where no unusual flow disturbances are anticipated. Additional freeboard is required at channel bends and junctions, where backwater effects may occur; and at locations where hydraulic jumps may occur. The additional freeboard required at channel bends and junctions is described in Sections 8.5.10 and 8.5.12 of this Manual. At those locations where a hydraulic jump could form, additional freeboard shall be provided to contain the jump according to the guidelines provided within Section 8.5.9 of this Manual.

Freeboard in regional watercourses, such as the Santa Cruz River, Rillito Creek, Tanque Verde Creek, Pantano Wash, and the Cañada del Oro Wash, shall be determined on a case-by-case basis, following a detailed river-mechanics study.

The lining of protected channels shall extend to an elevation necessary to include the freeboard requirement, unless approval to the contrary is granted, in writing, by the City of Tucson Floodplain Engineer.

8.5.2 Safety Considerations

Deep channels with steep side-slopes and high flow velocities can be a hazard to the health, safety, and welfare of the general public. Therefore, the design engineer must always consider the safety aspects of any design. The design of hazardous channels should be avoided, if possible. All channels greater than five feet deep which have side-slopes steeper than 2:1 shall have emergency escape ladders consisting of a series of iron rungs every 600 feet. Other site-specific safety measures shall be installed as deemed necessary by either the design engineer or the City Engineer.

8.5.3 Right-of-Way

All channels that are to be maintained by the City of Tucson must be dedicated to the City. Dedication may be either in fee title or in the form of an easement. The

width of the dedication shall be the width of the channel, including key-ins, plus the width of a maintenance access lane or lanes. The minimum maintenance access width for regional watercourses is thirty feet on each side of the channel. More right-of-way may be required, if a linear park is planned along the watercourse. For major watercourses greater than 2000 cfs, the required width for maintenance access is sixteen feet on each side of the channel. However, one of these access lanes may be omitted, at the discretion of the City Engineer, provided that the channel bottom equals or exceeds twenty feet in width, and is drivable utilizing maintenance vehicles. Maintenance access lanes on minor watercourses are variable, and will be established on a case-by-case basis. Generally, a 16-foot maintenance access lane on one side will be required, as a minimum. In all cases, the right-of-way must be sufficient to allow maintenance vehicles to operate freely.

In areas where basin-management plans have recommended particular channel alignments, or an alignment for a watercourse has been established by a regulatory agency, dedication shall be in accordance with same. The width of dedication in these areas shall be as recommended in the basin-management plan, or as established by the agency, unless a more recent study shows that an alternative alignment and/or width is adequate. Studies of this type must clearly demonstrate that there are no conflicts or adverse effects with existing upstream and/or downstream improvements.

8.5.4 Bank-Protection Key-Ins and Minor Side Drainage

Bank-protection key-ins refer to the additional material provided beneath the surface of the ground at the top of the bank protection. Key-ins are normally provided for concrete and shotcrete bank protection; for thin, soil-cement bank protection; and for riprap bank protection. Their purpose is (1) to prevent fractures along the upper edge of the bank protection; (2) to provide added structural stability for the bank protection; and (3) to help prevent minor side inflow from undermining and damaging the bank protection from the top. Typical key-ins are shown in Figure 8.1. The minimum key-in depth on major channels (excluding regional watercourses) shall be eighteen inches. On minor watercourses, the key-in depth shall also be eighteen inches, unless a lesser key-in is justifiable. Key-ins for soil-cement bank protection along regional watercourses are generally not required because of the thickness of the bank protection. However, if key-ins are required, the design shall be determined by a site-specific engineering analysis acceptable to the City Engineer.

When minor tributary or surface flows enter an unlined channel over its side, rill erosion can create headcuts that will travel away from the channel in the opposite direction of the tributary inflow. If the channel is lined, the side drainage can erode the soil from behind the bank protection and create hydrostatic pressures and seepage problems that can cause failure of the bank protection. Therefore, side drainage must be confined to selected entry points that are adequately protected, or the key-in associated with the lining must be deep enough to prevent, or lessen, the buildup of hydrostatic pressure and seepage behind the bank protection. Under such circumstances, and in the absence of a detailed soils analysis and a knowledge of subsurface flow patterns, the key-in shall extend to a depth that equals the depth of the channel along the tributary inflow area.

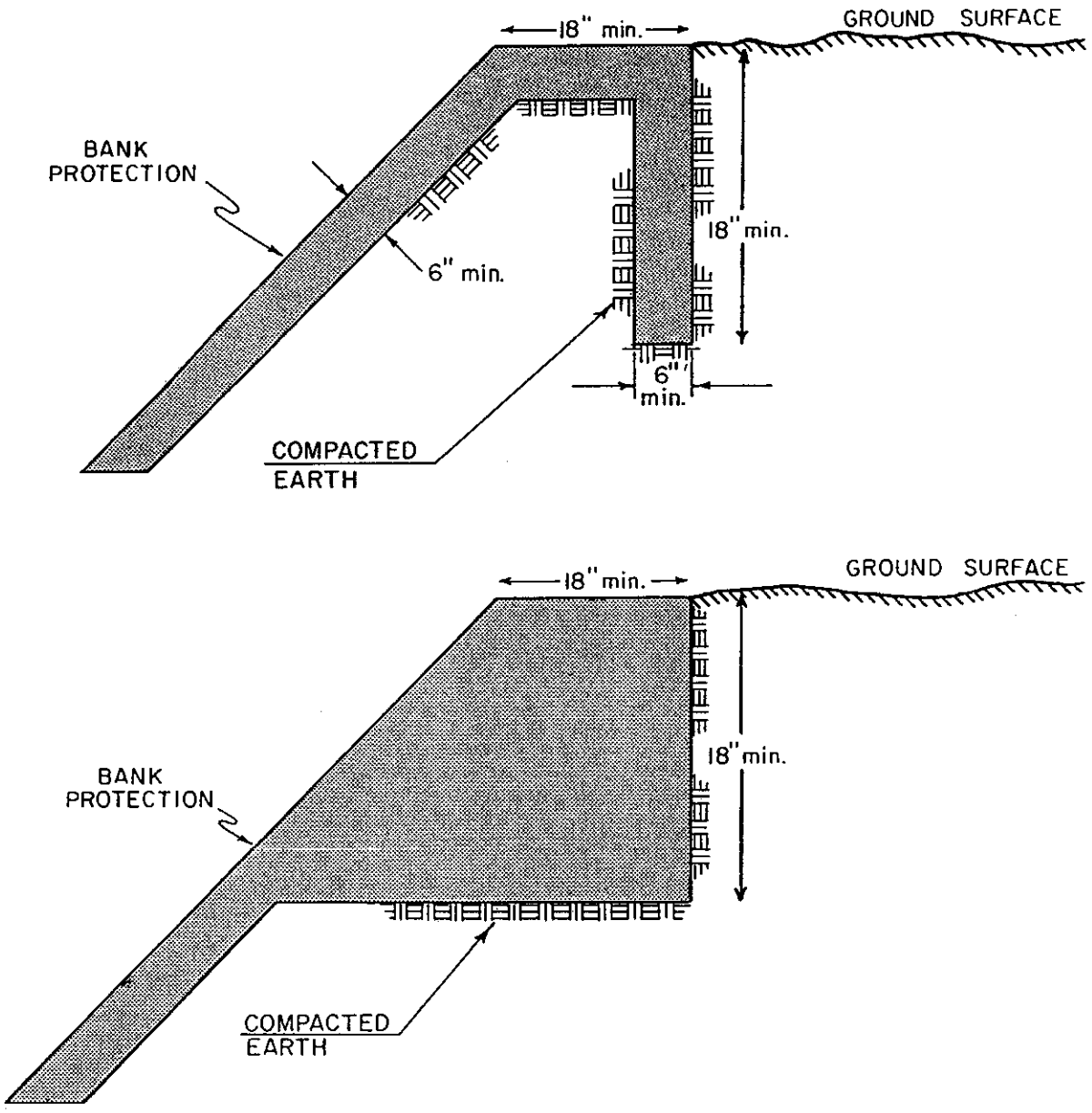


FIGURE 8.1
TYPICAL BANK-PROTECTION KEY-INs
(NOT TO SCALE)

8.5.5 Bank-Protection Toe-Downs

Bank-protection toe-downs refer to the extension of bank protection below the channel bed. Although shallow (i.e., ≤ 6.0 feet) toe-downs are normally vertical, they sometimes are extended below the channel bottom along the same side-slope as the bank itself. The purpose of a toe-down is to prevent failure of the bank protection due to scour or long-term degradation of the channel bed.

Bank-protection toe-downs shall extend to the combined depth associated with general scour, bend scour, local scour, low-flow incisement, sand-wave troughs, and long-term degradation predicted to occur within the channel. The procedures used in calculating these depths are presented in Chapter VI of this Manual. Below grade-control structures, the toe-down shall conform to the geometry of the scour hole, as determined by the methodology also presented in Chapter VI of this Manual.

The soil beneath the channel bed may contain erosion-resistant material, such as caliche. The scour depth calculated using the methodologies outlined in Chapter VI of this Manual may then become unrealistic. A geotechnical report which demonstrates that the bed is composed of erosion-resistant material may be submitted by a soils engineer to justify a reduction in the toe-down depth. However, the toe-down depth along major washes shall never be less than four feet, nor shall toe-downs along minor washes be less than one-half the depth of flow, unless bedrock is encountered.

8.5.6 Low-Flow and Compound Channels

8.5.6.1 Low-Flow Channels

Frequently, the design of a drainage channel that conveys the 100-year discharge leads to a situation in which the bottom of the channel cross section is too wide to efficiently convey the low-flow discharges. As a consequence, these more frequent discharges will create an incised low-flow channel that may meander back and forth across the bed of the channel, instead of allowing flow to spread uniformly across the entire channel width. This meandering process can cause frequent and unnecessary scouring at the toe of the primary banks; and, if left unchecked, can ultimately threaten both the horizontal and vertical stability of the channel. This meander action might even have the capability to destabilize totally lined channels by attacking the lining at the joint between the toe of the bank and the channel bottom. To avoid this meandering process, it is recommended that consideration be given to constructing a small low-flow channel within any larger channel in order to restrict the low flows to a designated area within the primary channel. This low-flow channel should be designed, where practicable, in a manner such that the unit discharge associated with the 2-year event is the same as that which exists under natural conditions. However, practical considerations may require that the low-flow channel, if installed, be somewhat smaller.

8.5.6.2 Compound Channels

A variation upon the concept of a constructed low-flow channel is the compound channel. A compound channel contains a significant portion of the design discharge in a stabilized lower channel. A terrace on each side of the stabilization contains the

remainder of the design discharge at a level above the low-flow channel. This terrace may or may not be stabilized. Compound channels are normally constructed in order to satisfy a multi-use concept (e.g., flood-control channels combined with linear parks). The Appendix to this Manual contains more information on the construction of compound channels.

When a compound channel is to be constructed within the corporate limits of the City of Tucson, the normal design discharge to be used in the low-flow portion of such a channel should be the 2-year to 10-year discharge. Because of the potential for erosion of a compound channel terrace during a large discharge event, bank protection which consists of a thin shell, or "veneer," over the supporting embankment is not recommended for these channels. However, observations made during major flood events in the Tucson area indicate that 9-foot-thick soil cement will remain in place following extensive removal of the bank material behind it. Therefore, this "massive" type of bank protection is recommended for the banks of a low-flow channel constructed within a compound channel, unless technical evidence can be provided to the City Engineer which clearly demonstrates that an alternate approach will function effectively within such a channel during a large discharge event. Because hydraulic roughness varies over the cross section of a compound channel, the hydraulic roughness must be "weighted" to develop a composite roughness coefficient for determining the correct depth/discharge relationship. Equation 6-18 in *Open-Channel Hydraulics* (Chow, 1959) is recommended for use in "weighting" roughness coefficients for compound channels.

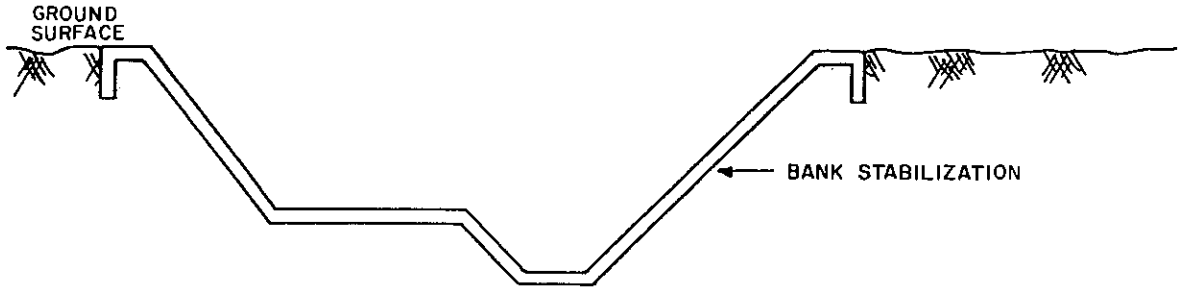
Since compound channels are normally maintenance intensive, they may not be accepted for maintenance by the City of Tucson. The City Engineer will evaluate the acceptability of these channels on a case-by-case basis. The City Engineer may also increase building setbacks from compound channels over those normally associated with completely lined channels, should the erosion potential of the affected watercourse warrant an increased setback. Figure 8.2 illustrates typical cross sections for low-flow and compound channels.

8.5.7 Upstream and Downstream Controls

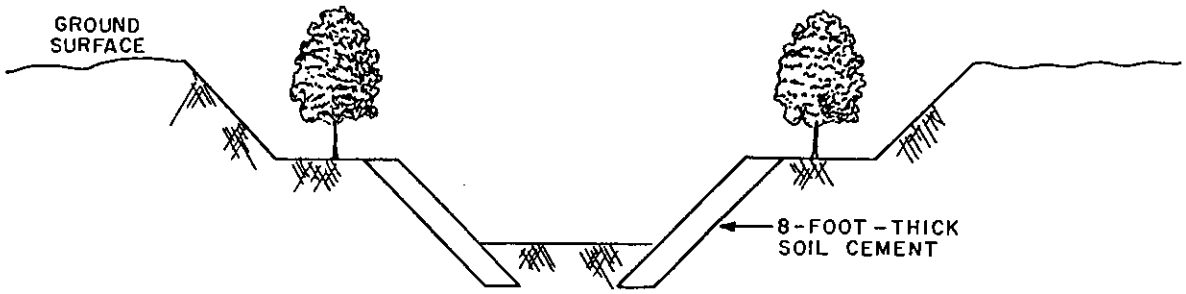
The upstream end of constructed channels must be designed to collect the entire design discharge without raising water-surface elevations on adjacent properties. This may be accomplished by providing wide entrance transitions, or collector channels, at the upstream end. See Section 8.5.11.1 of this Manual for information on entrance transitions.

The downstream end must also be designed to minimize adverse impacts upon adjacent properties. Adverse impacts could result from increased discharge, velocity, or concentration of flow. Mitigation measures to reduce or eliminate these impacts can be achieved by (1) providing expansions at the downstream end of the channels; (2) providing energy-dissipation structures; or (3) building box culverts at street crossings. See Section 8.5.11.2 of this Manual for information on exit transitions.

Drainage must be collected and delivered in the same manner and to the same concentration points that existed prior to channelization, unless a drainage master plan for the area dictates otherwise; or unless an agreement acceptable to the City Engineer



CHANNEL WITH LOW-FLOW CHANNEL (NTS)



COMPOUND CHANNEL (NTS)

FIGURE 8.2
TYPICAL LOW-FLOW AND COMPOUND CHANNELS

is obtained from all affected property owners. If a drainage master plan is available, dedication of all necessary rights-of-way shall be required, as specified within the master plan.

8.5.8 Channel Slope

The slope for a proposed channel is, to a great extent, dependent on the natural topography. However, variations can be achieved by altering the channel alignment within a development, and by adjusting the elevation of inflow and outflow points.

In general, channels with unlined bottoms should not be designed with a slope less than 0.3% in order to prevent vegetation and bed irregularities from creating stagnant pools of water after flows subside. Channels with a concrete bottom may be flatter. Where the natural fall of the land is less than 0.5%, the channel alignment producing the steepest possible slope should be chosen to avoid sediment buildup.

Abrupt changes in slope should be avoided, except where necessary to achieve a specific purpose (e.g., such as to induce a hydraulic jump). For example, if an abrupt change in slope might result in the formation of a hydraulic jump that is not desired, an analysis should be performed to determine whether a jump will occur, and where it will be located. When abrupt slope changes are unavoidable, the slope changes should not cause the channel top width to vary by more than fifteen percent.

Whenever possible, channels should be designed to convey the incoming sediment supply without causing aggradation or degradation. Refer to Chapter VI of this Manual, which addresses erosion and sedimentation, for more detailed information.

Channels with design Froude numbers between 0.86 and 1.16 should be avoided, if at all possible, because of the instability associated with critical flow.

Most channels with earthen beds are constructed on slopes that are steeper than their equilibrium slopes. In such cases, grade-control structures are required. Refer to Chapter VI for grade-control design guidelines.

8.5.9 Hydraulic Jump

A hydraulic jump occurs when flow changes rapidly from low-stage supercritical flow to high-stage subcritical flow. Hydraulic jumps can occur (1) when the slope of the channel abruptly changes from steep to mild; (2) at sudden expansions or contractions in the channel section; (3) at locations where a barrier, such as a culvert or bridge, occurs in a channel of steep slope; (4) at the downstream side of dip crossings or culverts; (5) where channels of steep slope discharge into other channels; and (6) at sharp bends.

Hydraulic jumps are useful in dissipating energy, and consequently they are often purposely forced to occur at drainageway outlet structures in order to minimize the erosive potential of floodwaters. However, because of the large amount of energy dissipated in hydraulic jumps, it is not advisable to allow them to occur except under controlled circumstances. Therefore, if during the design of a channel, it appears that a hydraulic jump might occur at an undesirable location, computations should be made

to determine the height, length, and characteristics of the jump. In addition, steps should be taken to either eliminate the jump or contain it, in order to prevent damage to the channel or surrounding property.

The type of hydraulic jump that forms, and the amount of energy it dissipates, is dependent upon the upstream Froude number, F_1.

The various types of hydraulic jumps that can occur are listed in Table 8.2.

TABLE 8.2: TYPES OF HYDRAULIC JUMPS

UPSTREAM FROUDE NUMBER	TYPE OF JUMP	ENERGY LOSS (%)
$1 < F_1 \leq 1.7$	Undular Jump	0-5
$1.7 < F_1 \leq 2.5$	Weak Jump	5-18
$2.5 < F_1 \leq 4.5$	Oscillating Jump	18-44
$4.5 < F_1 \leq 9$	Steady Jump	44-70
$F_1 > 9$	Strong Jump	70-85

8.5.9.1 Height of a Hydraulic Jump

The depth of flow immediately downstream of a hydraulic jump is referred to as the sequent depth. The sequent depth in rectangular channels can be computed by use of the following equation:

$$Y_2 = 1/2\ Y_1\ ([1 + 8F_1^2]^{1/2} - 1) \qquad \textbf{(8.5)}$$

Where:

Y_1 = Initial (upstream) flow depth, in feet;
Y_2 = Sequent (downstream) flow depth, in feet; and,
F_1 = Froude number upstream of the jump = $V_1/(gY_1)^{0.5}$, where V_1 = initial (upstream) flow velocity, in feet per second.

The solution for sequent depth in trapezoidal channels can be obtained from a trial-and-error solution of Equation 8.6. Equation 8.6 is derived from momentum equations (see Morris and Wiggert, 1972). It is also acceptable, for design purposes, to determine the sequent depth in trapezoidal channels from Equation 8.5. Equation 8.5 is much simpler to solve, and produces only slightly greater values for sequent depth for trapezoidal channels than does Equation 8.6.

$$\frac{ZY_1^3}{3} + \frac{bY_1^2}{2} + \frac{Q^2}{gA_1} = \frac{ZY_2^3}{3} + \frac{bY_2^2}{2} + \frac{Q^2}{gA_2} \qquad (8.6)$$

Where:

Y_1 & Y_2 are as defined in Equation 8.5; and,
b = Channel bottom width, in feet;
Z = Channel side-slope (horizontal/vertical), in feet per foot;
Q = Channel discharge, in cubic feet per second; and,
A_1 & A_2 = Cross-sectional areas of flow upstream and downstream, respectively, of the hydraulic jump, in square feet.

Figures 8.3 and 8.4 can also be used to determine the height of a hydraulic jump.

8.5.9.2 Length of a Hydraulic Jump

The length of a hydraulic jump, L, is defined as the distance from the front face of the jump to a point immediately downstream of the roller. Jump length can be determined from Figures 8.5 and 8.6.

8.5.9.3 Surface Profile of a Hydraulic Jump

The surface profile of a hydraulic jump may be needed to design the profile of extra bank protection, or training walls, required to contain the jump. The surface profile can be determined from Figure 8.7.

8.5.9.4 Location of a Hydraulic Jump

In most cases, a hydraulic jump will occur at the location in a channel where the initial and sequent depths and upstream Froude number satisfy Equation 8.5. This location can be found by performing direct-step calculations in either direction toward the suspected jump location, until the terms of the equation are satisfied. Refer to Section 15.7 of Chow (1959) for detailed information and an example on locating hydraulic jumps.

8.5.9.5 Undular Hydraulic Jumps

An undular hydraulic jump is the type of jump which occurs where the upstream Froude number is between 1.0 and 1.7. This type of jump is characterized by a series of undular waves which form on the downstream side of the jump. Experiments have shown that the first wave of an undular jump is higher than the height given by Equation 8.5. Therefore, the height of this wave should be determined as follows:

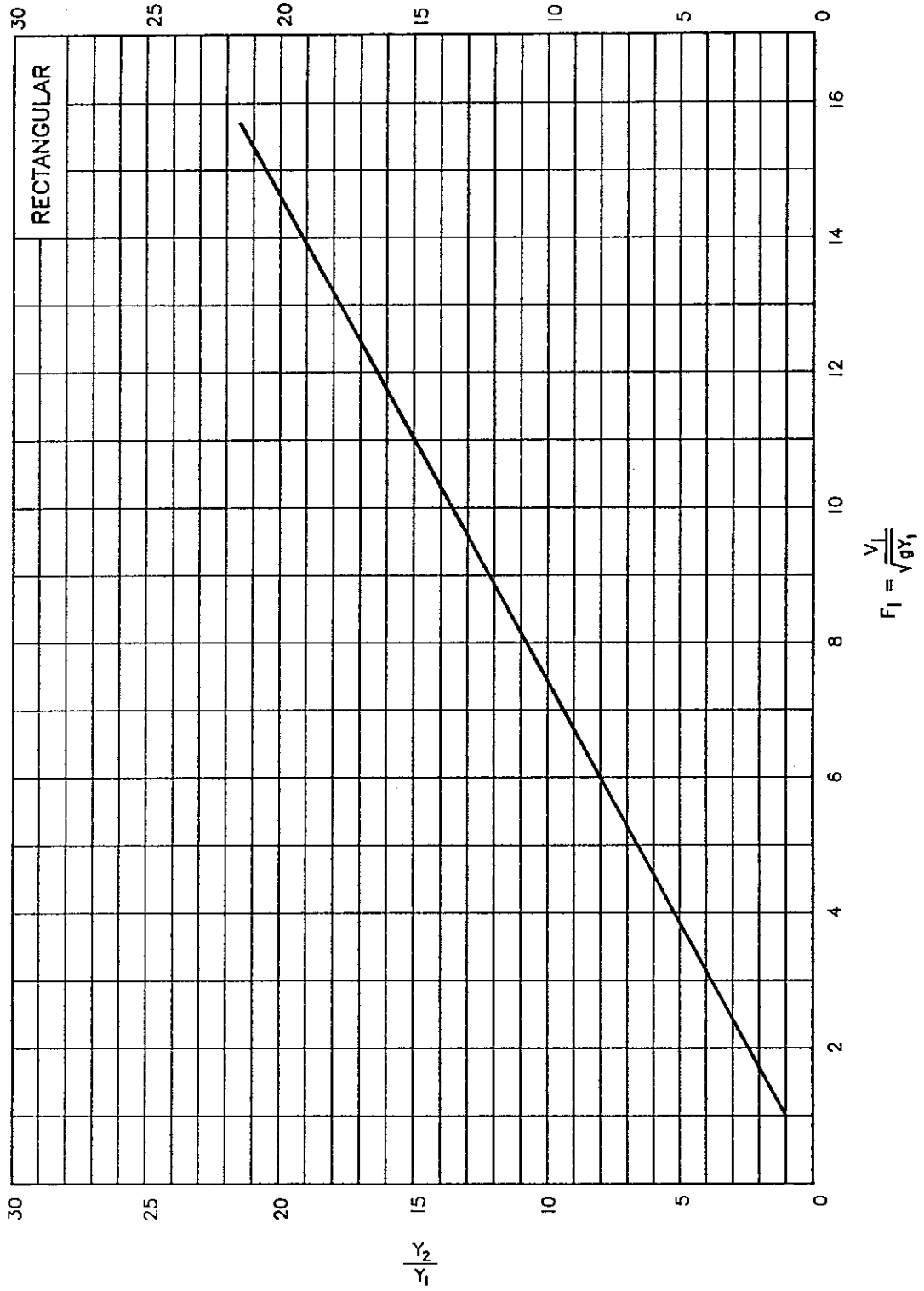


FIGURE 8.3
HEIGHT OF A HYDRAULIC JUMP FOR A HORIZONTAL, RECTANGULAR CHANNEL

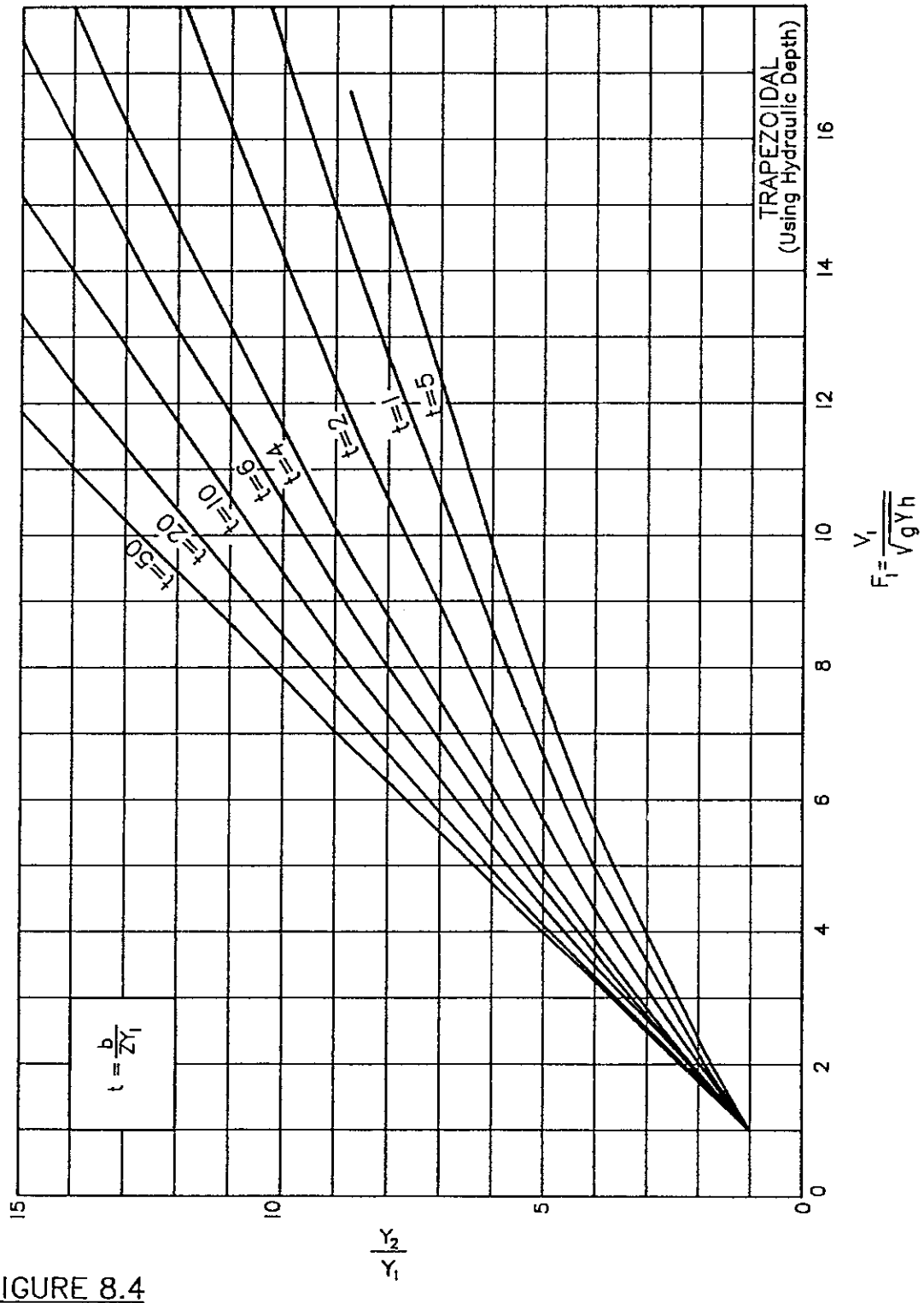


FIGURE 8.4
HEIGHT OF A HYDRAULIC JUMP FOR A HORIZONTAL, TRAPEZOIDAL CHANNEL (USING HYDRAULIC DEPTH)

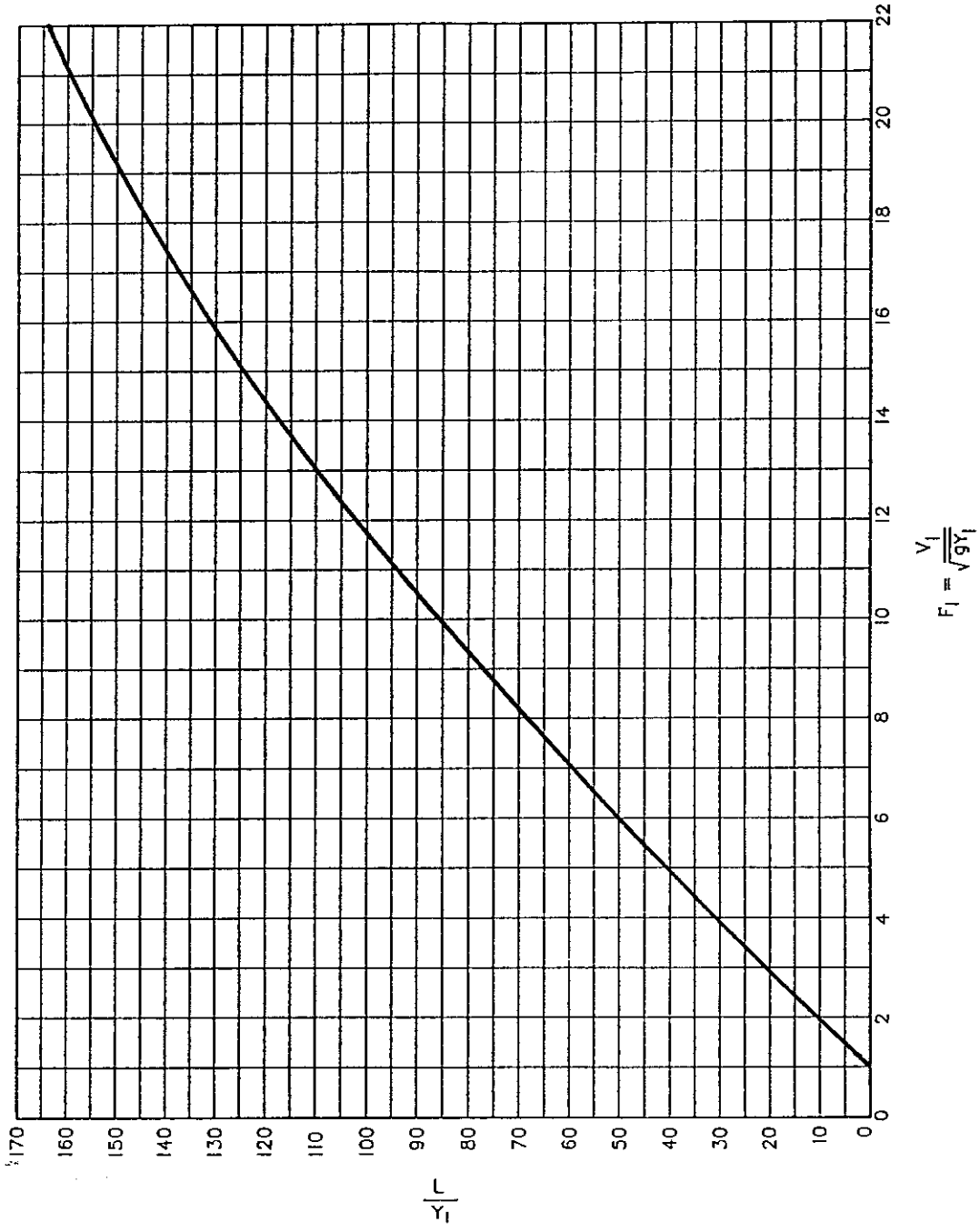


FIGURE 8.5
LENGTH OF A HYDRAULIC JUMP FOR A RECTANGULAR CHANNEL

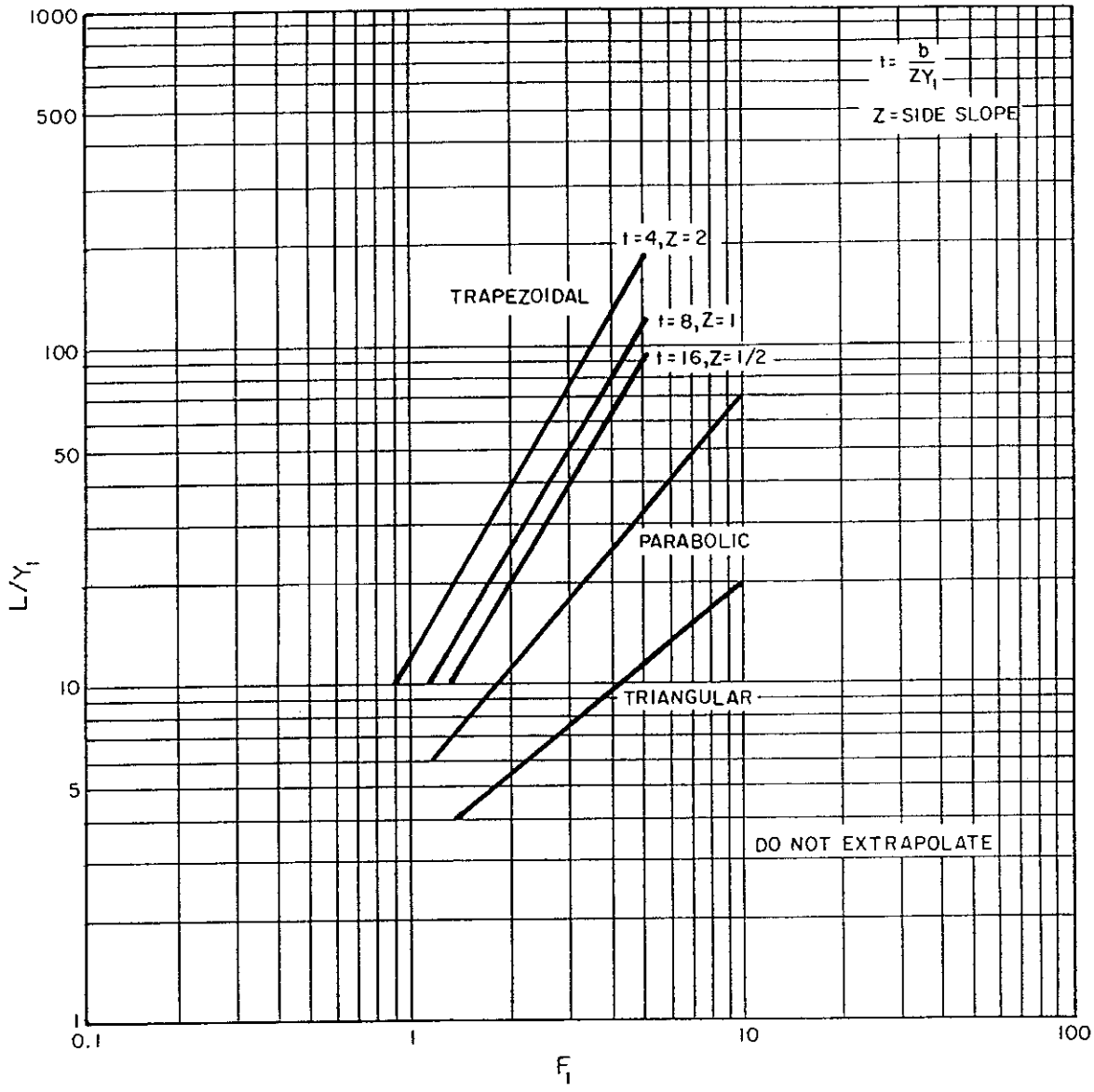


FIGURE 8.6
LENGTH OF A HYDRAULIC JUMP FOR NONRECTANGULAR CHANNELS

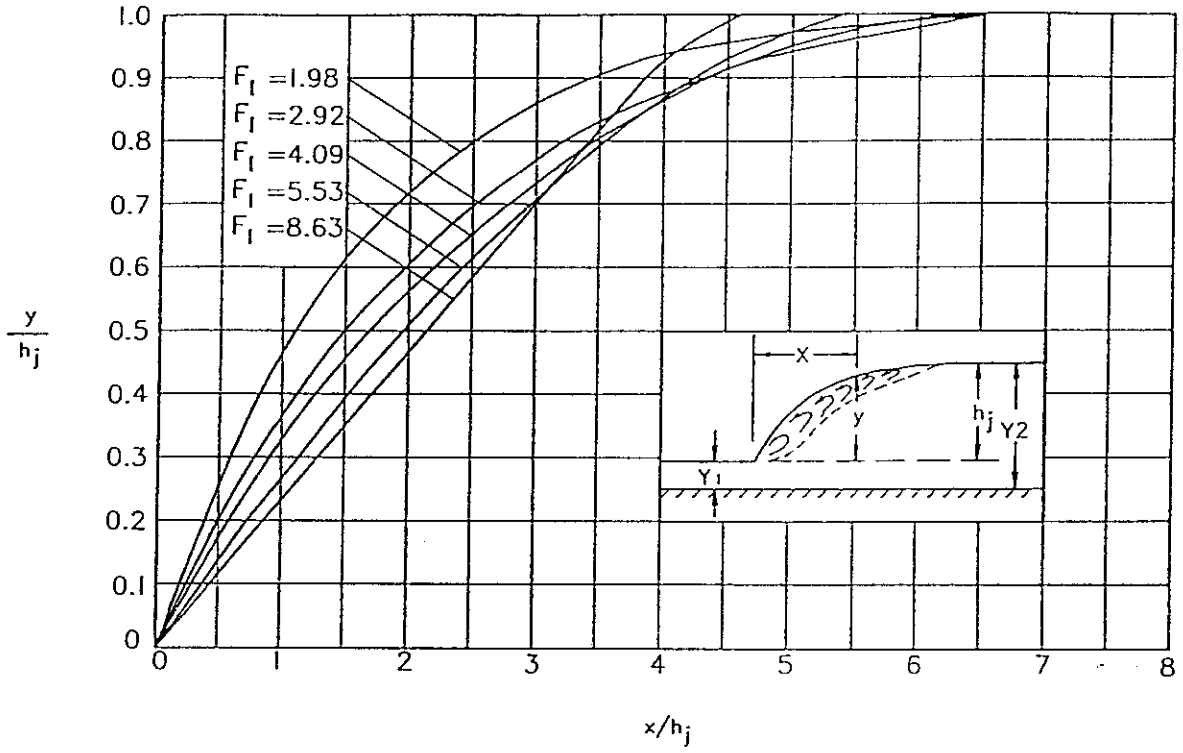


FIGURE 8.7
SURFACE PROFILE OF A HYDRAULIC JUMP

$$\frac{Y_2-Y_1}{Y_1} = F_1^2 - 1 \qquad \textbf{(8.7)}$$

Where all terms are as previously described.

See U.S. Army Corps of Engineers (1970) for the source of this equation.

8.5.10 Flow in a Curved Channel

Flow in a curved channel will create centrifugal forces which will cause a rise in the water surface along the outside of a bend. At the same time, a corresponding depression will be created in the water surface along the inside of the bend. In addition, spiral secondary currents tend to form within the bends. These currents can cause scour to occur along the outside of a bend, and deposition along the inside of a bend. Cross waves that propagate downstream will also form, if the flow around the bend is supercritical.

Although curves are inevitable in the design of most open channels, they should be minimized in order to avoid the special problems associated with their design. The design of channel bends must include consideration for superelevation, limiting curvature, bend scour, and special design curves.

8.5.10.1 Superelevation

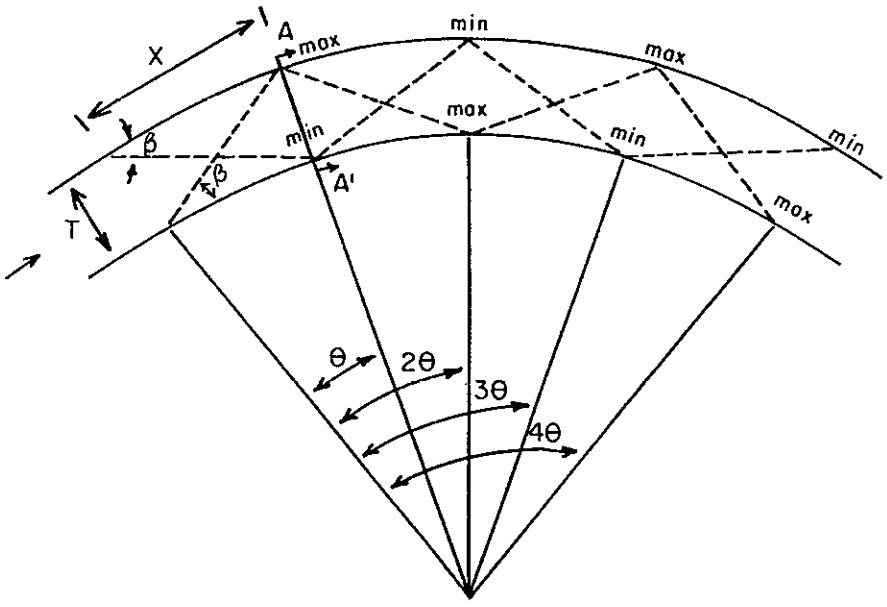
Superelevation is the rise in the water-surface elevation around the outside of a channel bend, with an accompanying lowering of the water surface along the inside of the bend. This outside rise in the water surface is generally measured with respect to the mean depth of flow in an equivalent straight reach. Additional freeboard is required along the outside of a channel bend to account for this rise (see Figure 8.8). Superelevation is computed as follows:

$$\Delta Y = \frac{1.5CV^2T}{gr_c} \qquad \textbf{(8.8)}$$

Where:

ΔY	=	Rise in water-surface elevation (superelevation) around the outside of a channel bend, in feet;
C	=	A coefficient (see Table 8.3);
V	=	Average velocity of flow, in feet per second;
T	=	Channel width at elevation of water surface, in feet;
g	=	Acceleration due to gravity (= 32.2 ft/sec^2);
r_c	=	Radius of curvature of channel centerline, in feet; and,
1.5	=	Factor of safety to account for alluvial channel conditions.

See U.S. Army Corps of Engineers (1970) for the source of this equation.



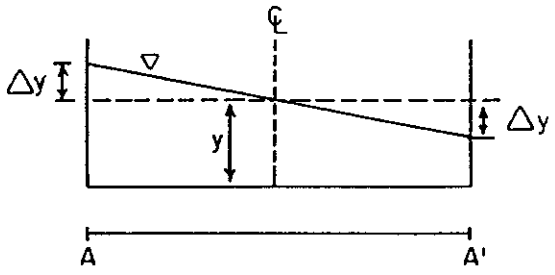


FIGURE 8.8

CROSS-WAVE PATTERN FOR SUPERCRITICAL FLOW IN A CURVED CHANNEL

The coefficient C in Equation 8.8 takes into account the rise due to cross waves and centrifugal forces.

TABLE 8.3: COEFFICIENTS FOR USE IN SUPER-ELEVATION FORMULA

FLOW TYPE	CROSS SECTION	TYPE OF CURVE	VALUE OF C
Tranquil	Rectangular	Simple Circular	0.5
Tranquil	Trapezoidal	Simple Circular	0.5
Rapid	Rectangular	Simple Circular	1.0
Rapid	Trapezoidal	Simple Circular	1.0
Rapid	Rectangular	Easement Transition	0.5
Rapid	Trapezoidal	Easement Transition	1.0

For subcritical flow, the upstream and downstream limits of additional freeboard shall correspond to the beginning and ending points of curvature according to the guidelines in U.S. Army Corps of Engineers (1970). The normal channel freeboard is expected to be adequate to contain any backwater effects of the superelevation upstream of the curve.

For supercritical flow, the disturbances caused by bends (cross waves) can propagate far downstream of the bend. Therefore, special treatment is required to eliminate or minimize these disturbances. Figure 8.8 shows a typical cross-wave pattern. The central angle of the cross-wave pattern, θ, is computed by use of the following equation:

$$\theta = \tan^{-1}\left(\frac{2b}{(2r_c+b)\tan\beta}\right) \qquad (8.9)$$

Where:

θ = Central angle of the cross-wave pattern, in degrees;
b = Channel bottom width, in feet;
r_c = Radius of curvature of channel centerline, in feet;
β = Wave front angle = $\text{Sin}^{-1}(1/F)$, in degrees; and,
F = Froude number.

See Rouse (1950) for the source of this equation.

Freeboard to account for superelevation in channels with supercritical flow shall begin at the upstream point of curvature, and continue at that level to a point downstream of the end of the curve a distance computed by Equation 8.10.

$$L' = \frac{3\,T}{\text{Tan}\,\beta} \qquad \textbf{(8.10)}$$

Where:

L' = Distance of *maximum* superelevation downstream of a curve in a channel with supercritical flow, in feet.

All other terms are as defined previously.

Beyond this point, freeboard to account for superelevation shall taper downward to the normal bank-protection height over an *additional* distance equal to $0.67L'$.

8.5.10.2 Easement Curves

Easement curves can be used to reduce cross waves in bends with supercritical flow (see Table 8.3). Easement curves are placed at both ends of the curve proper, and may be either spiral or circular in order to produce the same hydraulic effect. Circular easement curves are recommended, and must have a radius equal to twice the radius of the main curve. The length of the easement curve, L_e, is computed by:

$$L_e = \frac{0.32\,TV}{Y^{1/2}} \qquad \textbf{(8.11)}$$

Where all terms are as previously described.

8.5.10.3 Banking

Banking is an alternative to providing additional freeboard in order to contain superelevated flows around a channel bend. Banking is a modification of the cross slope of the channel bed such that the inside of the bend is lower than the outside of

the bend. When banking a channel, the difference in elevation between the inside of a bend (lowest point) and the outside of a bend (highest point) should be equal to the quantity V^2T/gr_c, in feet, where all terms are as previously defined. Hydraulically, this method is preferable to providing additional freeboard, but banking is difficult to construct. Therefore, *banking should only be used in conjunction with the design of totally lined channels.*

8.5.10.4 Limiting Curvature

For flow with a design Froude number less than 0.86, the minimum radius of curvature along the center line of the channel shall be three times the channel top width. For flow with a Froude number greater than or equal to 0.86, the minimum radius of curvature shall be computed as follows:

$$r_c = \frac{4V^2T}{gY_h} \qquad \textbf{(8.12)}$$

Where:

r_c = Radius of curvature of channel centerline, in feet;
V = Average velocity of flow, in feet per second;
T = Channel top width at the water surface, in feet; and,
Y_h = Hydraulic depth of flow, in feet.

See U.S. Army Corps of Engineers (1970) for the source of this equation.

The radius of curvature for channels with design Froude numbers greater than or equal to 0.86 shall not be less than $4T$.

8.5.11 Transitions

Transition sections designed to collect and/or discharge flow between the natural floodplain and constructed channels can be located at either the upstream or downstream ends of the constructed channels. They can also be located along a segment, or segments, of a constructed channel itself. In either case, it is necessary to design the flow transition to minimize the disturbance to flow. In the case where flow in a constructed channel is being transitioned back to the natural floodplain, sufficient distance must be allowed for the flow to adequately expand to the original width of the natural floodplain.

8.5.11.1 Entrance Transitions

When the upstream width of flow in a natural channel exceeds the width of proposed channel, a transition section must be provided. For subcritical flow, the angle of convergence, θ, between the center line of the proposed channel and the transitioning levee, or bank, is computed by use of the following equation:

$$\theta = \tan^{-1}\left(\frac{1}{3.375\ F_u}\right) \qquad \textbf{(8.13)}$$

Where:

θ = Transition angle, in degrees (see Figure 8.9); and,
F_u = Upstream Froude number.

See Pima County Department of Transportation and Flood Control District (1984) for the source of this equation.

The length, L, of the transition is computed by use of the following equation:

$$L = \frac{\Delta T}{2\tan\theta} \quad \textbf{(8.14)}$$

Where ΔT is the change in top width, in feet.

See U.S. Army Corps of Engineers (1970) for the source of this equation.

The maximum allowable transition angle is thirty degrees, unless supplemental engineering calculations demonstrate to the satisfaction of the City Engineer that an angle greater than thirty degrees can be used.

In addition to the design calculations associated with the transition section, a backwater analysis must be performed to determine what effect, if any, the transition will have upon upstream water levels.

The transition losses, h_t, to be used in the backwater analysis are to be computed by use of the following equation:

$$h_{tc} = C_c \Delta h_v \quad \textbf{(8.15a)}$$

or

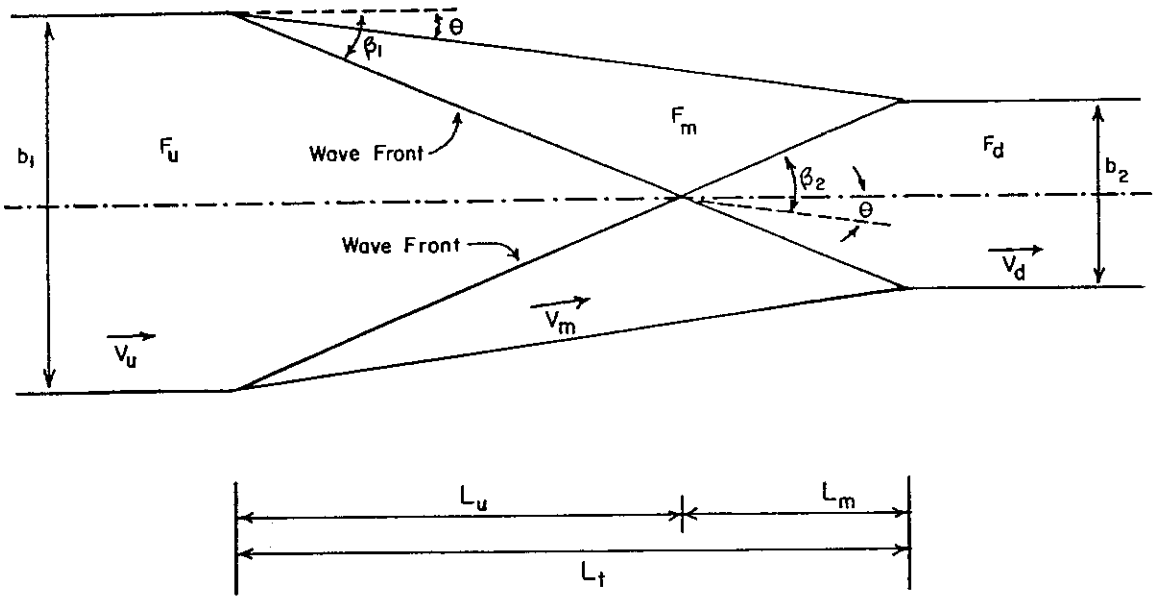
$$h_{te} = C_e \Delta h_v \quad \textbf{(8.15b)}$$

Where:

h_{tc}, h_{te} = Transition losses in contracting and expanding reaches, respectively, in feet;
C_c = Coefficient of contraction;
C_e = Coefficient of expansion; and,
Δh_v = Difference in velocity head between the upstream and downstream end of the transition, in feet.

See U.S. Army Corps of Engineers (1970) for the source of this equation.

The head-loss coefficients of expansion and contraction, C_c and C_e, are obtained from the following table:



NOTE: The subscripts u, m, and d represent upstream, midpoint, and downstream flow conditions, respectively.

FIGURE 8.9
TRANSITION FOR CHANNEL CONTRACTIONS IN SUPERCRITICAL FLOW

TABLE 8.4: HEAD-LOSS COEFFICIENTS FOR USE WITH TRANSITIONS IN OPEN CHANNELS

TRANSITION TYPE	C_c	C_e
Warped	0.10	0.20
Cylindrical quadrant	0.15	0.25
Wedge	0.30	0.50
Straight Line	0.30	0.50
Square End	0.30	0.75

For supercritical flow, entrance transitions must be designed to prevent flow disturbances which could propagate downstream. The convergence angle, θ (Figure 8.9), must be chosen to minimize cross-wave action. To accomplish this, the following three equations must also be satisfied:

$$(1) \quad L_1 = \frac{b_1}{2\text{Tan}\beta_1}; \tag{8.16}$$

and,

$$(2) \quad L_2 = \frac{b_2}{2\text{Tan}(\beta_2-\theta)}; \tag{8.17}$$

and,

$$(3) \quad L = L_1 + L_2 \tag{8.18}$$

$$(4) \quad L = \frac{b_1 - b_2}{2\ \tan\theta} \tag{8.19}$$

Where all terms are as defined in Figure 8.9.

See U.S. Army Corps of Engineers (1970) for the source of these equations.

The procedure for design of a supercritical transition is as follows:

1. Using the upstream Froude number, F_u, compute the wave-front angle, β_1, from the formula:

$$\beta = \text{Sin}^{-1}(1/F) \qquad \textbf{(8.20)}$$

Where:

$\beta = \beta_1$ and $F = F_u$ (see Figure 8.9).

2. Compute the distance L_1 from Equation 8.16.

3. Choose a trial transition length, L, where $L > L_1$.

4. Determine the trial transition angle, θ, from L, b_1, and b_2.

5. Determine the transition Froude number, F_t, from the hydraulic conditions at the distance L_1.

6. From F_t, compute a new wave-front angle, β_2, using Equation 8.20.

7. Compute L_2 according to Equation 8.17.

8. Repeat steps 3 through 7 until Equations 8.18 and 8.19 are both satisfied.

The table below is provided as an additional guide to aid in designing entrance transitions under supercritical flow conditions.

TABLE 8.5: RECOMMENDED CONVERGENCE RATES FOR ENTRANCE TRANSITIONS WITH SUPERCRITICAL FLOW

MEAN CHANNEL VELOCITY (FPS)	WALLFLARE (HORIZONTAL TO LONGITUDINAL)	θ DEGREES
10 - 15	1:10	5.71
15 - 30	1:15	3.81
30 - 40	1:20	2.86

8.5.11.2 Exit Transitions

The length of the exiting transition section, L_{TR}, where flow from the proposed channel is expanded to match the width of the natural floodplain, shall be computed by use of the following equation:

$$L_{TR} = 6.5\ (X_2 - 0.7X_1) \tag{8.21}$$

for subcritical flow ($F_u \leq 1$); and

$$L_{TR} = 6.5\ F_u\ (X_2 - 0.7X_1) \tag{8.22}$$

for supercritical flow ($F_u > 1$).

Where the terms for both equations are as described in Figure 8.10 (F_u = upstream Froude number).

Equations 8.21 and 8.22 are modified from equations found on Plate 24 of "Hydraulic Design of Flood Control Channels," U.S. Army Corps of Engineers (1970).

Exit transition sections are necessary to prevent adverse downstream impacts caused by increased flow velocities and depths. Acceptable transitions are required in all cases unless (1) an agreement, satisfactory to the City Engineer, can be made with all affected downstream property owners; or (2) a drainage master plan has been developed for the wash, which specifies a particular outlet configuration.

8.5.11.3 Internal Channel Transitions

Internal channel transitions must be gradual to minimize flow disturbances. The same formulas presented in the previous sections for entrance and exit transitions shall be used for contractions and expansions of flow within the channel. For transitions which constrict flow under subcritical conditions, use Equation 8.13 to determine the convergence angle. The maximum transition angle shall be thirty degrees. The length of the transition is computed by using Equation 8.14.

Contractions under supercritical flow conditions are computed by using Equations 8.16 through 8.20. The required length for internal expansions under supercritical flow conditions is computed by using Equation 8.22. Should a shorter transition be desired, it must be justified by computations that document the expected wave heights in accordance with procedures contained in standard hydraulics textbooks, such as Chow (1959) and Morris and Wiggert (1972). Additional freeboard, and possibly additional reinforcement of the channel lining, will be required to account for the destructive effects associated with wave formation.

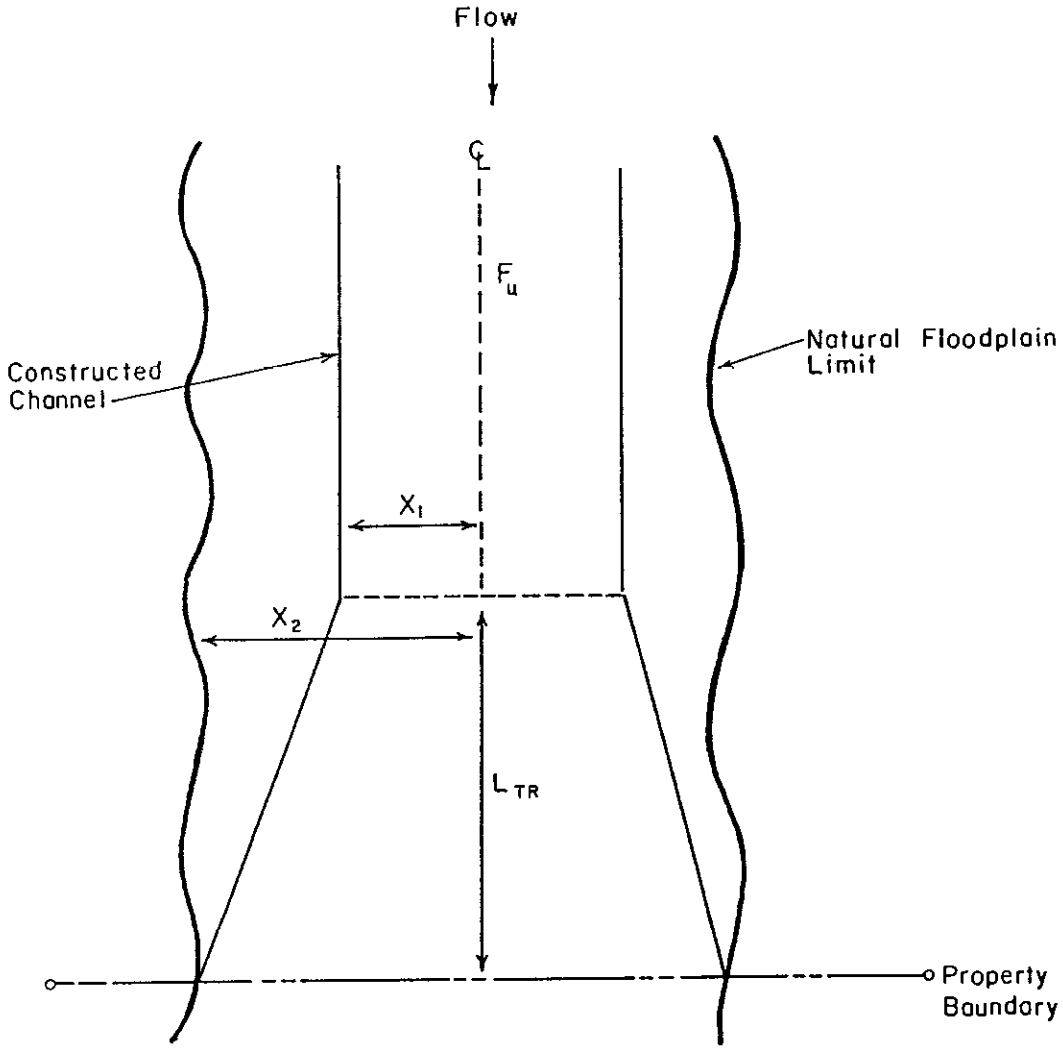


FIGURE 8.10
TRANSITION DISTANCE REQUIRED TO ALLOW FLOW TO RETURN TO NATURAL CONDITIONS

Where flow is to be transitioned from a supercritical state to a subcritical state, a hydraulic jump will develop. The jump must be contained within the transition structure. Additional freeboard will be required, as needed, to contain the jump (refer to Section 8.5.12 of this Manual for information on hydraulic jumps). Additional reinforcement of the channel lining may also be required. One method of ensuring that a hydraulic jump is contained within the designated area is to build an energy dissipator or stilling basin that is designed to contain the jump within a specified reach length. Refer to Chapter IX of this Manual for more detailed information concerning energy dissipators and/or stilling basins.

8.5.12 Channel Confluences

The design of a channel junction or a channel confluence is a very complex procedure due to the many variables involved (e.g., the angle of intersection, discharges, channel and junction shape, and the number of adjoining channels and type of flow encountered). Junctions under subcritical flow conditions must be designed to allow water to merge without creating a backwater condition that can result in the overtopping of one or more of the converging channels. The maximum wave height is generally located on the side-channel wall opposite the junction point, and on the main-channel wall downstream of the junction.

8.5.12.1 General Design Guidelines

General design guidelines for junctions are as follows:

1. Tapered training walls should be constructed between adjoining flows.

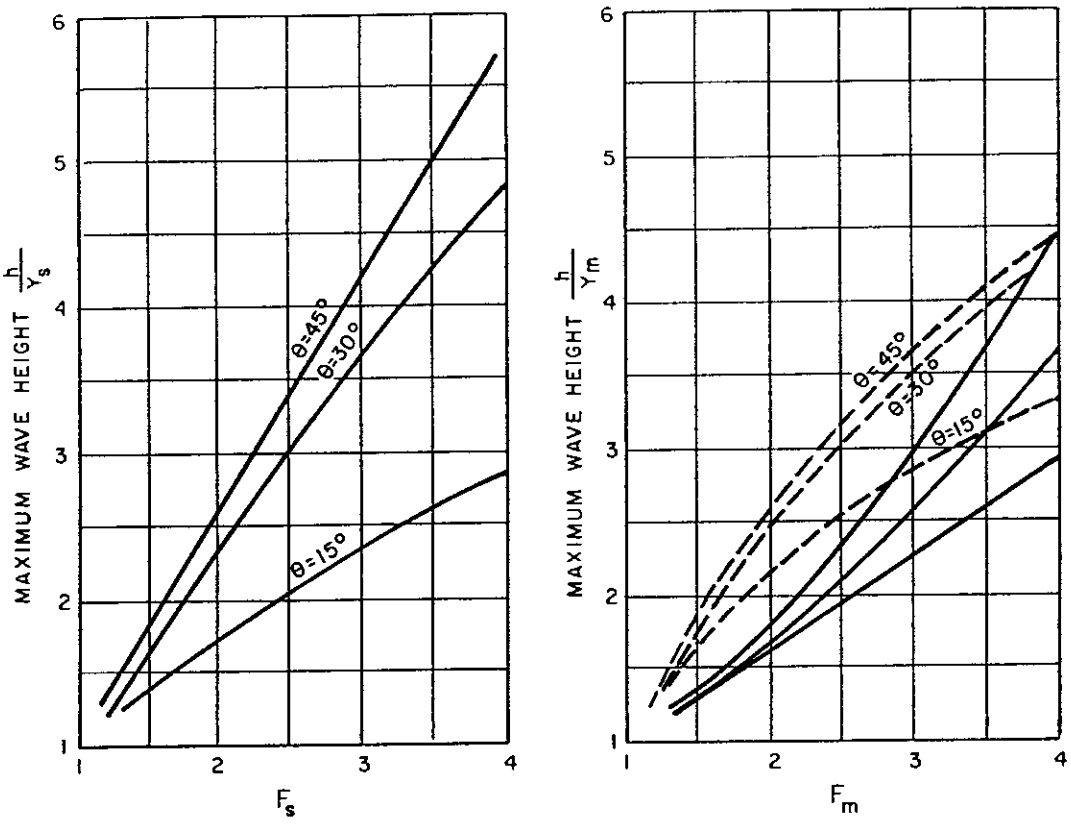
2. The side-channel wave originating at the junction apex should impinge upon the main-channel wall downstream of the enlargement (see Section 8.5.12.3 of this Manual).

3. Junction angles, θ, should be no greater than twelve degrees for subcritical flow, and no greater than six degrees for supercritical flow. Angles greater than these are acceptable, but only if extra bank protection is provided to heights equal to or greater than the maximum wave heights given by Figure 8.11. In addition, if the tributary flow is greater than ten percent of the main channel flow, the maximum angle of the confluence should not be allowed to exceed forty-five degrees. The extra height of bank protection required at a junction should extend downstream of same a distance, L, which is computed from the following equation:

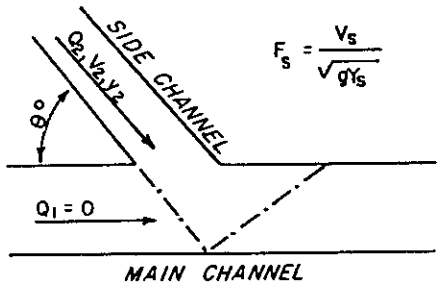
$$L = \frac{3b_2V_2}{V_3 sin\theta} \qquad (8.23)$$

Where:

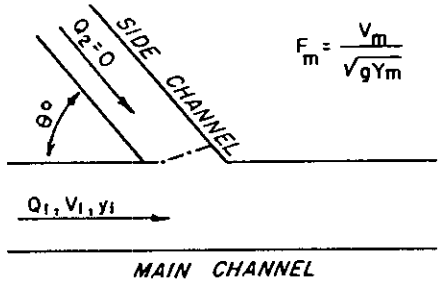
b_2 = Bottom width of the main channel downstream of the junction, in feet;



NOTE: The subscripts m and s represent the main channel and side channel flow conditions, respectively.



a. SIDE CHANNEL FLOW ONLY



b. MAIN CHANNEL FLOW ONLY

———— RECTANGULAR CHANNEL
———— TRAPEZOIDAL CHANNEL
—·—·— APPROXIMATE FLOW LINE PATTERN

FOR DESIGN PURPOSES θ SHOULD NOT BE GREATER THAN 12° FOR SUBCRITICAL FLOWS, AND NOT GREATER THAN 6° FOR SUPERCRITICAL FLOW.

FIGURE 8.11
MAXIMUM WAVE HEIGHT AT A CHANNEL JUNCTION

V_2 = Flow velocity in the main channel downstream of the junction, in feet per second;
V_3 = Flow velocity in the tributary or side channel, in feet per second; and,
θ = Junction angle, in degrees.

Tributary flows that are less than ten percent of the main channel flow may enter at angles up to ninety degrees, but only if extra bank protection is provided to a height that equals the elevation of the energy grade line of the tributary flow. If the angle of confluence is greater than forty-five degrees, the extra bank protection must extend upstream of the junction at least for a distance equal to the bottom width of the tributary channel.

4. Critical flow conditions at junctions should be avoided, if at all possible. Froude numbers should either be below the value 0.86, or greater than the value 1.13.

5. Transition sections should be avoided in the immediate vicinity of junctions.

8.5.12.2 Momentum Equation

Open-channel flow at a junction is best analyzed using the principle of conservation of momentum. There are many momentum-balance equations available that make simplifying assumptions about the flow and confluence configuration. These equations should be used with caution, because many design situations will not adequately meet the assumptions implicit in these equations.

A series of equations developed by the Los Angeles Flood Control District (1973) are of sufficient detail to be applicable for most junctions. These equations shall be used for designing projects to be located within the City of Tucson, unless the engineer can justify using other equations. The general form of the momentum equation is:

$$P_{h2} + M_2 = P_{h1} + M_1 + M_3 \text{Cos}\theta + P_{hi} + P_{hw} - P_{hf} \quad \textbf{(8.24)}$$

Where:
P_{h1} = Hydrostatic pressure on Section 1;
P_{h2} = Hydrostatic pressure on Section 2;
P_{hi} = Horizontal component of hydrostatic pressure on the channel invert;
P_{hw} = Axial component of hydrostatic pressure on the channel walls;
P_{hf} = Retardation force of friction;
M_1 = Momentum of the moving mass of water entering the junction at Section 1;

M_2 = Momentum of moving mass of water leaving the junction at Section 2; and,

$M_3 \text{Cos}\theta$ = Axial component of momentum of the moving mass of water entering the junction at Section 3.

Figures 8.12 and 8.13 show the relationship between the main channel and the tributary channel with respect to the preceding equation. For a trapezoidal channel, the following equations represent the variables comprising Equation 8.24:

$$M_1 = \frac{Q_1^2}{g(b_1+Z_1Y_1)Y_1} = \frac{Q_1^2}{gA_1} \tag{8.25}$$

$$M_2 = \frac{Q_2^2}{g(b_2+Z_2Y_2)Y_2} = \frac{Q_2^2}{gA_2} \tag{8.26}$$

$$M_3 = \frac{Q_3^2}{g(b_3+Z_3Y_3)Y_3} = \frac{Q_3^2}{gA_3} \tag{8.27}$$

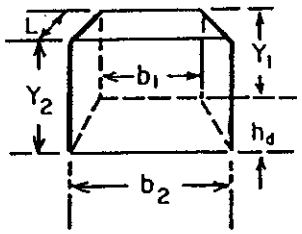
$$P_{h1} = \frac{Y_1^2}{6}(3b_1 + 2Z_1Y_1) \tag{8.28}$$

$$P_{h2} = \frac{Y_2^2}{6}(3b_2 + 2Z_2Y_2) \tag{8.29}$$

$$P_{hi} = \frac{b_1+b_2}{2} h_d \left[Y_1 + \frac{(Y_2-Y_1)(b_1+2b_2)}{3(b_1+b_2)} \right] \tag{8.30}$$

$$P_{hw} = \frac{Y_1+Y_2}{4} \left[\frac{b_1+b_2}{2} (Y_1-Y_2)+h'(Z_1Y_1+Z_2Y_2)+(b_2+Z_2Y_2)Y_2-(b_1+Z_1Y_1)Y_1 \right] \tag{8.31}$$

$$P_{hf} = \frac{L(S_1+S_2)}{4} \left[(b_1 + Z_1Y_1)Y_1 + (b_2+Z_2Y_2)Y_2 \right] \tag{8.32}$$



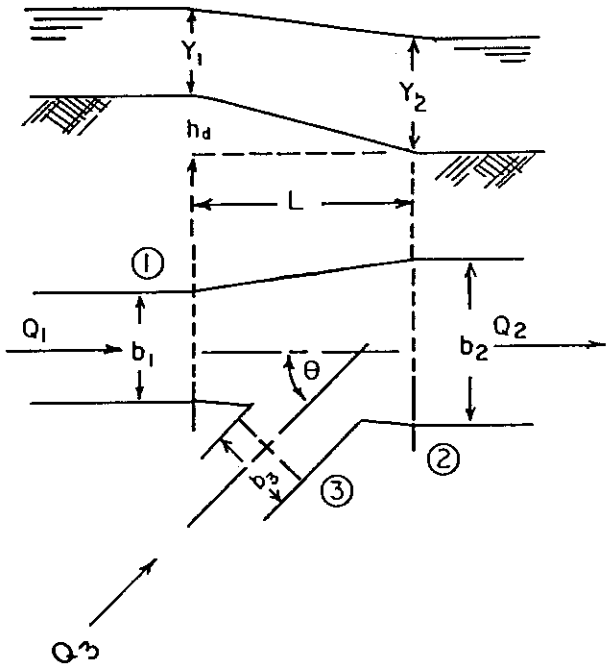


FIGURE 8.12
RECTANGULAR CHANNEL JUNCTION

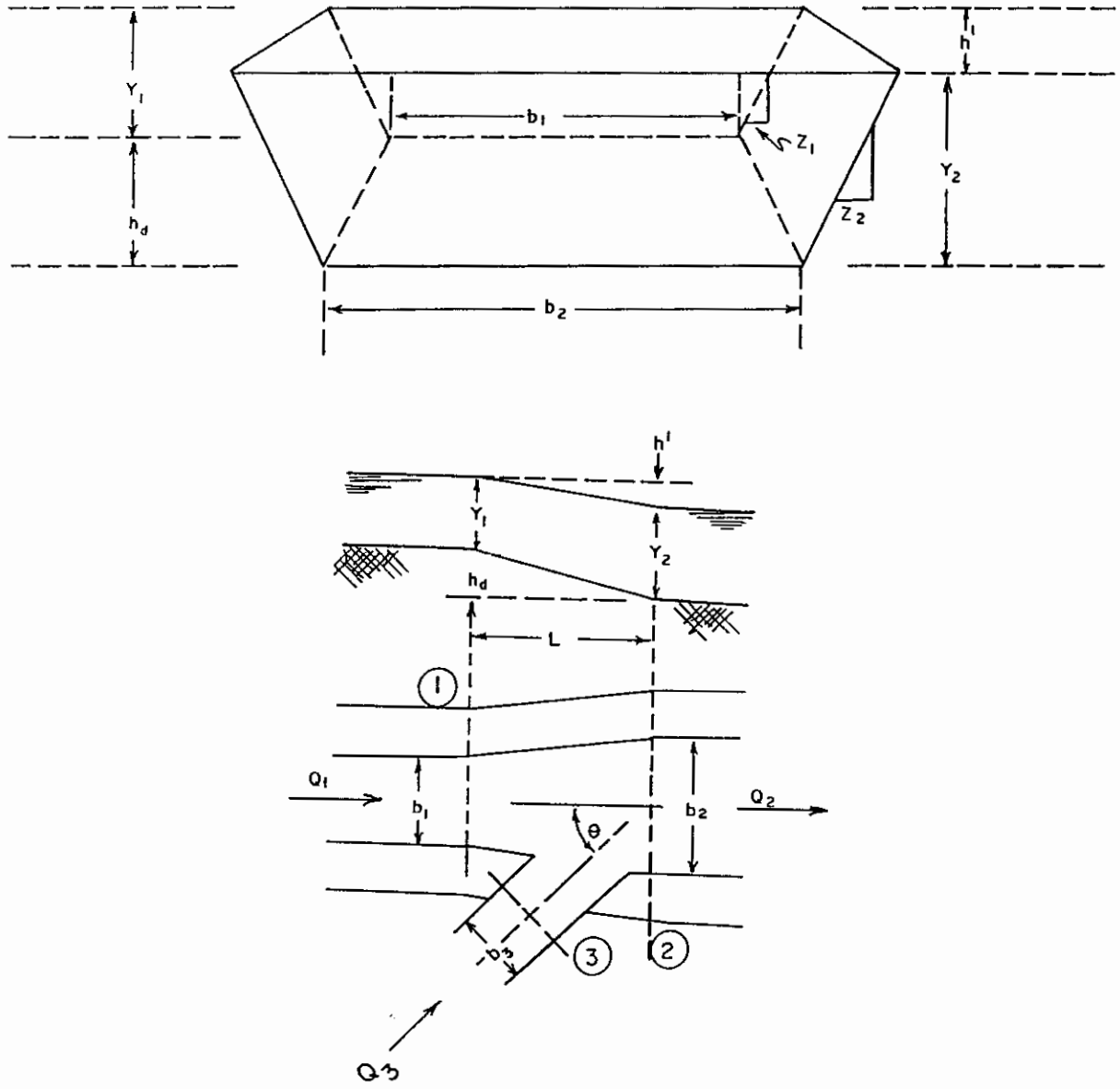


FIGURE 8.13
TRAPEZOIDAL CHANNEL JUNCTION

For a rectangular channel, the equations which represent the variables comprising Equation 8.24 are:

$$M_1 = \frac{Q_1^2}{g b_1 Y_1} \tag{8.33}$$

$$M_2 = \frac{Q_2^2}{g b_2 Y_2} \tag{8.34}$$

$$M_3 = \frac{Q_3^2}{g b_3 Y_3} \tag{8.35}$$

$$P_{h1} = \frac{b_1 Y_1^2}{2} \tag{8.36}$$

$$P_{h2} = \frac{b_2 Y_2^2}{2} \tag{8.37}$$

$$P_{hi} = h_d \left(\frac{b_1+b_2}{2}\right) \left[Y_1 + \frac{(Y_2-Y_1)(b_1+2b_2)}{3(b_1+b_2)}\right] \tag{8.38}$$

$$P_{hw} = \frac{Y_1+Y_2}{4} (b_2-b_1) \left[Y_1 + \frac{(Y_2-Y_1)(Y_1+2Y_2)}{3(Y_1+Y_2)}\right] \tag{8.39}$$

$$P_{hf} = \frac{L(S_1+S_2)}{4} (b_1 Y_1 + b_2 Y_2) \tag{8.40}$$

Where:

b_1, b_2, b_3	=	Bottom widths of channels 1, 2, and 3, respectively, in feet;
Y_1, Y_2, Y_3	=	Flow depths in channels 1, 2, and 3, respectively, in feet;
Q_1, Q_2, Q_3	=	Discharges in channels 1, 2, and 3, respectively, in cubic feet per second;
Z_1, Z_2, Z_3	=	Side-slopes of channels 1, 2, and 3, respectively (horizontal/vertical), in feet per foot;
S_1, S_2	=	Friction slopes of channels 1 and 2, respectively.
L	=	Length of channel junction, in feet.

h_d = Vertical drop in channel bottom through the junction, in feet; and,

h' = Vertical drop in water surface through the junction, in feet.

8.5.12.3 Design Procedure: Supercritical Flow

The design of junctions under supercritical flow conditions involves an iterative procedure in which different curve layouts are checked against the momentum equation until one is found that is acceptable. The upstream channel widths and hydraulic conditions are known, while the downstream channel width and depth of flow are the unknown parameters. The procedure is as follows:

1. Assume a downstream width of the channel bottom based upon the total discharge, the approximate channel shape, the selected roughness, and the slope. It is suggested that the first estimate of the width be the combined width of the two upstream channels (b_1+b_3).

   (In the following discussion b_1 refers to the upstream width of the main channel, b_2 is the width of the main channel at the downstream end of the junction, b_3 is the width of the secondary [tributary] channel, and b_4 is the width of the main channel downstream and beyond the influence of the junction).

2. Prepare the confluence layout assuming that the main-channel walls are parallel to the channel center line, as shown in Figure 8.14. If the difference (Δb_1) in widths between b_1 and b_2 is less than b_3, a centerline offset, as shown in Figure 8.14 A, is recommended. If Δb_1 is greater than b_3, an offset with respect to the right bank, as shown in Figure 8.14 B, is recommended to ensure that the horizontal distance between the parallel alignment of the left banks of the main channels b_1 and b_2 is equal to or less than b_3.

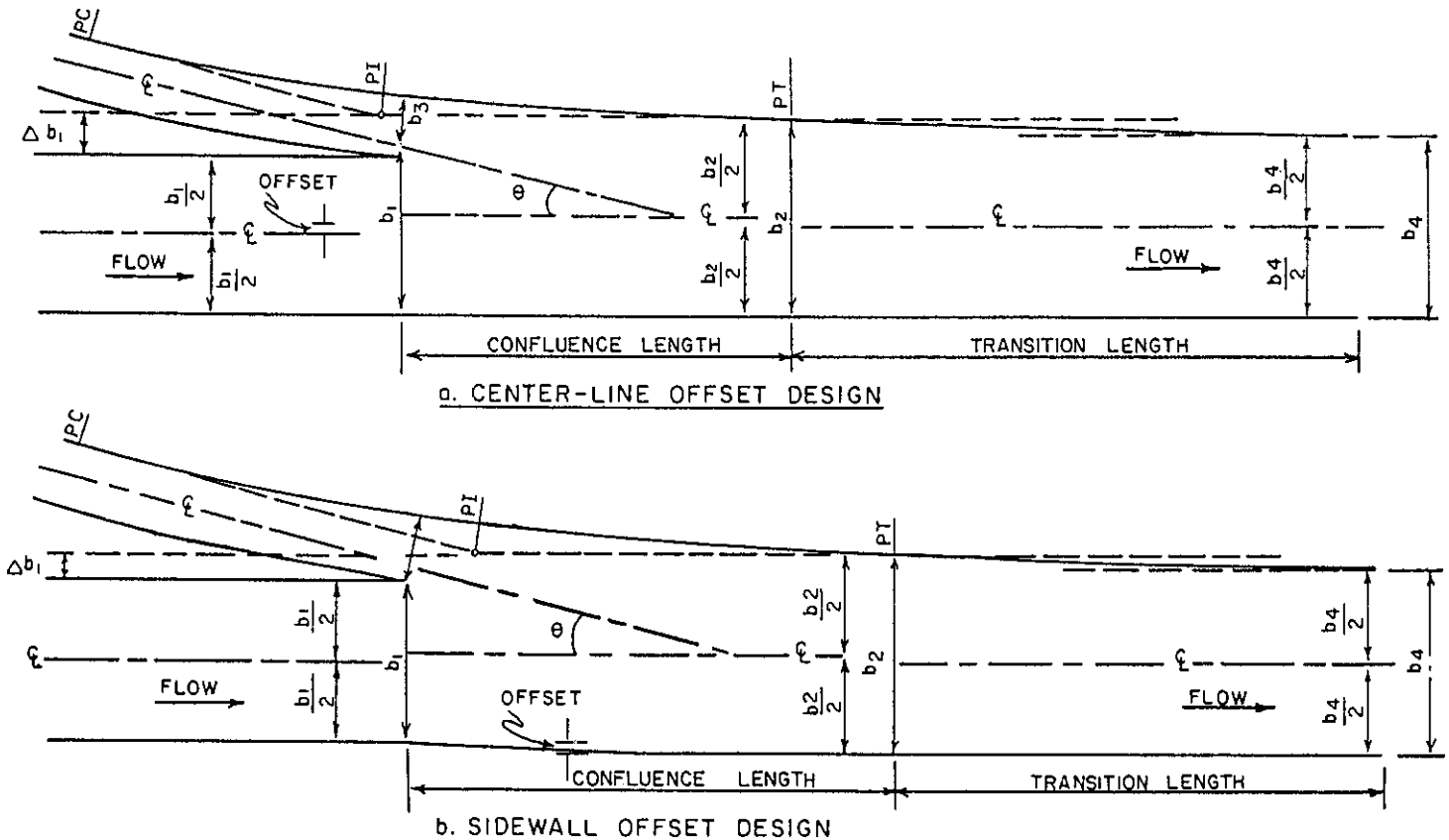
3. Using the point of intersection, *PI*, of the channel walls, draw a circular curve which is determined by the apex angle, θ (Figure 8.14). The radius of curvature of the curve is determined by use of the following equation:

$$r_c = \frac{4V_3^2 b_3}{gY_3} + 400 \qquad (8.41)$$

Where all terms are as previously defined.

See U.S. Army Corps of Engineers (1970) for the source of this equation.

This curve will connect the intersecting, straight channel walls, as shown in Figure 8.14, and will represent the revised edge of the bottom of the channel through the confluence area.



*FOR DESIGN PURPOSES, θ SHOULD BE NOT GREATER THAN 12 DEGREES FOR SUBCRITICAL FLOW AND NOT GREATER THAN 6 DEGREES FOR SUPER-CRITICAL FLOW.

FIGURE 8.14
TYPICAL CONFLUENCE LAYOUTS

4. Make the inside bank of the tributary channel bottom concentric with the circular curve, and locate the apex of the junction at the point where this edge of the tributary channel meets the main channel. The distance, L_o, between the Point of Tangency, *PT*, and the junction apex is computed by use of the following equation:

$$L_o = (r_c + b_3) \operatorname{Sin}\left[\operatorname{Cos}^{-1}\left[1 - \frac{b_3 - \Delta b_1}{r_c + b_3}\right]\right] \tag{8.42}$$

The total length of the curve, L_{ct}, from *PC* to *PT*, can be computed from:

$$L_{ct} = \frac{2\pi r\theta}{360} \tag{8.43}$$

The location of the point of curvature, *PC*, can be computed from:

$$PC = PI - r \operatorname{Tan}\frac{\theta}{2} \tag{8.44}$$

The location of the point of Tangency, *PT*, can be computed from:

$$PT = PC + L_{ct} \tag{8.45}$$

Figure 8.14 shows the relationship of these parameters.

5. Compute the confluence length, L_c, by using the following equations (Los Angeles County Flood Control District, 1973):

$$L_{c1} = \frac{b_3}{\operatorname{Sin}\theta}\ ; \tag{8.46}$$

and,

$$L_{c2} = 5(b_2 - b_1) \tag{8.47}$$

and compare these lengths to the distance L_o (Equation 8.42) from the apex to the *PT* point. The longest of the three is the confluence length, L_c.

6. Using the confluence length, L_c, and the momentum equation (i.e., Equation 8.24), determine the depth of flow and hydraulic conditions at b_2. If either the depth of flow or water-surface elevation is significantly different than its value in the upstream main channel, select a new b_2 and repeat the procedure.

7. Once satisfactory hydraulic conditions at b_2 have been established, determine the transition distance to b_4 by the procedure outlined in Section 8.5.11 of this Manual. (Note: b_2 in Section 10.5.11 of this Manual is equivalent to b_4 in this section of the Manual.)

   An example of this procedure is provided at the end of this chapter.

When designing junctions, consideration should be given to the waves that will occur along the opposite channel wall when only one of the converging channels is discharging into the composite channel. Due to the sporadic nature of thunderstorms in the Tucson Area, it is possible to have flow in one channel and not in the other. Under supercritical flow conditions, experiments have shown that waves can be quite high, particularly if the angle of confluence is excessive. Fortunately, if the angle of confluence is equal to or less than twelve degrees (preferably six degrees), and the design procedure described above is followed, these type of waves should not be a problem. However, should a greater angle of confluence be dictated by site conditions, extra freeboard will be required according to the procedure described in Section 8.5.12.1(3) of this Manual in order to contain waves created by flow impinging onto the opposite bank.

8.5.13 Collector Channels

Collector channels are generally designed to collect unconsolidated sheet flow, or wide, shallow, braided flow for the purpose of removing the downstream property from the floodplain. Collector channels generally do not follow the existing drainage pattern. Therefore, they have more stringent design requirements than do most other channels.

8.5.13.1 Cross Section and Slope

Collector channels provide the best hydraulic performance if the width/depth ratio is as low as possible. Cross sections with wide bottoms and low depths should be avoided, if topography permits. Channel slopes should be as steep as reasonably possible to help accelerate the water and prevent sediment buildup.

8.5.13.2 Depth

The discharge in collector channels increases with distance along the channel. Collector channel flows are subject to head losses associated with the impact and turbulence created by flow entering the channel over its bank, in addition to the normal losses created by friction. Therefore, normal-depth procedures and step-backwater calculations are *not* applicable. The correct procedure for analyzing spatially-varied flow of the type that occurs in collector channels is given in many

hydraulics textbooks under the heading "Side-Channel Spillways" (e.g., see Chow, 1959, page 329).

The minimum depth of a collector channel in the City of Tucson shall be twice the critical depth of the design flood for channels with supercritical slopes, and twice the normal depth of the design flood for channels with subcritical slopes. This depth will vary along the length of the channel as the discharge increases. The transition from the collector channel to the main channel shall be designed using standard backwater procedures. Backwater computations should begin at the point where inflow over the side of the collector channel ceases, and end at a point where normal depth is encountered, or where flow is no longer affected by the collector channel.

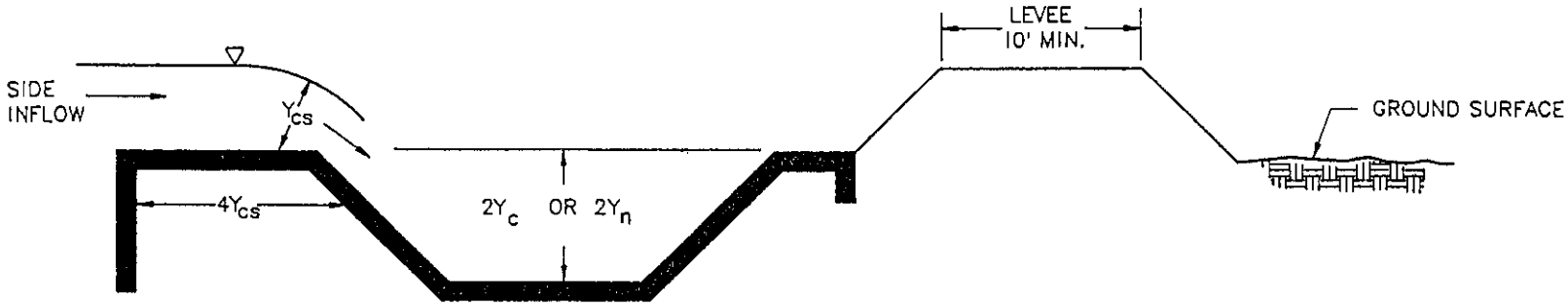
When unusual circumstances exist, such as the presence of a definite control point at or near the end of a collector channel, the "Method of Numerical Integration," as outlined in Chow (1959) shall be used to design same. This method may also be used if there is reason to believe that the guidelines presented above result in an overdesign of a collector channel.

8.5.13.3 Erosion Protection

Erosion protection for a collector channel requires special consideration because of inflow from the side. Hydrostatic pressure in the soil and seepage behind the bank protection can cause the bank protection to fail. Another problem is scour caused by side inflow.

To prevent failure of the bank protection along a collector channel due to side inflow, seepage, and/or hydrostatic pressure, a horizontal concrete apron is normally required along the top of the upstream (inflow) side of the collector channel. This concrete apron shall be connected to the bank protection, and have a width, measured perpendicular to the bank, which is at least four times the critical depth of side inflow during the design flood. A key-in at the upstream edge of the concrete apron should extend to a depth equal to the depth of the collector channel. However, the apron and key-in are not required if the channel bank is constructed of 9-foot-thick soil cement.

The bottom of the collector channel shall be lined, unless the toe-down protection for the bank is deep enough to protect against the scour caused by side inflow. The procedures given in Chapter VI of this Manual shall be used to compute side-inflow scour depth. Normal-depth shall be used as the tailwater depth in the channel for this equation. If the width of the channel is less than five times the computed scour depth, extra toe-down protection to the full depth of scour is needed on *both* banks. For channel bottom widths at least ten times the depth of scour, no extra toe-down is needed on the opposite bank. For widths between five and ten times the depth of scour, the toe-down on the opposite bank should be computed via a linear interpolation between the side-flow scour depth and the normal toe-down depth. A typical collector channel is shown in Figure 8.15.



Y_{cs} = CRITICAL DEPTH OF SIDE FLOW

Y_c = CRITICAL DEPTH OF CHANNEL FLOW

Y_n = NORMAL DEPTH OF CHANNEL FLOW

NOTE:
A PROPERLY DESIGNED LEVEE OF HEIGHT Y_{cc} OR Y_{nc} CAN BE CONSTRUCTED ALONG THE BANK OPPOSITE THE SIDE INFLOW IN LIEU OF THE $2Y_{cc}$ OR $2Y_{nc}$ REQUIREMENT.

FIGURE 8.15
TYPICAL COLLECTOR–CHANNEL CROSS SECTION

8.5.13.4 Sediment

Depending upon the amount of sediment supply, and upon sediment-transport capacity, a collector channel could either aggrade or degrade, if not properly designed. The reader is referred to Chapter VI of this Manual for those procedures that consider the effects of deposition and/or scour of alluvial sediments upon open-channel design.

8.5.13.5 Additional Design Considerations

Material removed by excavation to form the collector channel could be used to construct a levee along the side opposite the lateral inflow. Such a levee, if properly designed, would then be able to serve as a substitute for the depth requirement otherwise imposed upon the design of a collector channel (i.e., two times the appropriate flow depth), and would ensure that all lateral inflow is captured by the collector channel. The minimum height of such a levee should be equal to the normal depth of flow at the peak of the design flood for subcritical conditions, and equal to the critical depth of flow at the peak of the design flood for supercritical conditions.

The lowest floor of the first tier of buildings along the downstream side of a collector channel should be at least one foot above the 100-year water-surface elevation in the collector channel in order to safeguard against possible failure of the collector-channel embankment. This water-surface elevation shall be determined either by the Method of Numerical Integration or by assuming an elevation equal to either (1) two times the normal depth at the peak of the design flood for subcritical flow, or (2) two times the critical depth at the peak of the design flood for supercritical flow, whichever is greater.

EXAMPLE 8.1: SEQUENT DEPTH IN A TRAPEZOIDAL CHANNEL

A hydraulic jump is to be formed in a trapezoidal channel through the use of baffle blocks and an abrupt change in slope from steep to mild. Hydraulic conditions *upstream* of the jump are:

Discharge (Q)	=	500 cfs
Channel Slope (S)	=	0.015
Bottom Width (b)	=	10 ft
Side Slopes (Z)	=	1:1
Roughness (n)	=	0.015
Depth (Y)	=	2.3 ft
Froude Number (F_u)	=	2.2
Hydraulic Depth (Y_h)	=	1.9 ft

Equation 8.6 will be used. Normal depth *upstream* of the jump is 2.3 feet; so, as an initial estimate, a sequent depth of four feet will be chosen. From Equation 8.6:

$$\frac{1(2.3)^3}{3} + \frac{10(2.3)^2}{2} + \frac{500^2}{g(28.3)} = \frac{1(4)^3}{3} + \frac{10(4)^2}{2} + \frac{500^2}{g(56.0)}$$

$$304.9 = 240.0$$

Momentum does not balance, so a new sequent depth is chosen. By trial and error, the sequent depth is found to be 5.6 ft:

$$\frac{1(2.3)^3}{3} + \frac{10(2.3)^2}{2} + \frac{500^2}{g(28.3)} = \frac{1(5.6)^3}{3} + \frac{10(5.6)^2}{2} + \frac{500^2}{g(87.4)}$$

$$304.9 = 304.2 \quad \text{(close enough)}$$

The engineer should exercise care in using Equation 8.6, especially with calculator or computer-program "root solvers," because there are two other roots besides the correct one for sequent depth. One obvious solution is $Y_2 = Y_1$. The third root is usually negative. In this case, the value -13.1 also satisfies the equation.

Figure 8.4 can also be used to solve for sequent depth in this example. To do this, first compute $t = 10/[1(2.3)] = 4.3$. From Figure 8.4, using $F_u = 2.2$ and $t = 4.3$, $Y_2/Y_1 = 2.4$. Y_2 is then: 2.4 (2.3 ft) = 5.5 ft.

EXAMPLE 8.2: THE DESIGN OF AN OPEN-CHANNEL JUNCTION UNDER SUPER-CRITICAL FLOW CONDITIONS

In this example, a main-channel flow, Q_1, of 2000 cubic feet per second (cfs) is to be joined by a side-channel flow, Q_3, of 775 cfs. The confluence angle, θ, is six degrees. The slope and bottom-width of the side channel have been established to ensure that the depth of flow at the junction is the same as the depth of flow in the main channel. It is desired that this depth of flow be maintained throughout the junction.

Hydraulic conditions in the section located upstream of the channel junction are as follows:

Main Channel			Side Channel		
Q_1	=	2000 cfs	Q_3	=	775 cfs
n	=	0.015 (concrete)	n	=	0.015 (concrete)
b_1	=	20.0 ft	b_3	=	8.0 ft
Y_1	=	4.0 ft	Y_3	=	4.0 ft
Z	=	1:1	Z	=	1:1
S_1	=	0.01 ft/ft	S_3	=	0.008 ft/ft
F_1	=	2.0	F_3	=	1.70
A_1	=	95.8 ft^2	A_3	=	47.8 ft^2
V_1	=	20.9 fps	V_3	=	16.2 fps

Hydraulic conditions in the composite channel section located downstream of the junction are as follows:

Q_4	=	2775 cfs
n	=	0.015 (concrete)
b_4	=	28.0 ft
Y_4	=	4.0 ft
Z	=	1:1
S	=	0.01 ft/ft
F	=	2.0
A_4	=	127.7 ft^2
V_4	=	21.7 fps

STEP 1: Assume $b_2 = b_1+b_3 = 20+8 =$ *28 feet*.

Use centerline offset (Figure 8.14 A).

$\Delta b_1 = 8\ ft$

$$r_c = \frac{4V_3^2 b_3}{gY_3} + 400 = \frac{4(16.2)^2(8)}{g(4)} + 400 = \textit{465.2 feet}$$

Assume station $PI =$ *100+00*

Station $PC = 100+00 - r_c \text{ Tan } \frac{\theta}{2}$

Station $PC = 100+00 - 465.2\ Tan\ 6/2 =$ *99+75.62*

Curve length, $L_{ct}, = r_c\ (\theta)\ \frac{2\pi}{360}$

$$L = 465.2(6)\ \frac{2\pi}{360} = \textit{48.72 feet}$$

Station $PT = 99+75.62 + 48.72 =$ *100+24.34*

Because $b_3 = \Delta b_1$, the distance from the apex to PT is 0.

The confluence length, L_c, is:

$$L_c = \frac{(8)}{Sin\ (6°)} = \textit{76.5 feet}$$

or

$$L_c = \frac{(28-20)10}{2} = \textit{40.0 feet}$$

Using the largest of these values yields:

$L_c =$ *76.5 feet*

Assume the depth of flow at $b_2 = 4$ *feet*.

From Equations 8.25 to 8.32:

$$M_1 = \frac{(2000^2)}{[20+1(4)]g(4)} = \underline{\underline{1294.0}}$$

$$M_2 = \frac{(2775)^2}{[28+1(4)]g(4)} = \underline{\underline{1868.4}}$$

$$M_3 = \frac{(775)^2}{(47.8)g} = \underline{\underline{390.2}}$$

$$P_{h1} = \frac{(4)^2}{6}[3(20) + 2(1)4] = \underline{\underline{181.3}}$$

$$P_{h2} = \frac{(4)^2}{6}[3(28) + 2(1)4] = \underline{\underline{245.3}}$$

$$P_{hi} = \left(\frac{20+28}{2}\right)0.77\left(4 + \frac{(4-4)[20+2(28)]}{3(20+28)}\right)$$

$$= \underline{\underline{73.9}}$$

$$P_{hw} = \frac{4+4}{4}\left(\frac{20+28}{2}(4-4)+0.77\,[1(4)+1(4)]+[28+1(4)]4-4[20+1(4)]\right)$$

$$= \underline{\underline{76.3}}$$

$$P_{hf} = \frac{76.5\,(0.01+0.01)}{4}\left([20+1(4)]4+[28+1(4)]4\right)$$

$$= \underline{\underline{85.7}}$$

Using Equation 8.24:

$$245.3+1868.4 = 181.3+1294.0+390.2\text{Cos}6°+73.9+76.3-85.7$$

$$2113.7 = \underline{1927.9}$$

Since forces do not balance, another depth should be tried using the same width.

By trial and error, obtain $D_2 = \underline{4.5 \text{ feet}}$.

$$M_2 = \frac{(2775)^2}{[28+1(4.5)]g(4.5)} = \underline{1635.2}$$

$$P_{h2} = \frac{(4.5)^2}{6}[3(28) + 2(1)4.5] = \underline{313.9}$$

$$P_{hi} = \left[\frac{20+28}{2}\right] 0.77 \left[4 + \frac{(4.5-4.0)[20+2(28)]}{3(20+28)}\right]$$

$$= \underline{78.8}$$

$$P_{hw} = \frac{4.0+4.5}{4}\left[\frac{20+28}{2}(4.0-4.5)+0.27[1(4)+1(4.5)]+[28+1(4.5)]4.5-[20+1(4)]4\right]$$

$$= \underline{86.2}$$

$$P_{hf} = \frac{76.5(0.01+0.01)}{4}\left[[20+1(4)]4 + [28+1(4.5)]4.5\right]$$

$$= \underline{92.7}$$

By Equation 8.23:

$$313.9+1635.2 = 181.3+1294.0+390.2\cos 6°+78.8+86.2-92.7$$

$$1949.1 = \underline{1935.7} \qquad \text{(close enough)}$$

The momentum balance at this point is close enough to cease further iterations. Therefore, the hydraulic conditions at the end of the junction are as follows:

Q = 2775 cfs
b_3 = 28.0 ft
Y_3 = 4.5 ft
Z = 1:1
F_3 = 1.7
V_3 = 19.0 fps
A_3 = 146.3 ft^2

Additional bank-protection height will be needed to accommodate this depth. A step-backwater computation may be used to compute the distance from the end of the junction to the point at which normal depth occurs.

10.6.9 Clogging

The following guidelines should be followed to provide an appropriate factor of safety against clogging at pavement inlets:

GRATES AND SLOTTED DRAINS:

1. Sump Conditions:
   a. Orifice Flow: required area = 2.0 x calculated area.
   b. Weir Flow: required perimeter = 2.0 x calculated perimeter.
2. Continuous-grade conditions:
   a. Required length of opening = 2.0 x calculated length.

CURB INLETS:

1. Sump Conditions:
   a. Required length of opening = 1.50 x calculated length.
2. Continuous-grade conditions:
   a. Required length of opening = 1.25 x calculated length.

COMBINATION GRATE AND CURB INLET:

1. Sump Conditions:
   a. Orifice Flow: required area = 2.0 x calculated area for grate; required length = 1.25 x calculated length for curb inlet.
   b. Weir flow: required perimeter = 1.0 x calculated perimeter for grate; required length = 1.25 x calculated length for curb inlet.
2. Continuous-grade conditions:
   a. Required length of opening = 1.0 x calculated length for grate; required length = 1.25 x calculated length for curb inlet.

ADOT STANDARD TYPE-3 CATCH BASINS:

1. Continuous-Grade Conditions:

   a. Required curb-inlet length upstream from catch basin = 1.25 x calculated length.

   b. Required length of grate = 1.0 x calculated length.

These general guidelines should be used unless more-detailed information about clogging for a specific grate type is available. A publication by the American Society of Civil Engineers and Water Pollution Control Federation (1987) gives relative rankings for debris-handling efficiencies of several types of grates. Figure 10.5 can also be used to obtain an estimate of the ability of a grate to handle debris. Grates that are longer than necessary to intercept 100 percent of frontal flow will have greater debris-handling efficiencies than will shorter grates.

10.7 Inlet Design Procedure

Inlet Locations:

1. Using the plan-and-profile information developed for the proposed roadway, locate all points where 100-percent interception of runoff will be required. These will be located at sumps, street intersections, and at other locations where it is felt that anything less than 100-percent interception would be unacceptably hazardous.

2. Choose a proposed street-and-gutter cross section. The maximum allowable cross-slope for a street is two percent. Depressed concrete gutters with a width of twenty-one inches and a cross-slope of 0.048 may be used to increase gutter capacity. Using the proposed cross section and slopes, determine the maximum discharge that the street will carry according to the design limitations.

3. Locate drainage area (D.A.) concentration points and determine discharges for all offsite runoff affecting the project. Offsite inlets will be needed for all offsite drainage exceeding the design capacity of the street.

4. The remaining drainage area should consist of the street itself, and possibly some offsite sheet flow. The watershed should be long, and more or less of uniform width. Using (1) an assumed time of concentration of five minutes; (2) the maximum discharge capacity computed in Step Two; and (3) an appropriate runoff coefficient, apply the City of Tucson hydrology method in order to determine the area of watershed required to produce the maximum allowable street discharge. When this area is divided by the width of the watershed, it will give the length of the watershed from its approximate upstream end to the first storm-drain inlet. Check the watershed hydrology to ensure that the assumed five-minute time of concentration is correct.

To determine total gutter flow, the cross section is divided into segments of equal width, and the discharge for each segment is computed by Manning's equation. The parabola can be approximated very closely by two-foot-wide segments. The total discharge is the sum of the discharges in all segments. This procedure is illustrated by Example 10.13.1, found at the end of this chapter.

Some streets within the City of Tucson have inverted crowns (i.e., the lowest point is at the center of the street, instead of at the curb). Discharge for this type of street cross section can be estimated using the following procedures.

For a parabolic cross section, use Manning's equation, along with the following relationships:

$$\text{Area } (A) = 2/3TY, \text{ in square feet;} \qquad (10.6)$$

$$\text{Wetted perimeter } (P) = T + 8/3\left[\frac{Y^2}{T}\right], \text{ in feet;} \qquad (10.7)$$

$$\text{Top Width } (T) = 3/2\left[\frac{A}{Y}\right], \text{ in feet; and,} \qquad (10.8)$$

$$\text{Hydraulic Depth } (Y_h) = 2/3\ Y, \text{ in feet.} \qquad (10.9)$$

Where:

Y = Maximum Depth, in feet.

However, it should be noted that, within the City of Tucson, streets with inverted crowns are normally built using a triangular cross section. For flow in a triangular inverted-crown section, use either Equation 10.3 or the nomograph shown in Figure 10.1.

10.6 Pavement Inlets

The capability of pavement inlets to quickly remove water from the street and into a storm drain depends upon their inlet geometry and upon the flow characteristics in the street and gutter. Pavement inlets are normally divided into the following three general types, with each having many variations:

1. Grate inlets: These inlets consist either of an opening in the gutter, covered by one or more grates, or an opening which spans the entire width of pavement (i.e., a "street grate").

2. Curb inlets: These inlets consist of a vertical opening in the curb, through which the gutter flow passes.

3. Combination inlets: These inlets consist of a curb inlet and a grate inlet acting as a single unit.

Grate inlets are most effective where clogging due to debris is not a problem. Excluding the effect of debris, the inlet capacity of grates in a sag condition depends mainly upon the open area of the grate and upon the depth of ponding. Capacity of grate inlets on a continuous grade depends primarily upon the discharge flowing directly over the grate, and upon the length and type of grate.

Grate inlets become more effective in relation to curb inlets as the grade of the roadway increases. *On grades of over three percent, grate inlets should be used instead of curb inlets.* Grates are also useful where cross-slopes for depressed gutters at curb inlets are not desirable, from a traffic standpoint, and at locations other than the edge of curb. For instance, grates are commonly used to collect flow at the middle of an inverted street.

The most efficient types of grates on a continuous grade are those which have all bars parallel to the direction of flow. Unfortunately, these grates typically are not safe for bicyclists; and therefore are *not permitted* to be used on City streets. However, there are many varieties of "bicycle-safe" grates which can be used on City streets (the interested reader should refer to a publication by the American Society of Civil Engineers and the Water Pollution Control Federation, 1987).

Curb inlets have few clogging problems; and they are most effective on relatively flat grades, where the depth of flow is sufficient for the inlet to perform efficiently. The interception capacity of curb inlets is largely dependent upon flow or ponding depth at the curb, and upon the length and height of the curb inlet. The flow-interception capacity is increased by a gutter depression at the curb inlet, or a depressed (composite) gutter to increase the proportion of the total flow adjacent to the curb. Top-slab supports can decrease the capacity of an inlet, if placed flush with the opening. Supports should be recessed several inches from the curb line.

One advantage to curb inlets is that they pose little threat to bicyclists. A disadvantage is that the openings are relatively wide, and could pose a danger to children. Therefore, it is recommended that curb inlets with a height of six inches or more be fitted with cross bars. Another disadvantage of curb inlets is that the depression adjacent to them could be hazardous to traffic at some locations.

Combination inlets can be very effective if the grate is placed at the downstream end of the structure--thereby allowing the curb inlet to collect the debris before it can clog the grate. The design capacity of these structures is the sum of the individual design capacities. If the curb inlet and grate are placed adjacent to each other, the total design capacity is only that of the grate alone.

Capacity charts for grate and curb inlets are widely available. However, due to the variety of configurations on the market, it is considered more useful here to merely present the basic relationships under which they operate.

10.6.1 Capacity of a Grate Inlet in a Sag

At low-water depths, a grate inlet in a sag operates as a weir, with a crest length equal to the outside perimeter of the grate along which the flow enters. Weir operation continues to a depth of about 0.4 foot above the top of grate, and the discharge intercepted by the grate is:

$$Q_i = 3.0\ P_g Y^{3/2} \qquad (10.10)$$

Where:

Q_i = Rate of discharge into the grate opening, in cubic feet per second;
P_g = Perimeter of grate opening, in feet, disregarding bars and neglecting the side against the curb, if present; and,
Y = Depth of water at the grate, in feet.

When the depth at the grate exceeds about 1.4 feet, the grate begins to operate as an orifice, and the discharge intercepted by the grate is:

$$Q_i = 5.35\ AY^{1/2} \qquad (10.11)$$

Where:

Q_i = Rate of discharge into the grate opening, in cubic feet per second;
A = Clear-opening area of the grate, in square feet; and,
Y = Depth of ponded water above the top of grate, in feet.

For depths over the grate between about 0.4 feet and about 1.4 feet, the operation of the grate inlet is indefinite. In this case, the depth of flow should be computed by both equations. The equation which yields the higher of the two values for depth should then be used for design purposes.

If the grate is sloped such that the side away from the curb is considerably higher than the curb side, the side inflow and end inflow should be computed separately. Inflow over the end of a grate, when it is operating as a weir, should be computed from:

$$Q_e = 2/5 \left(\frac{CL}{Y_2 - Y_1} \right) \left(Y_2^{5/2} - Y_1^{5/2} \right) \qquad (10.12)$$

Where:

Q_e = Rate of discharge over the end of the grate opening, in cubic feet per second;
Y_1 = Depth of flow at the shallow side of the grate, in feet;
Y_2 = Depth of flow at the deep side of the grate, in feet;
L = Distance from Y_1 to Y_2, in feet; and,
C = Weir coefficient = 3.0.

Total interception of the flow is then computed by summing the flows calculated at each end of the grate opening, using Equation 10.12, with the flow calculated on each side of the grate opening, using Equation 10.10.

When a sloped grate is operating under conditions of orifice flow, the following equation should be used to compute its interception capacity:

$$Q_i = 3.60\left(\frac{A}{Y_2 - Y_1}\right)\left(Y_2^{3/2} - Y_1^{3/2}\right) \quad (10.13)$$

Where all terms are as previously defined within Equation 10.11 and Equation 10.12.

10.6.2 Capacity of a Curb Inlet in a Sag

A curb inlet in a sag operates as a weir to depths up to the height of the curb inlet, and as an orifice at depths greater than 1.4 times the opening height. Between those depths, flow is in a transition stage.

The equation for computing the interception capacity of a curb inlet *without a depression* which operates as a weir is:

$$Q_i = 2.3\ LY_i^{3/2} \quad (10.14)$$

Where:

L = Length of curb inlet, in feet; and,
Y_i = Depth at lip of curb inlet, in feet (i.e., $Y_i = TS_x$).

The equation for computing the interception capacity of a *depressed* curb inlet which operates as a weir is:

$$Q_i = 2.3\ (L + 1.8W)Y_i^{3/2} \quad (10.15)$$

Where:

W = Lateral width of depression, in feet; and all other terms are as previously described.

Equation 10.15 is applicable to depths at the curb which are approximately equal to the height of the opening, plus the depth of the depression.

Curb inlets operate as orifices at depths greater than $1.4(h)$ (see Figure 10.3). The equation for interception capacity is then:

$$Q_i = 5.35A(Y_i - h/2)^{1/2} \quad \textbf{(10.16a)}$$

or

$$Q_i = 5.35\ AY_o^{1/2} \quad \textbf{(10.16b)}$$

Where:

Y_o = Effective head on the center of the orifice throat, in feet;
A = Clear area of opening, in feet;
Y_i = Depth at lip of curb inlet, in feet;
h = Height of curb-inlet orifice, in feet; and,
L = Length of curb inlet, in feet.

Figure 10.3 gives the relationship between the variables for horizontal-throat, inclined-throat, and vertical-throat inlets.

Curb-inlet capacity in the transition stage, when ponding depth is 1.0 to 1.4 times the opening height, should be computed using both the weir equation and the orifice equation. The equation which yields the lesser discharge at equal head should then be used for design purposes.

10.6.3 Capacity of a Combination Inlet in a Sag

When weir-flow applies, the interception capacity of a combination inlet in a sag, consisting of a grate and a curb inlet, is essentially equal to the capacity of the grate only, unless the grate becomes clogged. In orifice flow, the capacity is equal to the capacity of the grate, plus the capacity of the curb inlet.

10.6.4 Capacity of a Slotted Inlet in a Sag

A slotted inlet in a sag normally operates as a weir to depths of about 0.2 feet. At depths greater than about 0.4 feet, it performs as an orifice. Between these depths, the more conservative of the two equations (i.e., the one which predicts the greatest depth) should be used for design purposes. The interception capacity, Q_i, of a slotted inlet operating as an orifice should be computed from:

$$Q_i = 6.42\ LWY^{1/2} \quad \textbf{(10.17)}$$

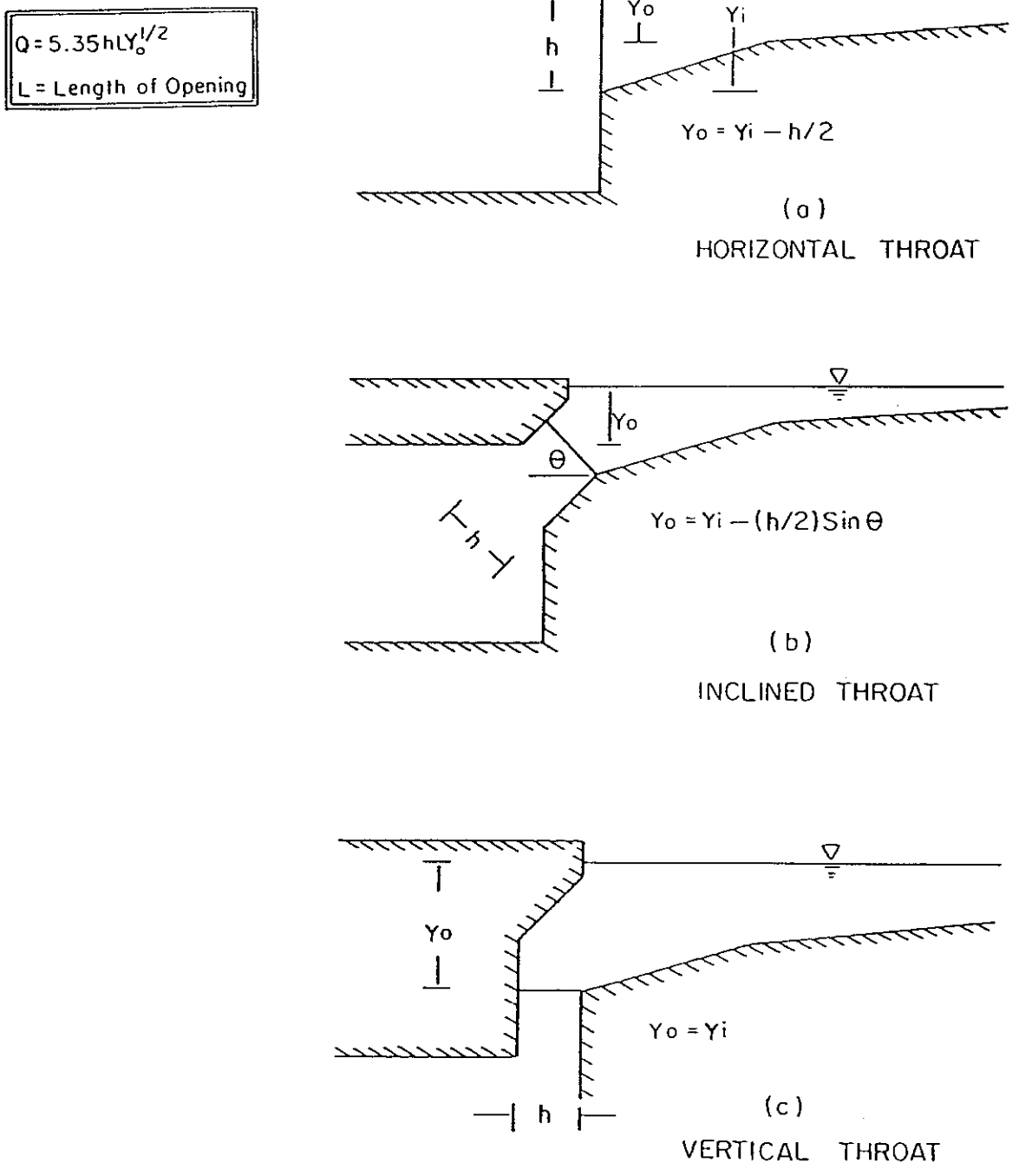


FIGURE 10.3
CURB-OPENING INLETS

Where:

L = Length of slot, in feet;
W = Width of slot, in feet; and,
Y = Depth of water at slot, in feet.

10.6.5 Capacity of a Grate Inlet on a Continuous Grade

A grate inlet on a continuous grade will intercept all of the frontal flow passing over the grate, unless the grate becomes clogged or splash-over occurs. Splash-over will occur, and only a portion of the frontal flow will be intercepted, if the velocity is high or the grate is short. Normally, a small part of the flow along the side of the grate will also be intercepted. Therefore, the total capacity of a grate is the sum of the frontal flow and the side flow, minus the splash-over flow.

The amount of frontal flow, Q_f, should be computed with the following equation:

$$\frac{Q_f}{Q_T} = E_o = 1 - (1 - W/T)^{8/3}$$

Where:

Q_f = Frontal flow at width W, in cubic feet per second;
Q_T = Total gutter flow, in cubic feet per second;
W = Width of grate, in feet;
T = Total spread of water at the gutter, in feet; and,
E_o = Ratio of frontal flow to total gutter flow.

Figure 10.4 provides a graphical solution of the frontal-flow equation.

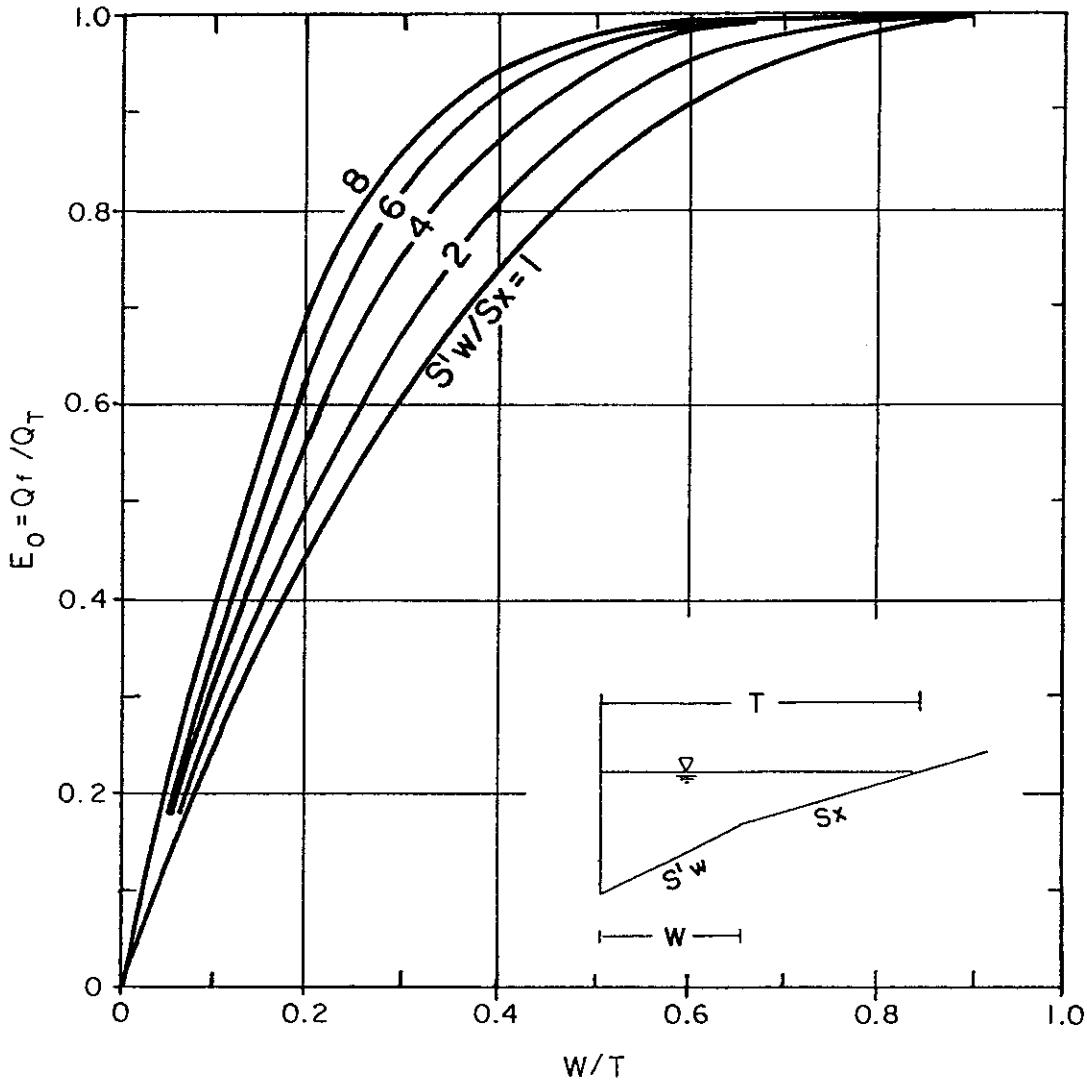
The ratio, R_f, of frontal flow intercepted, Q_{fi}, to total frontal flow, Q_f, is expressed by:

$$\frac{Q_{fi}}{Q_f} = R_f = 1 - 0.09\,(V - V_o) \qquad \textbf{(10.19)}$$

Where:

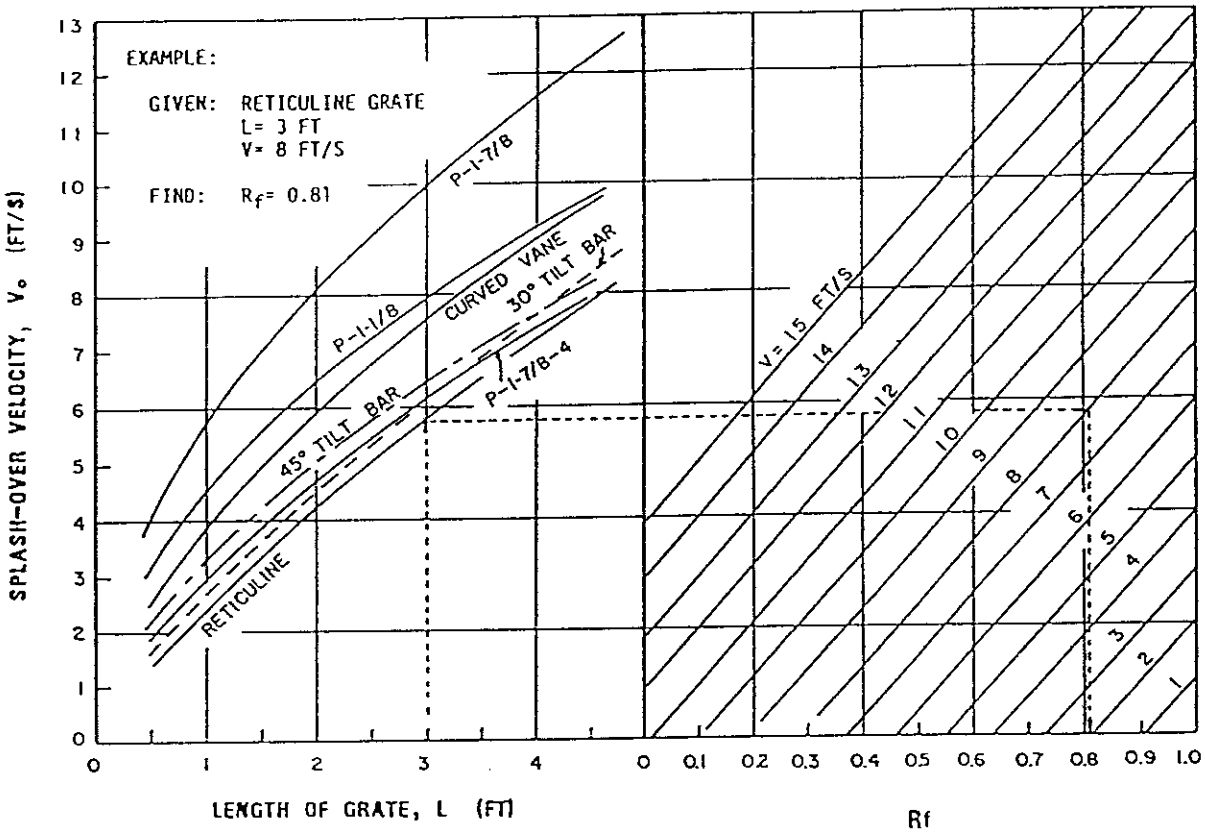
V = Velocity of flow in the gutter, in feet per second; and,
V_o = Gutter velocity at which splash-over first occurs, in feet per second.

V_o is different for different grates, and must be determined experimentally. Figure 10.5 gives splash-over velocities for several common grate types and sizes described in a publication by the American Society of Civil Engineers and Water Pollution Control Federation (1987). Figure 10.5 also provides a graphical solution to the ratio of frontal flow captured to total frontal flow.



$$Q_f = E_o Q_T$$

FIGURE 10.4
RATIO OF FRONTAL FLOW TO TOTAL GUTTER FLOW



$$Q_{fi} = R_f Q_f$$

FIGURE 10.5
FRONTAL-FLOW INTERCEPTION EFFICIENCY FOR GRATE INLETS

The amount of side flow, Q_s, is equal to the total flow minus the frontal flow (i.e., $Q_s = Q_T - Q_f$).

The ratio, R_{sf}, of side flow intercepted, Q_{si}, to total side flow, Q_s, is given by:

$$\frac{Q_{si}}{Q_s} = R_{sf} = \left[1 + \frac{0.15\,V^{1.8}}{S_x\,L^{2.3}} \right]^{-1.0} \qquad \textbf{(10.20)}$$

Where:

L = Length of the grate, in feet, and the other terms are as previously defined.

Note the negative exponent in this equation. Figure 10.6 provides a graphical solution to this equation.

The total interception capacity (Q_i) of a grate inlet on a continuous grade is therefore equal to:

$$Q_i = R_f Q_f + R_{sf} Q_s \qquad \textbf{(10.21)}$$

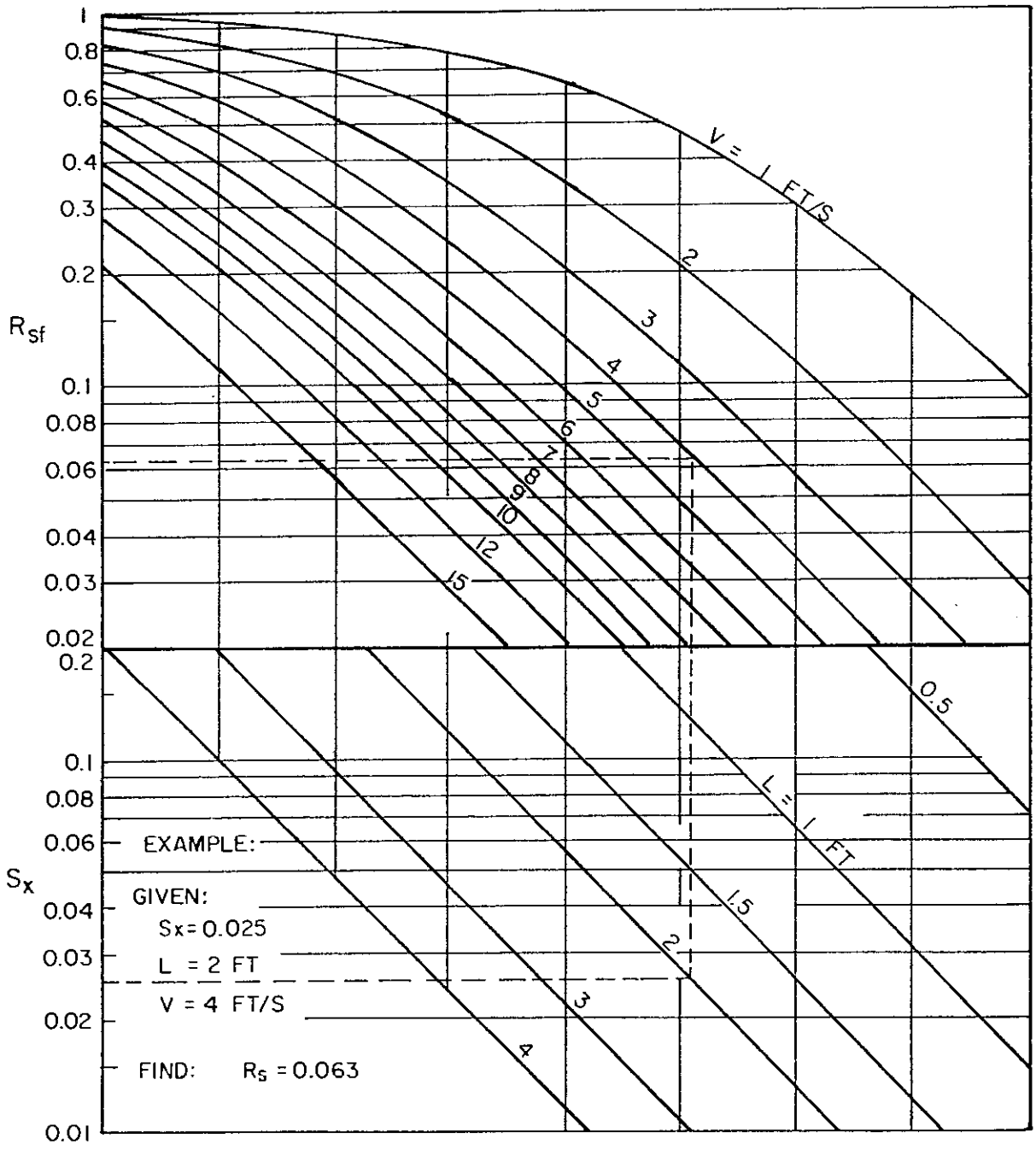
10.6.6 Capacity of a Curb Inlet on a Continuous Grade

The length of a curb inlet required for total interception of gutter flow on a pavement section with a straight cross-slope (i.e., no gutter depression) is expressed by:

$$L_t = 0.6 \left[Q_T^{0.42} S_o^{0.3} \right] \left[\frac{1}{n\,S_x} \right]^{0.6} \qquad \textbf{(10.22)}$$

Where:

L_t = Curb-inlet length required to intercept 100 percent of the gutter flow, in feet;
S_x = Pavement cross-slope, in feet per foot;
S_o = Longitudinal slope of gutter, in feet per foot; and,
n = Manning's roughness coefficient.



$$Q_{si} = R_{sf} Q_s$$

FIGURE 10.6
SIDE-FLOW INTERCEPTION EFFICIENCY FOR GRATE INLETS

The efficiency of curb inlets shorter than the length required for total interception is expressed by:

$$E_i = 1 - (1 - L_i/L_t)^{1.8} \quad (10.23)$$

Where:

E_i = Ratio of discharge intercepted by the curb inlet to total discharge (i.e., the "efficiency" of the curb inlet);
L_i = Curb-inlet length, in feet; and,
L_t = As defined in Equation 10.22

Figure 10.7 is a nomograph for the solution of Equation 10.22, and Figure 10.8 provides a solution of Equation 10.23.

The length of inlet required for total interception by depressed curb inlets, or curb inlets in depressed gutter sections, can be found by the use of an equivalent cross slope, S_e, in place of S_x in Equation 10.22, as determined by the following equation:

$$S_e = S_x + S'_w E_o \quad (10.24)$$

Where:

$S'_w = \frac{a}{12W}$ = Cross-slope of the gutter, measured from the cross-slope of pavement, S_x, in feet per foot.

And where:

a = Gutter depression, in inches, at the curb inlet (measured as the vertical distance between the low point of the gutter and the point where the cross slope of the pavement intersects the curb. For a standard twenty-one-inch gutter width, with a one-inch drop from one side to the other and a two-percent street cross-slope, "a" is equal to six-tenths of an inch);
W = Width of depressed gutter, in feet; and,
E_o = Ratio of flow in the depressed section to total gutter flow.

NOTE: E_o is the same ratio as that used to compute the frontal flow interception of a grate inlet.

Equations 10.22 and 10.23 can be combined to directly compute the length of the curb inlet required to intercept a certain percentage of the total discharge. This expression is:

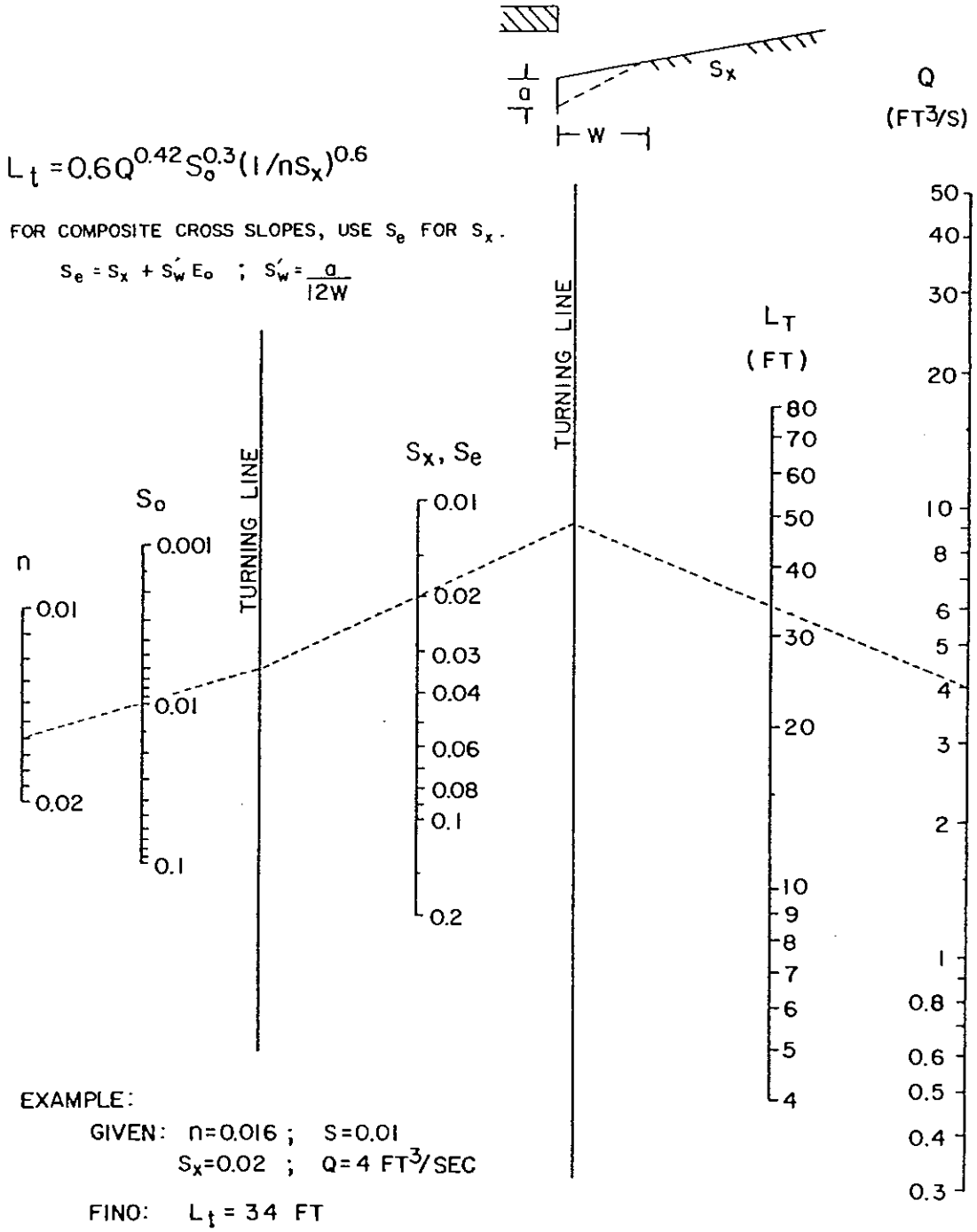


FIGURE 10.7
INLET LENGTH FOR TOTAL INTERCEPTION BY CURB OPENINGS AND SLOTTED DRAINS

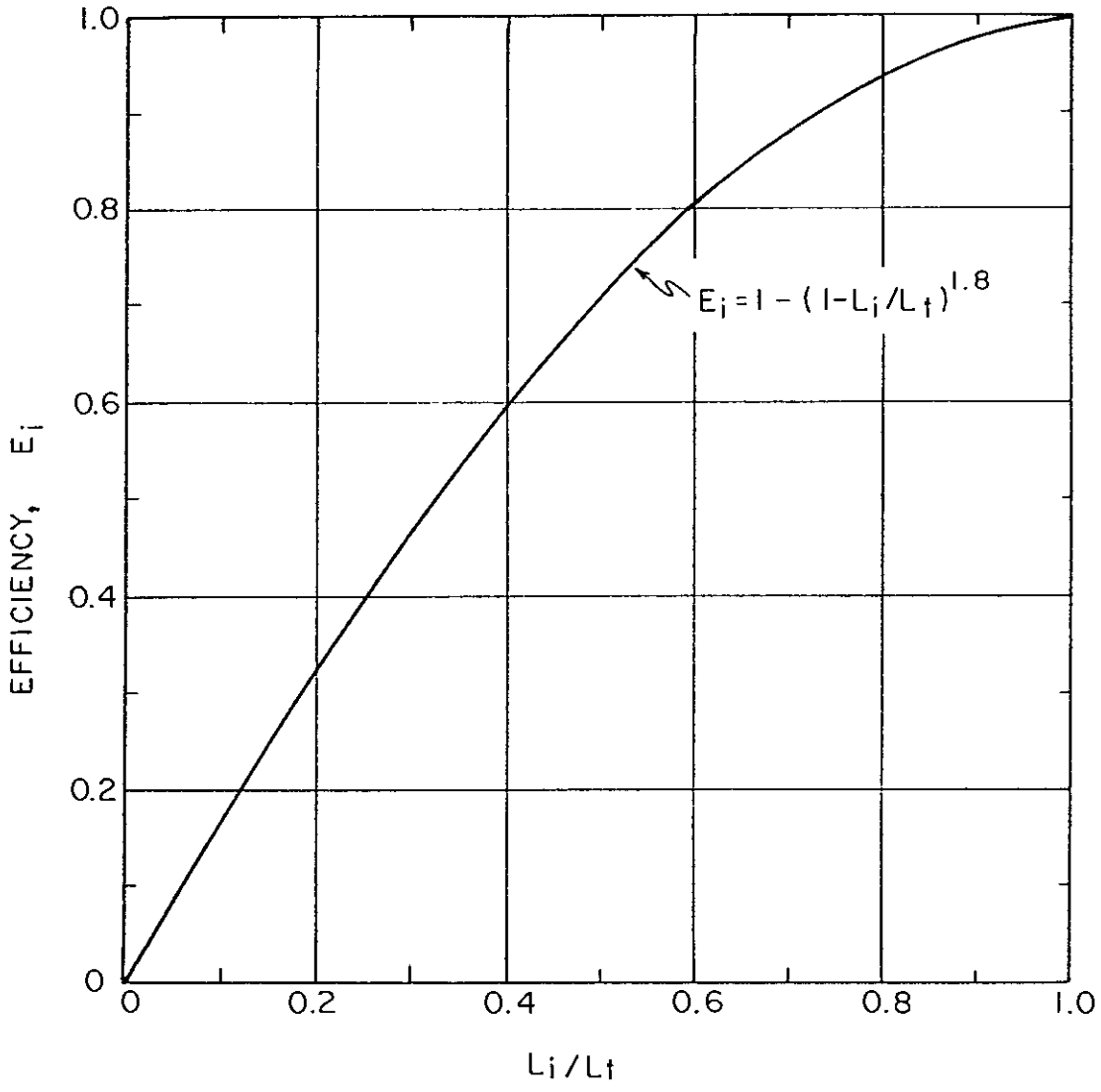


FIGURE 10.8
INLET INTERCEPTION EFFICIENCY FOR
CURB OPENINGS AND SLOTTED DRAINS

$$L_i = 0.6 \left(\frac{Q^{0.42} S_o^{0.3}}{n^{0.6} S_x^{0.6}} \right) \left(1 - [1-E_i]^{0.56} \right) \quad (10.25)$$

Where all terms are as previously defined.

As with Equation 10.22, the S_x term is replaced by an equivalent cross slope, S_e, for a compound gutter section (see Figure 10.9). The equivalent cross slope can then be computed by combining Equations 10.4 and 10.24 to form the expression:

$$S_e = S_x + 0.0467 \left(\frac{a S_o^{1/2}}{Q n} \right) \left(\frac{Y_{cf}^{8/3} - Y_{gb}^{8/3}}{Y_{cf} - Y_{gb}} \right) \quad (10.26)$$

Where all terms are as previously defined.

NOTE: In Equation 10.24, the "Y_{cf}" and "Y_{gb}" terms represent the depth of flow at the curb face and the depth of flow at the gutter edge, in the gutter approaching the curb inlet, respectively.

As a rule of thumb, for preliminary sizing of curb-inlet lengths with compound gutter sections, it can be assumed that the curb-inlet capacity is 0.75 cfs/foot, if the pavement spread is over two lanes, and 0.40 cfs/foot, if the pavement spread is over only one lane. This assumes a two-inch depressed gutter at the curb inlet; a 75-percent inlet efficiency; and *no consideration for clogging due to debris.*

10.6.7 Capacity of a Combination Inlet on a Continuous Grade

A combination inlet on a continuous grade, where the curb inlet and grate are placed side-by-side, does not have much greater capacity than the grate alone. This type of inlet should not be used on a continuous grade. However, combination inlets with the curb inlet located upstream of the grate are useful, because the curb inlet intercepts normal debris loads which could otherwise clog the grate on a frequent basis. The capacity of these inlets is the sum of the capacities of the curb inlet and the grate. However, the discharge over the grate must be reduced by an amount equal to the interception capacity of the curb inlet.

10.6.8 Capacity of a Slotted Inlet on a Continuous Grade

The capacity of a slotted inlet on a continuous grade can be computed using the same formulas and charts that are used for computing curb-inlet capacities. The advantage of using slotted inlets is their versatility. They can be used on both curbed and uncurbed streets to collect a wide variety of flow patterns.

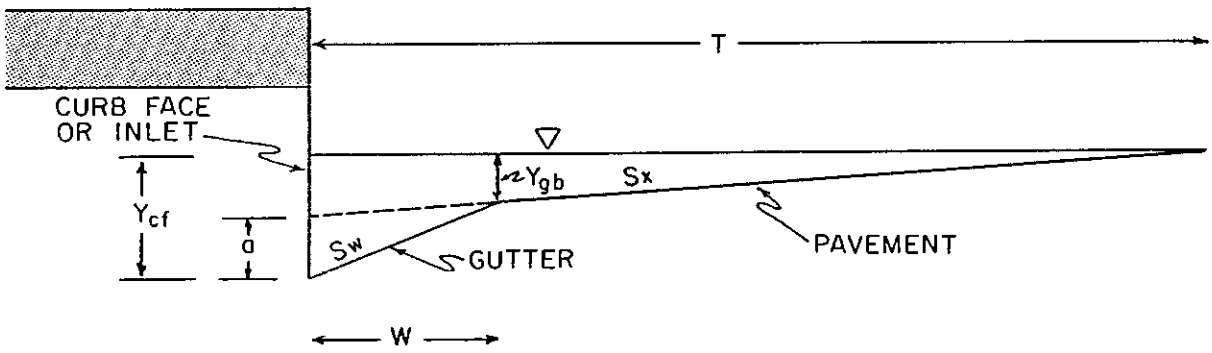


FIGURE 10.9
COMPOUND GUTTER SECTION

10.6.9 Clogging

The following guidelines should be followed to provide an appropriate factor of safety against clogging at pavement inlets:

GRATES AND SLOTTED DRAINS:

1. Sump Conditions:
   a. Orifice Flow: required area = 2.0 x calculated area.
   b. Weir Flow: required perimeter = 2.0 x calculated perimeter.
2. Continuous-grade conditions:
   a. Required length of opening = 2.0 x calculated length.

CURB INLETS:

1. Sump Conditions:
   a. Required length of opening = 1.50 x calculated length.
2. Continuous-grade conditions:
   a. Required length of opening = 1.25 x calculated length.

COMBINATION GRATE AND CURB INLET:

1. Sump Conditions:
   a. Orifice Flow: required area = 2.0 x calculated area for grate; required length = 1.25 x calculated length for curb inlet.
   b. Weir flow: required perimeter = 1.0 x calculated perimeter for grate; required length = 1.25 x calculated length for curb inlet.
2. Continuous-grade conditions:
   a. Required length of opening = 1.0 x calculated length for grate; required length = 1.25 x calculated length for curb inlet.

ADOT STANDARD TYPE-3 CATCH BASINS:

1. Continuous-Grade Conditions:

   a. Required curb-inlet length upstream from catch basin = 1.25 x calculated length.

   b. Required length of grate = 1.0 x calculated length.

These general guidelines should be used unless more-detailed information about clogging for a specific grate type is available. A publication by the American Society of Civil Engineers and Water Pollution Control Federation (1987) gives relative rankings for debris-handling efficiencies of several types of grates. Figure 10.5 can also be used to obtain an estimate of the ability of a grate to handle debris. Grates that are longer than necessary to intercept 100 percent of frontal flow will have greater debris-handling efficiencies than will shorter grates.

10.7 Inlet Design Procedure

Inlet Locations:

1. Using the plan-and-profile information developed for the proposed roadway, locate all points where 100-percent interception of runoff will be required. These will be located at sumps, street intersections, and at other locations where it is felt that anything less than 100-percent interception would be unacceptably hazardous.

2. Choose a proposed street-and-gutter cross section. The maximum allowable cross-slope for a street is two percent. Depressed concrete gutters with a width of twenty-one inches and a cross-slope of 0.048 may be used to increase gutter capacity. Using the proposed cross section and slopes, determine the maximum discharge that the street will carry according to the design limitations.

3. Locate drainage area (D.A.) concentration points and determine discharges for all offsite runoff affecting the project. Offsite inlets will be needed for all offsite drainage exceeding the design capacity of the street.

4. The remaining drainage area should consist of the street itself, and possibly some offsite sheet flow. The watershed should be long, and more or less of uniform width. Using (1) an assumed time of concentration of five minutes; (2) the maximum discharge capacity computed in Step Two; and (3) an appropriate runoff coefficient, apply the City of Tucson hydrology method in order to determine the area of watershed required to produce the maximum allowable street discharge. When this area is divided by the width of the watershed, it will give the length of the watershed from its approximate upstream end to the first storm-drain inlet. Check the watershed hydrology to ensure that the assumed five-minute time of concentration is correct.

For design discharges less than the 100-year flood, use appropriate ratios and procedures as outlined in Chapter IV of this Manual.

5. Choose a type of inlet that is appropriate for the location; and, using the appropriate procedures as described herein, develop a preliminary inlet design. Approximately 75 percent of the flow should be intercepted for maximum design efficiency.

6. Repeat Step Four to determine the distance to the next downstream inlet. Although not strictly accurate, the carry-over flow, Q_{co}, is added directly to the discharge produced in the intervening watershed between the two inlets. In reality, there should be a lag in peaks, and the amount to be accepted by a downstream inlet should be determined by adding hydrographs. However, this procedure would soon become very tedious. In view of the fact that the times of concentration are generally small, and that the inlets are spaced close together, direct adding of peaks is acceptable, and provides a measure of safety to the final design of the inlets.

7. Steps Five and Six are repeated, as necessary, until all drainage is accounted for within the system. At this time, needed revisions may become apparent for practical or economic reasons. Revisions should be made, and standard designs chosen, for all inlets. If the standard designs differ from the preliminary designs, the procedure should be repeated with the standard designs in order to ensure that the system works properly.

Work sheets for this procedure are presented in Figure 10.10, and an example is provided at the end of this chapter.

10.8 Storm-Drain Calculations

The two simplest methods of hydraulic analysis for use in the design of storm drains are (1) the "normal-flow method", and (2) the "pressure-flow method". The "normal-flow method" is much simpler to utilize, but it is often inaccurate. Its use often results in undersized pipes--especially if there are manholes, bends, junctions, and transitions that create energy (head) losses in the storm drain. On the other hand, the "normal-flow method" could also result in the design of storm drains that are larger and more expensive than necessary--particularly if there is sufficient head to create higher than normal flow velocities.

The pipe slope and the friction slope of storm drains designed for normal flow are assumed to be equal. It is therefore not necessary to calculate a hydraulic grade line for these storm drains if the soffits of connecting pipes of unequal size are set at the same elevation, and if the so-called "minor" head losses along the storm drain are minimal.

A hydraulic grade line for pressure flow will need to be computed whenever there is a high tailwater; or when it is desired to determine the effects which occur when a larger than design-frequency storm occurs; or whenever minor losses or pipe alignment may induce pressure flow; or when it is desired to check to see if a smaller pipe size

Sheet_____ Of_____

PAVEMENT-DRAINAGE WORKSHEET

LOCATION DATA:

Location: _____

Project No: _____

DESIGN DATA:

Frequency_____

T_{all} =

Curb Height =

n = _____

RUNOFF CALCULATIONS:

From Station	To Station	L ft.	W ft.	D.A. acre,	C_w	T_c min.	I in/hr.	Q_{100} cfs	Q_{design} cfs	Q_{co} cfs	Q_T cfs	S_o ft/ft	S_x ft/ft	D_{ft}	T_{ft}

INLET CALCULATIONS

Station	Inlet Type	Y ft.	Q_i cfs	$Q_{co} = Q_T - Q_i$

Computed by:_____ Checked by:_____

Figure 10.10: Pavement Drainage Worksheet

could be used under conditions of pressure flow. It will generally be a requirement to compute the design hydraulic grade line for any proposed storm drain.

10.8.1 Normal-Depth Calculations

Normal-depth calculations are accomplished by using Manning's equation:

$$Q = \frac{1.486}{n}\left[\frac{A}{P}\right]^{2/3} S_o^{1/2} A \qquad (10.27)$$

Where:

Q = Discharge, in cubic feet per second;
A = Flow area within the pipe, in feet;
n = Manning's roughness coefficient;
P = Wetted perimeter of flow, in feet; and,
S_o = Pipe slope, in feet per foot.

Figure 10.11 shows the relationship of these parameters for a circular conduit.

10.8.2 Pressure-Flow Calculations: Computation of Hydraulic Grade Line

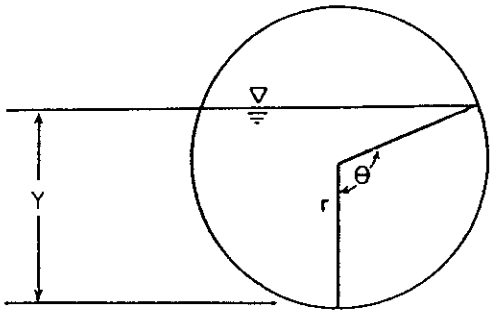
Hydraulic grade-line computations for pressure flow are based on the Bernoulli equation. This equation is as follows:

$$\frac{V_1^2}{2g} + D_{hg1} + S_o L = \frac{V_2^2}{2g} + D_{hg2} + S_f L + H_m \qquad (10.28)$$

Where:

H_m = "Minor" head losses, in feet, and all other terms are as defined by Figure 10.12.

The hydraulic grade line is computed by starting with the control tailwater elevation at the drain outlet, and subsequently performing a hydraulic grade-line calculation in the upstream direction. Friction and minor losses are computed for each segment of the storm drain. These energy losses are added to the total energy elevation at the downstream endpoint of the storm-drain segment in order to obtain the total energy elevation at the upstream endpoint of the segment. The hydraulic grade line is equal to the total energy grade line, minus velocity head at any point along the storm drain.



$\theta = \cos^{-1}\left(\frac{r-Y}{r}\right)$ (in radians)

$A = r^2(\theta - \sin\theta\cos\theta)$

$P = 2r\theta$

D = DIAMETER PIPE = 2r

MAX Q AT $\frac{Y}{D} = 0.938$

MAX R AT $\frac{Y}{D} = 0.813$

R = HYDRAULIC RADIUS = $\frac{A}{P}$

FIGURE 10.11
HYDRAULIC PARAMETERS OF A CIRCULAR CROSS SECTION

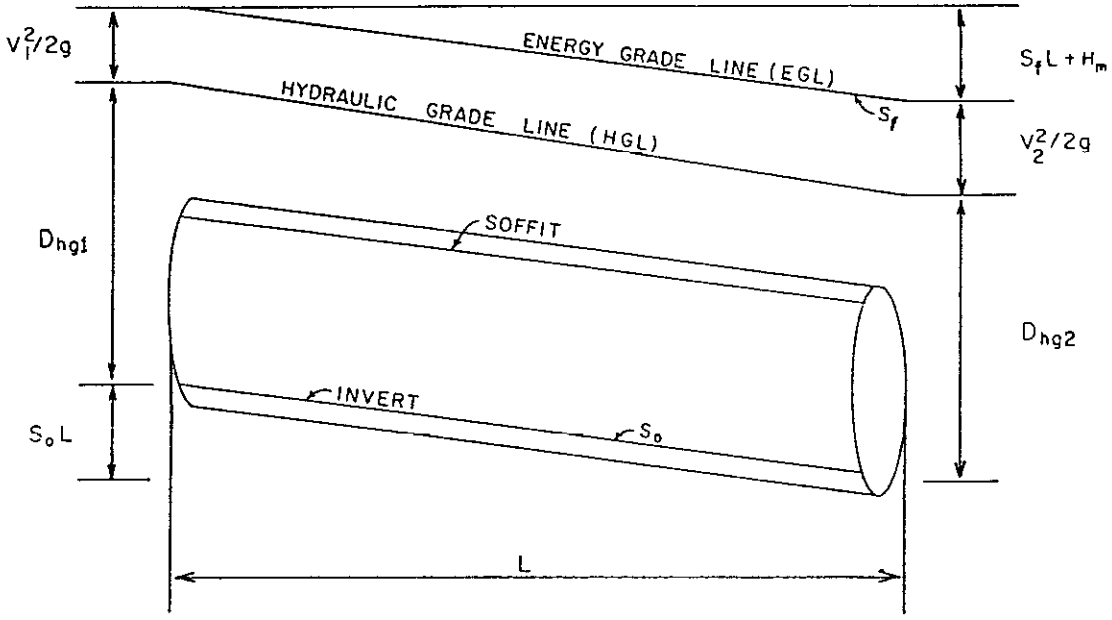


FIGURE 10.12
HEAD-LOSS DIAGRAM FOR PIPES

10.8.3 Friction Losses

Friction losses, h_f, are computed by Manning's equation for an assumed or given discharge. The form of Manning's equation used is:

$$S_f = \frac{29.2n^2}{R^{1.33}} \left(\frac{V^2}{2g} \right) \tag{10.29}$$

Where:

R = Hydraulic radius (i.e., the cross-sectional area of flow divided by the wetted perimeter of flow), in feet.

All other terms are as previously defined.

The friction loss for a storm-drain segment is then computed by the following equation:

$$h_f = S_f L = \text{Friction loss} \tag{10.30}$$

10.8.4 Minor Losses

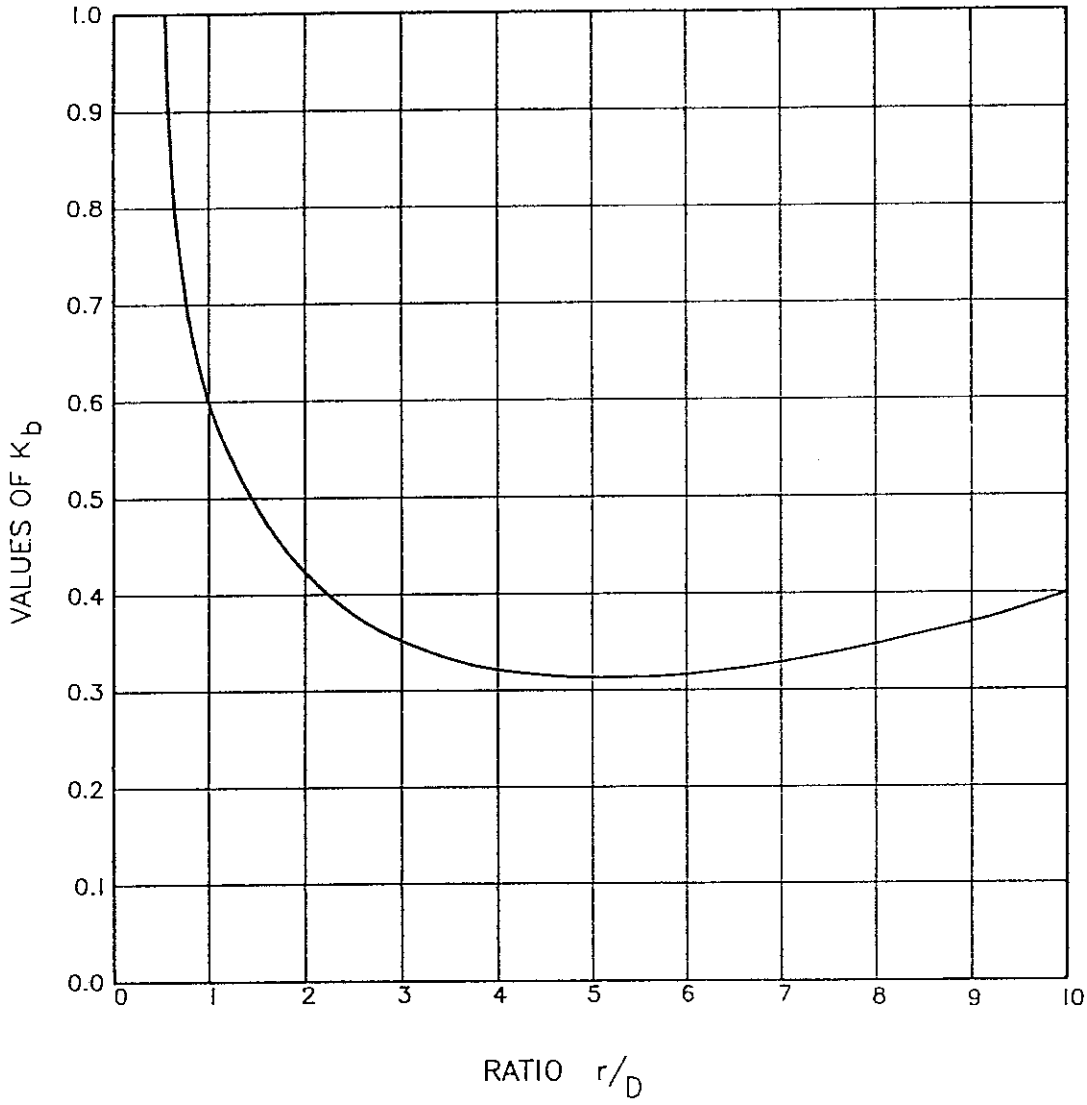
"Minor" losses in a storm drain are those that are associated with the energy necessary for the passage of water through areas such as junctions, manholes, and transitions. The total head loss is the sum of friction losses and minor losses. Minor losses, H_m, are normally represented as a factor K of velocity head:

$$H_m = K \left(\frac{V^2}{2g} \right) \tag{10.31}$$

The factor K varies widely, depending on the type of loss (e.g., bend, entrance, junction, manhole, etc.) and the configuration of the particular structure creating the head loss. A publication by the Denver Regional Council of Governments (1969) gives detailed information on minor losses, as do many hydraulics text books. It is important to note that these so-called "minor" losses can sometimes exceed friction losses within a storm-drain system, and therefore should always be evaluated at some point during the design process. Some of the more common minor losses encountered in storm-drain design are covered in the following sections.

10.8.5 Bend Losses

Head-loss coefficients for pipe bends with a deflection angle of 90 degrees, K_{b90}, can be determined from Figure 10.13.



r = radius of ℄ of bend; D = diameter
of circular section or side of square section

FIGURE 10.13
HEAD–LOSS COEFFICIENT FOR 90° PIPE BEND

K_{b90} for 90-degree, square elbows, where there is no rounding of corners of the intersecting conduits, ranges from 1.25 to 1.50. In cases of bends where the deflection is less than 90 degrees, determine the head-loss coefficients for bends as follows:

K_b (For bend < 90°) =

$$\left[1 - \left[\frac{90 - \text{deflection in degrees}}{90}\right]^2\right] K_{b90} \qquad (10.32)$$

Bend head loss, h_b, is then:

$$h_b = K_b \left[\frac{V^2}{2g}\right] \qquad (10.33)$$

10.8.6 Junction Losses

Junction losses, h_j, where the diameter of the main pipe does not change, shall be computed by:

$$h_j = \frac{V_2^2}{2g} - \frac{V_1^2}{2g} - \left[\frac{A_3 V_3^2}{A_2 g}\right] Cos\theta \qquad (10.34)$$

Figure 10.14A illustrates this type of junction.

In the case where $D_1 \neq D_2$, junction loss shall be calculated by the Thompson equation:

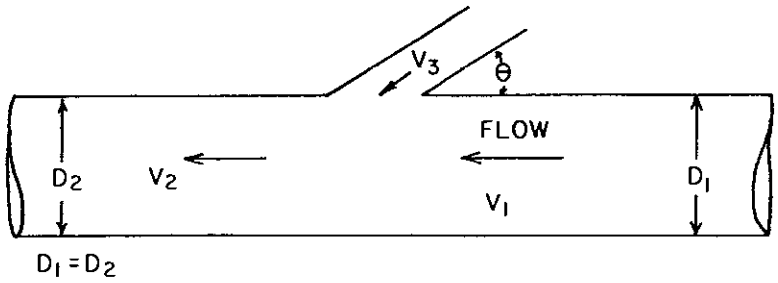
$$\Delta HG = \left[\frac{2}{A_1 + A_2}\right] \left[\frac{Q_2 V_2 - Q_1 V_1 - Q_3 V_3 Cos\theta}{g}\right] \qquad (10.35)$$

Figure 10.14B illustrates this type of junction.

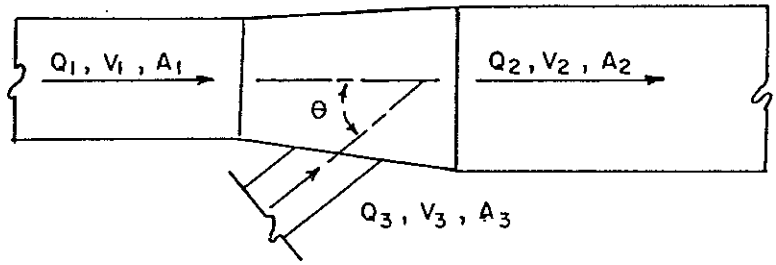
Where:

ΔHG = Difference in hydraulic gradient for the two ends of the junction, in feet;

A JUNCTION



B JUNCTION



C TRANSITION

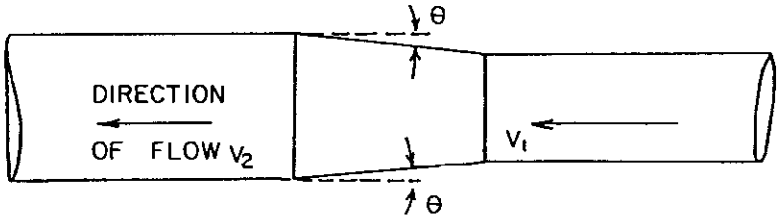


FIGURE 10.14
JUNCTION AND TRANSITION CONFIGURATIONS

A_1 = Flow area of mainline pipe upstream of the junction, in square feet;
A_2 = Area of mainline pipe downstream of the junction, in square feet;
A_3 = Area of tributary pipe, in square feet;
Q_1 = Discharge of mainline pipe upstream of the junction, in cubic feet per second;
Q_2 = Discharge of mainline pipe downstream of the junction, in cubic feet per second;
Q_3 = Discharge of tributary pipe, in cubic feet per second;
V_1 = Flow velocity in mainline pipe upstream of the junction, in feet per second;
V_2 = Flow velocity in mainline pipe downstream of the junction, in feet per second;
V_3 = Flow velocity in tributary pipe, in feet per second; and,
θ = The angle formed by the junction between the tributary pipe and the mainline pipe, in degrees.

It is very important to note that ΔHG in this equation is the difference in hydraulic grade-line elevation, not the energy grade line. The total energy loss at the junction, h_j, is represented by:

$$h_j = \Delta HG + \frac{V_1^2}{2g} - \frac{V_2^2}{2g} \qquad \textbf{(10.36)}$$

Junction loss should always be applied at the upstream side of the junction.

At junctions where there is more than one tributary inflow, the computation of head loss becomes more complicated. In most simple cases, Equation 10.35 can be used by subtracting $Q_n V_n \text{Cos}\theta$ terms in the numerator for each junction pipe. A publication by the Denver Regional Council of Governments (1969) gives junction losses for many detailed examples found in storm-drain design.

10.8.7 Transition Losses

Transition losses, h_t, for velocities which increase in the direction of flow (i.e., a contraction) are to be calculated using the following formula:

$$h_{tc} = 0.1\left(\frac{V_2^2}{2g} - \frac{V_1^2}{2g}\right) \qquad \textbf{(10.37)}$$

Where velocities decrease in the direction of flow (i.e., an expansion), the formula to be used is:

$$h_{te} = 0.2\left[\frac{V_1^2}{2g} - \frac{V_2^2}{2g}\right] \quad \textbf{(10.38)}$$

See Figure 10.14C for a diagram which illustrates how to calculate transition losses using Equation 10.36.

10.8.8 Manhole Losses

For manholes with no change in pipe size or discharge, and where the flow is straight through, manhole losses, h_{mh}, shall be computed by:

$$h_{mh} = K_{mh}\left[\frac{V^2}{2g}\right] \quad \textbf{(10.39)}$$

Where $K_{mh} = 0.05$.

Head loss for manholes where flow changes direction, but where there is no change in discharge or pipe size, should be determined from Figure 10.15.

For manholes which contain junctions, or that have changes in pipe size, the head loss associated with these elements should be computed according to the guidelines for junction and transition losses, as presented within this chapter. This head loss should then be added to the head loss computed by use of either Equation 10.39 or Figure 10.15, in order to obtain the total head loss through these types of manholes.

10.8.9 Entrance and Outlet Losses

Entrance losses, h_e, are calculated by the following equation:

$$h_e = K_e\left[\frac{V^2}{2g}\right] \quad \textbf{(10.40)}$$

Values for K_e are given by:

TYPE OF INLET	VALUE OF K_e
Inward Projecting	0.78
Sharp Cornered	0.50
Bell Mouth (Beveled)	0.04

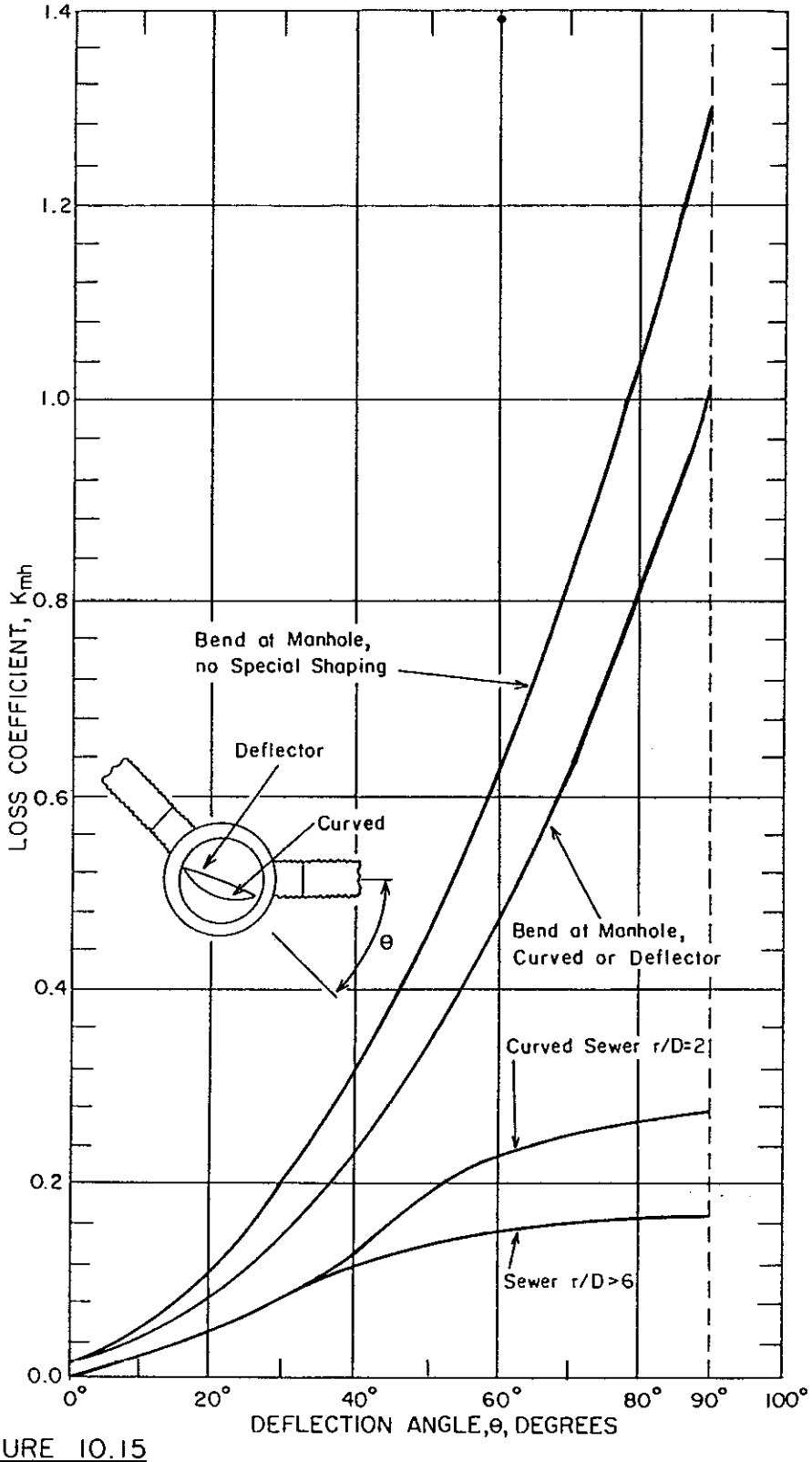


FIGURE 10.15
MANHOLE HEAD LOSS

CULVERT OUTLET VELOCITY	SUGGESTED OUTLET PROTECTION
Less than 4 fps	No protection required
More than 4 fps and less than 10 fps	Dumped rock riprap
More than 10 fps	Wire-tied riprap

If the velocity is greater than 10 fps, consider using a concrete energy dissipator, or increasing culvert size.

2. Structurally-designed downstream cut-off walls should be installed whenever the equilibrium channel slope is less than the existing channel slope. Refer to Chapter VI of this Manual for the sizing and spacing of cut-off walls.

3. Downstream embankment stabilization should be provided whenever the 100-year design flood overtops the roadway for a continuous period of time exceeding 10 minutes in duration (Pima County Department of Transportation and Flood Control District, 1984, P. VI-8).

11.5 Culvert vs. Bridge Crossings

Sedimentation at culvert crossings may be a problem when the culvert cannot transport all of the sediment being delivered by the approach channel. In general, pipe culverts will transport less sediment than box culverts, and smooth pipes (e.g., concrete) will transport more sediment than corrugated metal pipes. However, the most effective method of eliminating sedimentation problems is to utilize a bridge structure which minimizes changes to the hydraulics or geometry of the approach channel. Equation 11.9 is provided as an aid to the engineer in determining if a particular culvert crossing may experience sediment deposition either within the culvert or at its entrance.

$$\Re_s = \frac{Q_{ac}}{Q_p}\left(\frac{S_{ac}}{S_p}\right)^{1.66}\left(\frac{n_{ac}}{n_p}\right)^{-1.55}\left(\frac{R_{ac}}{R_p}\right)^{0.91} \qquad (11.9)$$

Where:

$\Re_s$ = Sediment-transport ratio (channel to culvert);
Q_{ac} = Discharge in approach channel, in cubic feet per second;
Q_p = Total culvert discharge, in cubic feet per second;
S_{ac} = Longitudinal slope of approach channel, in feet/foot;
S_p = Longitudinal slope of culvert, in feet/foot;
n_{ac} = Manning's roughness coefficient for the approach channel;

DEFAULT TO CRITICAL SLOPE ONLY IF PIPE IS FLOWING UNDER PRESSURE FLOW - PER ZELLER'S ADDENDUM

n_p = Manning's roughness coefficient for the culvert;
R_{ac} = Hydraulic radius of flow in approach channel, in feet; and,
R_p = Hydraulic radius of flow within the culvert, in feet.

If the value $\mathfrak{R}_s$ in Equation 11.9 is less than 1.0, the culvert will most likely be able to transport the sediment being delivered by the approach channel. If the value of $\mathfrak{R}_s$ is greater than 1.0, sedimentation may occur, and an alternate culvert or a bridge structure should be considered. The value of S_p in Equation 11.9 should never exceed the critical slope of the culvert for the discharge involved. The culvert itself may be placed on a slope greater than critical, but critical slope should always be used in Equation 11.9 under such circumstances. Additionally, if tailwater exceeds the soffit of the culvert, then a hydraulic grade line should be calculated, and the friction slope of the culvert should be used in Equation 11.9.

11.6 At-Grade (Dip) Crossings

Crossings of watercourses which are designed to allow drainage to flow across roadways at-grade are commonly referred to as either *at-grade* or *dip* crossings. These "structures" are often used where strict all-weather-access criteria do not need to be met. Nevertheless, when flows pass over *at-grade* crossings, hazardous conditions may be created both during and immediately after such flows because of downstream erosion and/or sediment and debris buildup within the crossing itself.

In order to minimize these hazardous conditions during and immediately after a flow event, the *at-grade* crossing should be built with a minimum four-percent cross slope, unless horizontal and vertical controls for traffic safety dictate otherwise, in order to reduce the potential for sedimentation within the crossing. The cross-slope should be accomplished by providing the vertical rise on the upstream side of the crossing, with the downstream side meeting existing grade (Pima County Department of Transportation and Flood Control District, 1984). At a minimum, a two-foot-deep cutoff wall should be placed along the upstream side of the *at-grade* crossing in order to protect the pavement edge from general scour. In addition, an adequately deep cutoff wall (i.e., based upon criteria contained within this Manual, but in no case less than three feet in depth), should be placed along the downstream side of the pavement in order to prevent erosion damage, due to local scour and channel degradation, from occurring immediately downstream of the *at-grade* crossing.

Council-Regular Meeting **D1**

Meeting Date: 11/19/2024

To: Mayor and Council

Submitted For: Andrea De La Cruz, Assistant to the Town Manager

From: Andrea De La Cruz, Assistant to the Town Manager

Date: November 19, 2024

Strategic Plan Focus Area:
Vibrant Community, Cherished Heritage

Subject: Resolution No. 2024-104: Relating to Development; adopting the amended Town of Marana Public Art Policy (Andrea De La Cruz)

Discussion:

On September 19, 2023, the Town Council adopted the Town of Marana Public Art Policy. Since its adoption, the Marana Public Art Review Committee was created and has convened several times to identify future locations for public art and to evaluate the policy for clarity. The Committee, along with Town staff, identified sections of the policy that require revisions for better clarity and structure.

The list below highlights and describes the proposed amendments to the Town of Marana Public Art Policy:

- Allow either the Director or Deputy Director of Development Services, Parks and Recreation, and Public Works to serve as a member of the Committee at any meeting.
- Remove the Town Engineer as a member of the Marana Public Art Review Committee and replace this position with an appointee designated by the Town Manager.
- Establish a four-year term for public members serving on the Marana Public Art Review Committee.
- Clarify that Capital Improvement Projects funded through restricted sources (such as impact fees, grants, or loans) are not required to contribute to the Marana Public Art Fund.

Included within the packet are a clean copy of the amended policy and a redline showing the proposed changes to the policy.

Staff Recommendation:

Staff recommends approval of Resolution No. 2024-104

Suggested Motion:

I move to adopt Resolution No. 2024-104; adopting the amended Town of Marana Public Art Policy.

Attachments

Resolution No. 2024-104

Exhibit A - Amended Public Art Policy

Redline of Public Art Policy

MARANA RESOLUTION NO. 2024-104

RELATING TO DEVELOPMENT; ADOPTING THE AMENDED TOWN OF MARANA PUBLIC ART POLICY

WHEREAS on September 19, 2023, the Town Council adopted Resolution No. 2023-099 approving the Town of Marana Public Art Policy (the "Policy"); and

WHEREAS since the adoption of the Policy, the Marana Public Art Review Committee (the "Committee") was created and has convened several times to identify future locations for public art and to evaluate the Policy for clarity; and

WHEREAS the Committee, along with Town staff, identified sections of the Policy that require revisions for better clarity and structure; and

WHEREAS the Town Council finds that adopting the amended Town of Marana Public Art Policy as set forth in this resolution is in the best interests of the Town and its citizens.

NOW, THEREFORE, BE IT RESOLVED BY THE MAYOR AND COUNCIL OF THE TOWN OF MARANA, ARIZONA, that the amended Town of Marana Public Art Policy attached to this resolution and incorporated by this reference as Exhibit A is hereby approved and the Town's Manager and staff are hereby directed and authorized to undertake all other and further tasks required or beneficial to carry out the Policy.

PASSED AND ADOPTED by the Mayor and Council of the Town of Marana, Arizona, this 19th day of November, 2024.

_____
Mayor Ed Honea

ATTEST:

_____
David L. Udall, Town Clerk

APPROVED AS TO FORM:

_____
Jane Fairall, Town Attorney

Title:	Town of Marana Public Art Policy
Effective Date:	November 1, 2023
Approved:	Council Resolution No. 2023-099
Revised:	November 19, 2024 by Resolution No. 2024-104

Purpose

The purposes of the Town of Marana Public Art Policy are to:

- Identify community beautification opportunities that will strengthen Marana's identity, spirit, and pride;
- Establish a Marana Public Art Fund;
- Establish a Marana Public Art Review Committee;
- Provide direction for the selection of high-quality public art.

Definitions

1. **Development Project:** A project involving the issuance of a permit for construction or reconstruction, but not a permit to operate.

2. **Marana Public Art Fund:** Either a separate account within the Town's General Fund or a separate book or ledger entry designation for funding public art on Town owned property or Town Capital Improvement Projects.

3. **Public Art:** Artistic creations of a professional artist within a public space or spaces. The artwork is typically large scale and may include sculpture, mosaic, painting, ceramic, video, photography, works of light, integrated artist designed land works, aesthetic landscaping and monuments, and other works determined by the Town to meet the requirements of the project.

4. **Tenant Improvements:** The customized alterations a building owner makes to rental space as part of a lease agreement, in order to configure the space for the needs of that particular tenant. For the purpose of this policy, tenant improvements shall exclude general maintenance and repair.

Marana Public Art Fund

The Marana Public Art Fund is established and dedicated to funding high-quality public art installations, and maintenance, throughout the Marana community. Contributions to the Fund shall be collected from private developments and Town of Marana Capital Improvement Projects. Decisions on how to allocate the funds shall be made by the Marana Public Art Review Committee.

Marana Public Art Review Committee

The Marana Public Art Review Committee shall designate locations for public art installation and review design proposals according to the Marana Public Art Design Principles.

The Marana Public Art Review Committee shall consist of seven members divided into two category types:

- Town Representatives:
  - Director or Deputy of Development Services
  - Director or Deputy of Parks and Recreation
  - Director or Deputy of Public Works
  - Communications Manager
  - An appointee designated by the Town Manager

For the Town Representative positions designated as either the Director or Deputy, either representative, but not both representatives, may attend and serve as a member at any Committee meeting depending upon availability.

- Local Art Community Members: Two positions each serving a four-year term. These members may seek reappointment by submitting a new application upon completion of their term.

Private Development Contributions

Any development project that meets the following conditions shall contribute to the Marana Public Art Fund in the form of a cash donation:

- New construction of a project containing 10,000 square feet or more net floor area of any commercial, industrial, or office use within any zoning district; or
- Phased projects with one or more buildings that contain a total of 10,000 square feet or more net floor area of commercial, industrial, or office use within any zoning district;
- New construction of any multi-family development site consisting of 50 or more units;

- Tenant improvements of 10,000 square feet or more net floor area of any commercial, industrial, or office use within any zoning district.

Commercial, office, and multi-family uses shall contribute 1% of the building permit valuation to the Fund. Industrial uses shall contribute 0.5% of the building permit valuation to the Fund. The contribution shall be collected at the time of the building permit issuance. If a development consists of multiple buildings, the property owners(s) shall contribute the appropriate amount with each building permit pulled.

Where a building shell is constructed and tenant improvements are done separately, the building shell will be charged 50% of the applicable contribution requirement and tenant improvements will be charged the remaining 50%.

Maximum Contribution

The maximum contribution for any one private development project shall be $150,000.

Town of Marana Capital Improvement Projects Contributions

All Town of Marana Capital Improvement Projects (CIP) with an estimated budget of $500,000 or more shall include 1% of the total project cost as a contribution to the Marana Public Art Fund, except for projects funded via a restricted funding source that does not permit expenditures for public art (i.e., impact fees, grants, loans, etc.). The Public Works Director or designee will ensure that this 1% cost is added to the project's total budget.

All or a portion of the contributions derived from the Marana Capital Improvement Project may fund artwork for the specific CIP project, or the balance of the funds may be deposited into the Marana Public Art Fund.

Waiver: The Town Manager may waive the public art contribution requirement for projects that are determined to be solely maintenance obligations. Any waiver shall be made in writing and sent to Development Services to be placed in the project permit file.

Designated Public Art Locations

The Marana Public Art Review Committee shall identify locations for public art installations throughout the community. A list of locations, and priority ranking, will be presented to the Town Council for approval. The list of locations and priority ranking shall be updated as new facilities are accepted or as priorities change.

Each installation shall allow for unrestricted viewing from a variety of vantage points. To ensure the general public has access, installations shall be within or adjacent to public parks, trails, or other publicly-owned property that is easily accessible and clearly visible to the general public.

Public art installations shall not be located in a proposed or existing Town right-of-way unless the public art installation is intended to be part of a Capital Improvement Project, or as approved by the Town Engineer.

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The committee will use the following design principles in assessing Conceptual Art Proposals.

1. *Design.* Artwork should incorporate aspects of Marana's natural and cultural heritage and should be a "uniquely Marana" piece.
2. *Quality.* Artwork demonstrates originality, artistic quality, and excellence in design and artisanship, demonstrated through renderings, explanation of construction, materials, and artist resume.
3. *Community Relevance.* Artwork is appropriate in scale, material, form, and content for the immediate and general social, economic, and physical environments with which it is to relate.
4. *Durability.* Artwork demonstrates structural and surface integrity and permanence; material provides protection against theft, vandalism, weathering, and excessive maintenance and repair costs.
5. *Safety.* Artwork does not present a hazard or create unsafe conditions.
6. *Diversity.* Artwork contributes to a diversity of style, scale, media, artists, community values, and forms of expression within the Town.
7. *Visibility.* Artwork is visible and accessible for the purposes of public enjoyment and security, considering pedestrian and vehicular traffic, lighting, active hours on site, future development, and vegetation growth.
8. *Feasibility.* Artwork is likely to be successfully completed based on the project budget, timeline, artist's experience, soundness of materials, and any other relevant factors.

Title:	Town of Marana Public Art Policy
Effective Date:	November 1, 2023
Approved:	Approved by Council Resolution No. 2023-099

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7. *Visibility.* Artwork is visible and accessible for the purposes of public enjoyment and security, considering pedestrian and vehicular traffic, lighting, active hours on site, future development, and vegetation growth.

8. *Feasibility.* Artwork is likely to be successfully completed based on the project budget, timeline, artist's experience, soundness of materials, and any other relevant factors.

Council-Regular Meeting **D2**

Meeting Date: 11/19/2024

To: Mayor and Council

Submitted For: Terry Rozema, Town Manager

From: Jane Fairall, Town Attorney

Date: November 19, 2024

Strategic Plan Focus Area:
Thriving Commerce, Vibrant Community, Cherished Heritage

Strategic Plan Focus Area Additional Info:
FOCUS AREA 1: CHERISHED HERITAGE Leverage the region's historic and cultural legacy to strengthen community character, increase community pride, and build heritage-driven tourism.
Goal: PROVIDE LOCATIONS WHERE RESIDENTS CAN CELEBRATE AND LEARN ABOUT MARANA'S HISTORY AND TRADITIONS.
STRATEGY: Develop strategies to leverage developments, public facilities, events, and amenities to embed heritage-related art features and cultural expression.
FOCUS AREA 2: VIBRANT COMMUNITY Strengthen the sense of place and create opportunities for community connections.
GOAL: ESTABLISH A STRONG SENSE OF PLACE THROUGH THE CREATION OF UNIQUE PUBLIC SPACES AND ARCHITECTURE THAT FOSTER COMMUNITY PRIDE
STRATEGY: Build a Marana-wide lifestyle brand that reflects Marana's unique character and identity.
FOCUS AREA 3: THRIVING COMMERCE Recruit and maintain a diverse commercial sector that is supported by local workforce training and funding opportunities.
Goal: PROVIDE A SUPPORTIVE ENVIRONMENT FOR INDUSTRY LEADERS, STARTUPS, SMALL BUSINESSES, AND ENTREPRENEURS THROUGH EVERY STAGE OF BUSINESS DEVELOPMENT.
STRATEGY: Evaluate and implement economic development tools and strategies to support the retention and expansion of Marana key employers and attract new compatible sectors.
STRATEGY: Develop a conceptual vision, design standards, and implementation strategy for Downtown Marana.

Goal: EXPAND MARANA'S THRIVING TOURISM INDUSTRY BY PROMOTING ITS HERITAGE, CULTURAL RESOURCES, SCENIC OPEN SPACES, AND SIGNATURE EVENTS.
STRATEGY: Expand Marana's tourism efforts and enhance its regional relevance through a comprehensive assessment of the Town's strengths and unique offerings.
STRATEGY: Continue to enhance visitor experiences and partner with stakeholders to promote Marana's entertainment, recreation, sports and cultural events, and hospitality venues

Subject: Relating to Economic Development; discussion and consideration of proposal from Marana Urban LLC in response to Town of Marana Request for Proposals (RFP) for Lease and Development of Town-Owned Property Located at Marana Main Street and Civic Center Drive and possible direction to staff to commence negotiations for a lease agreement (Terry S. Rozema)

Discussion:

On May 17, 2024, the Town released a Request for Proposals (RFP) for the Lease and Development of Town-Owned Property Located at Marana Main Street and Civic Center Drive. The Town sought proposals from developers to lease and develop approximately 19 acres of Town-owned land as part of a vibrant Downtown Marana. As noted in the Town's Economic Development Strategic Plan: "Across the entire world, a community's downtown personifies its window to the world. Downtowns are not only how the world sees a community, they also represent the heart and soul of the people and businesses who call that community home. Downtown is a vital intersection of business, commerce, tourism and cultural exchanges and serves as a fundamental cornerstone for the community's economy and identity. A vibrant and healthy downtown benefits all citizens and businesses of Marana." The Town of Marana has a unique opportunity to build its downtown from the ground up and seeks a creative and innovative partner to help bring the Town's vision to life.

As the RFP detailed, the Town seeks a developer who will enter into a long-term lease of up to 50 years, with potential options for renewal, to develop the property located adjacent to the Town's Marana Municipal Complex, east of Marana Main Street and north of Civic Center Drive. The developer must commit to long-term investment in the property and in the development of Downtown Marana. The successful proposer must be the primary developer of the property and will be responsible for securing long-term tenants, if applicable.

The Town's goals for development of the property include:

- Spurring development of Downtown Marana
- Stimulating economic development and expanding employment opportunities in the Town
- Complementing other nearby retail, academic, residential, and professional office development with a vibrant downtown area
- Expanding entertainment and dining options by providing more variety, as well as providing amenities desirable to attract and retain the employees sought by

employers in Southern Arizona
- Generating new tax revenues

The Town desires for the development of the property to be initiated and completed within a reasonable time period acceptable to the Town. The lease agreement ultimately negotiated between the Town and the successful developer will include timelines for development of the property and provisions that allow the Town to terminate the lease agreement if development timelines are not met.

The Town received one proposal in response to the RFP, from Marana Urban LLC. An evaluation committee consisting of Town staff from Development Services, Economic Development, Town Manager's Office, Water, and Legal evaluated the initial response and submitted additional clarifying questions to the proposer. Marana Urban responded to those additional questions and also provided a preliminary infrastructure cost estimate for the Downtown Marana development.

The RFP provides that once the evaluation committee process has been completed, a recommendation will be submitted to the Town Council. If the Town Council approves the recommendation, Town staff will commence negotiations with the successful proposer on the final form of lease agreement. No binding contract will be formed until the lease agreement is finalized and approved by the Town Council. Negotiations may be terminated by the Town and its designated representatives at any time for any reason(s) the Town deems appropriate.

At this time, the evaluation committee recommends that the Council direct staff to begin negotiations with Marana Urban LLC on a final form of lease agreement for the Town-owned property subject to the provisions of the RFP.

Attached to this report are the following documents:
- RFP 2024-015 Lease and Development of Town-Owned Property Located at Marana Main Street and Civic Center Drive
- Marana Urban LLC's July 11, 2024 submittal in response to the RFP
- Marana Urban LLC's September 10, 2024 response to follow-up questions
- Marana Urban LLC's October 31, 2024 preliminary infrastructure cost estimate

Financial Impact:

There is no immediate financial impact associated with tonight's item, which is the consideration and possible approval to proceed with negotiations. The complete financial impact will be dependent on the benefits and obligations described in the final, negotiated lease. We do, however, anticipate that the Town will have some obligation to either construct or reimburse the developer for certain public infrastructure elements within the public rights-of-way including, but not limited to, parking, road infrastructure, landscaping, lighting and illuminated signage. Town benefits and obligations of the final, negotiated lease will be budgeted in future years as part of the annual budget process.

Staff Recommendation:

Staff recommends that Council direct staff to commence negotiations with Marana Urban LLC for a lease agreement for the lease of Town-owned property located adjacent to the Town's Marana Municipal Complex, east of Marana Main Street and north of Civic Center Drive.

Suggested Motion:

I move to direct staff to commence negotiations for a lease agreement with Marana Urban LLC for the lease and development of Town-owned property located at Marana Main Street and Civic Center Drive.

Attachments

RFP 2024-015

Marana Urban LLC Response to RFP 2024-015

Marana Urban Response to Follow-up questions

Marana Urban Preliminary Cost Estimate

Map of Parcel

MARANA AZ
FINANCE

TOWN OF MARANA
REQUEST FOR PROPOSALS (RFP)

Solicitation Number:	2024 - 015
Solicitation Title:	Lease and Development of Town-Owned Property Located at Marana Main Street and Civic Center Drive
Release Date:	May 17th, 2024
Final Date for Inquiries:	June 20th, 2024, at 3:00pm Arizona time
Due Date and Time:	July 11th, 2024, at 3:00 pm Arizona time
Submittal Location:	Marana Municipal Complex First Floor Reception Desk 11555 W. Civic Center Drive Marana, AZ 85653
Contact for Inquiries:	Vicky Edwards / Rudy Torres Procurement Officers 11555 W. Civic Center Drive Marana, Arizona 85653 (520) 382-2642 vedwards@maranaaz.gov and rtorres@maranaaz.gov

This solicitation is available at **www.PublicPurchase.com.**

All prospective proposers are responsible for obtaining the RFP and any subsequent related documents from the Town's partner: **www.PublicPurchase.com**. This system provides automatic notification and transmittal of solicitation opportunities. To view a solicitation, you must be registered with Public Purchase. The Town will not be responsible for the failure of a prospective proposer to obtain addenda and other information related to this RFP.

Published:
Daily Territorial on May 17th, 2024, and May 21st, 2024

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Schedule

Released	May 17th, 2024
Final Date for Inquiries	June 20th, 2024, at 3:00pm Arizona time
Due Date and Time	July 11th, 2024, at 3:00pm Arizona time
Evaluation	To be determined
Lease Award	To be determined

All inquiries regarding this RFP shall be directed to the Solicitation Contact for Inquiries identified on page 1 of this solicitation.

Instructions to Proposers

1. **Preparation of Proposal:**
    a. There is no prescribed format for proposals, but all proposals must include the required information necessary to adequately respond to this Request for Proposal.
    b. Faxed or e-mailed proposals will not be considered.
    c. Periods of time, stated as a number of days, will be calendar days.
    d. It is the responsibility of all proposers to examine the entire Request for Proposal package and seek clarification of any item or requirement that may not be clear and to check all responses for accuracy before submitting a proposal.

2. **Proposal Packet:**
    a. Proposals shall be submitted in one original and two hard copies in a sealed envelope, along with one electronic copy on a CD or flash drive. The original shall be marked "ORIGINAL". Detailed written responses shall be on 8 ½" x 11" paper, using a font no smaller than 12 point.
    b. The proposer's name and address must appear on the outside of the sealed envelope, which shall be clearly marked as: Lease and Development of Town-Owned Property Located at Marana Main Street and Civic Center Drive - RFP #2024-015.
    c. All proposals must include the signed RFP Signature Page.

3. **Inquiries:** Any question related to the Request for Proposals must be directed to the contact whose name appears on the cover page.

4. **Irrevocable Offer:** A proposal is an offer to contract with the Town based upon the terms, conditions and specifications contained in this RFP and all addenda thereto, and the proposal. No contractual relationship will be established until the proposer has signed and the Town Council has approved, at a public meeting in compliance with the Arizona Open Meeting law, an agreement between the Town and the proposer. To allow for an adequate evaluation, the proposal shall be considered valid and irrevocable for 180 days after the Proposal Due Date and Time indicated on the cover of this RFP.

5. **Withdrawal of Proposal:** At any time prior to the specified proposal due date and time, a proposer may withdraw the proposal in writing.

6. **Cost of Proposal Preparation:** The Town will not reimburse proposers for the cost of developing, presenting, or providing a proposal.

7. **Public Record**: Properly submitted proposals will not be returned to proposers. All proposals will become the property of the Town and will, after approval of an agreement by the Town Council as a result of this RFP, become public records available for public inspection in accordance with Town policy and state law. The proposer must clearly label any portions of the proposal that it deems confidential or proprietary. If the Town receives a public records request to which such portions are responsive, the Town will promptly notify the proposer. The Town will disclose those portions to the requesting party unless the proposer obtains an order from a court of competent jurisdiction, within ten days after the Town's notice to the proposer, that prohibits the Town from doing so.

8. **Applicability of Procurement Code**. Except for Article III (Ethics), the Town's Procurement Code does not apply to this RFP. This RFP is governed by the terms stated in this RFP and any applicable law.

9. **Additional Information:** Notwithstanding any other provision of this Request for Proposals, the Town expressly reserves the right to:
    a. Select one or more respondents with whom the Town may pursue negotiations pursuant to this Request for Proposals.
    b. Reject any or all proposals for whatever reason deemed necessary or for no specified reason.
    c. Amend or otherwise modify or cancel this Request for Proposals with or without substitution.

A. Purpose

The Town of Marana seeks proposals from developers to lease and develop approximately 19 acres of Town-owned land as part of a vibrant Downtown Marana. As noted in the Town's Economic Development Strategic Plan:

> Across the entire world, a community's downtown personifies its window to the world. Downtowns are not only how the world sees a community, they also represent the heart and soul of the people and businesses who call that community home. Downtown is a vital intersection of business, commerce, tourism, and cultural exchanges and serves as a fundamental cornerstone for the community's economy and identity. A vibrant and healthy downtown benefits all citizens and businesses of Marana.

Marana, Arizona: Honoring Our Heritage. Heralding the Future. An Economic Development Strategy for Marana, AZ, IO. Inc., p. 21.

The Town of Marana has a unique opportunity to build its downtown from the ground up and seeks a creative and innovative partner to help bring the Town's vision to life.

B. Background Information

The Town of Marana, incorporated in 1977, is a rapidly growing community located in Southern Arizona between Phoenix and Tucson. The population of the Town per the 2020 Census was 51,908, having grown at least 43% from the 2010 Census. Current estimates place the Town's population at approximately 60,000 residents. The Town covers approximately 121 square miles, resides in two counties (Pima and Pinal), and spans 18 miles of Interstate 10. Three mountain ranges hug the outer borders of the Town, the Tortolita Mountains to the northeast, Ironwood Forest National Monument to the west, and the Saguaro National Park to the south.

C. Scope

The Town of Marana seeks proposals from developers to lease and develop approximately 19 acres of Town-owned land located adjacent to the Town's Marana Municipal Complex, east of Marana Main Street and north of Civic Center Drive. A map of the property is included as **Appendix A**. The property is bisected by an El Paso Natural Gas (EPNG) utility easement. The property is also located in two Federal Emergency Management Agency (FEMA) Flood Hazard Zones: Zone AO 1 (90.25% or about 17.23 acres), Zone X - Shaded (9.75% or about 1.86 acres). Development of the property must comply with any applicable limitations imposed by the EPNG easement and the FEMA Flood Hazard Zones.

The property is zoned SP – Specific Plan and is part of the Rancho Marana West Town Center Specific Plan Amendment implemented by the June 17, 2008 adoption of Marana Ordinance No. 2008.14. The Specific Plan was amended on March 21, 2023, by adoption of Marana

Ordinance No. 2023.007. The 2023 amendment updated development and architectural standards for commercial uses.

The Rancho Marana West Town Center Specific Plan Amendment implements the Town Center concept for the Town of Marana, as an activity center with a comprehensive mixed-use environment including commercial, retail, office, institutional, entertainment, and residential uses. The Town Center is planned to be the focus of civic activities for the residents of Marana. A variety of uses will be organized around public open spaces in a high-intensity and multi-story development setting. The Town Center encourages development of compact, pedestrian-scaled, mixed-use commercial and neighborhood areas.

Consistent with the Town Center concept, in October 2023, the Town began construction of the new Marana Community & Aquatic Center (MCAC). The MCAC will be located at 13455 N. Marana Main Street, on the east side of Marana Main Street, across the street from the 19-acre parcel that is the subject of this Request for Proposals. The MCAC will be a cornerstone of development in the Downtown Marana area, bringing citizens from all over Marana to its state-of-the-art gymnasium, aquatic center, and gathering facilities.

The Town seeks a developer who will enter into a long-term lease of up to 50 years, with potential options for renewal, to develop the property as part of a vibrant Downtown Marana. The developer must commit to long-term investment in the property and in the development of Downtown Marana. The successful proposer must be the primary developer of the property and will be responsible for securing long-term tenants, if applicable.

The Town's goals for development of the property include:

- Spurring development of Downtown Marana
- Stimulating economic development and expanding employment opportunities in the Town
- Complementing other nearby retail, academic, residential, and professional office development with a vibrant downtown area
- Expanding entertainment and dining options by providing more variety, as well as providing amenities desirable to attract and retain the employees sought by employers in Southern Arizona
- Generating new tax revenues

The Town desires for the development of the property to be initiated and completed within a reasonable time period acceptable to the Town. The lease agreement ultimately negotiated between the Town and the successful developer will include timelines for development of the property and provisions that allow the Town to terminate the lease agreement if development timelines are not met.

The Town has had the property appraised and the appraiser's opinion of fair market rental value is $0.26 per square foot. While a developer's rent proposal will be a factor in evaluation of proposals, it is not dispositive. The Town Council has authority under A.R.S. §9-500.11 to

engage in any activity that it "has found and determined will assist in the creation or retention of jobs or will otherwise improve or enhance the economic welfare of the inhabitants" of the Town, including specifically "the acquisition, improvement, leasing or conveyance of real or personal property."

Evaluation Criteria

The proposals will be evaluated based on the below criteria. The Town has not assigned numerical weighting to the criteria as the Town will evaluate proposals based on the totality of the circumstances.

1. Project Description
2. Qualifications & Experience
3. Project Delivery Approach
4. Business Plan
5. Lease and Rent Proposal

Requirements Specific to Evaluation Criteria

1. Project Description
    a. Executive Summary: Include a summary of the entire proposal describing the most important elements of the proposal.
    b. Land Use/Site Plan: Include a conceptual site plan and building elevations for the development of the property.
    c. Proposed Development Elements: Describe the proposed mixed uses planned for the project site. Describe the conceptual mix of uses onsite, including how commercial retail, restaurant, or other uses will be balanced amongst themselves and complement one another. Provide breakdown by square footage and percentage of total buildable area. Discuss mix of elements such as multi-family, office, retail usage by local, regional, or national chain, and how that is determined. Briefly detail any discussion and coordination that has already occurred with potential occupants and users.
    d. Circulation: Provide circulation plan(s) showing transit, vehicular, bicycle and pedestrian access and circulation within and around the project site for the various existing and proposed users.
    e. Infrastructure: Describe infrastructure included in the project, including utilities, site access/egress, and any other supporting elements necessary to have the site function.
    f. Local Impacts: Describe how the proposed uses fit within the immediate neighborhood location and how it will serve the neighborhood and local area. In particular, describe how the proposed development complements or leverages current or future development in the area.
    g. Schedule: Include a tentative proposed schedule for construction of improvements and investments in the property, taking into account the Town's desire to have the

project initiated and completed within a reasonable time period acceptable to the Town.

i. Provide a schedule for the design and construction of the project. Include the time frames for those steps deemed critical to initiate immediately following award, if the lease is awarded to proposer.
ii. Provide separate information regarding the timing of the various planned structures, site development and shared spaces. Indicate phasing of these elements based on the level of support to the anchor elements and location within the conceptual site plan.

h. Economic Impact to Town: Describe the potential economic impact and benefits to the Marana community of the proposed project, including how the project will achieve the Town's goals for development of the property as described in the Scope, above.

2. Qualifications & Experience
   a. Identification of the Lead Entity, including:
      i. Legal name and address of organization or individual proposing to lease the property.
      ii. Legal form of organization (e.g. partnership, corporation, non-profit status, etc.), with supporting documentation, such as articles of incorporation. If joint venture, identify the members of the joint venture and provide all information required within this section for each member.
      iii. Disclosure of "parent company" if proposer is a wholly-owned subsidiary (or subject to other partnerships).
      iv. Physical address(es) of office(s) working on this project.
      v. Name, title, address, email, and telephone number of the person to serve as project manager and a proposal contact (if different).
   b. Experience
      i. Describe the development team's experience in developing similar projects.
      ii. Provide information regarding at least two representative projects completed by the development team, that demonstrate the proposer's capacity to deliver the project as described.
      iii. Describe the development team's capacity and intent to proceed without delay if awarded the lease.
      iv. Include resumés for key personnel as attachments.

3. Project Delivery Approach
   a. Proposed Method to Accomplish the Work
      i. Briefly describe the proposer's technical and management philosophy regarding the successful development of property.
      ii. Describe how the proposer will attract and retain businesses and tenants for the development.
      iii. Describe how the proposer will work with the Town of Marana to promote Town programs and special events in coordination with the development.
   b. Knowledge an Understanding of the Local Environment

i. Express and demonstrate a knowledge and understanding of the local environment and culture by describing the proposer's experience with the Tucson Metro community and how the proposer plans on maintaining an open local presence while working with Town of Marana staff.
ii. Display an understanding of the proposed Downtown Marana area and its vicinity, as part of a vibrant destination center with a complement of unique dining and entertainment experiences.

4. Business and Financial Plan
    a. Preliminary Project Business Plan
        i. Submit a business and financial plan for the project.
        ii. Demonstrate the developer's business and financial resources to meet the development goals as stated in the Scope, above.
        iii. Demonstrate a balanced business plan that identifies potential project revenues and expenses.
        iv. If the project is to be developed in phases, describe the timing and triggers for each phase.
    b. Financial Capacity
        i. Describe the developer's financial capacity to execute, complete, and operate the project successfully.
        ii. Provide credit and business references.
    c. Business Revenue Risk
        i. Describe the plan for long-term success.
        ii. Describe how the project is sustainable over the long term.

5. Lease and Rent Proposal
    a. Lease Proposal
        i. Describe the proposed lease term.
        ii. Describe any public improvements to the property the developer proposes the Town complete as part of the lease agreement.
        iii. Describe any other terms or conditions of the lease relevant to the developer's proposal.
    b. Rent Proposal
        i. Provide a rent proposal based on the totality of the circumstances, including the proposer's review of the Town appraiser's opinion of rental value.
        ii. Describe the rent structure, including any proposals for reduced or graduated rates during different phases of the project, based on a reasonable rate of return for the developer.
    c. Gift Clause Considerations
        i. Describe how the lease and rent proposal complies with the Arizona Gift Clause (Gift Clause, Ariz. Const. art. IX, § 7) in light of recent caselaw, including *Schires v. Carlat*, 250 Ariz. 371, 374, 480 P.3d 639, 642 (2021) and *Neptune Swimming Foundation v. City of Scottsdale*, -- Ariz. --, 542 P.3d 241 (2024).

Evaluation Process

The Town will appoint an Evaluation Committee, which will conduct the selection process generally according to the schedule listed on the cover page of this RFP and in accordance with the terms of this RFP. The Town may conduct discussions/clarifications with any responsible proposer to assure full understanding of the proposer's proposal and its conformance to the RFP requirements and to clarify proposal details provided that they do not substantially change the content of the proposal.

The Town does not intend to conduct interviews, but reserves the right to short-list proposers and conduct interviews if determined in the best interest of the Town. If the Town holds interviews or requests clarifications from short-listed proposers, the Town will issue a written request for Best and Final Proposal setting forth the date, time, and place for submission. If a proposer fails to respond to the request for Best and Final Proposal or fails to submit a notice of withdrawal, the Town will consider their immediate previous proposal as their Best and Final Proposal.

After the evaluation process has been completed, a recommendation will be submitted to the Town Council for approval. If the Town Council approves the award recommendation, Town staff will commence negotiations with the successful proposer on the final form of lease agreement. No binding contract will be formed until the lease agreement is finalized and approved by the Town Council. Negotiations may be terminated by the Town and its designated representatives at any time for any reason(s) the Town deems appropriate.

RFP Signature Page

The proposer must sign this Signature Page.

In the absence of any exceptions identified in the proposal, the proposer will be bound by all of the terms and conditions outlined in the RFP.

TO THE TOWN OF MARANA:
The undersigned represents that he or she:

1. Is duly authorized to make binding offers on behalf of the proposer.
2. Has read and understands all information, terms, and conditions in the RFP.
3. Has not engaged in any collusive actions with any other potential proposers for this RFP.
4. Hereby certifies that the proposer takes no exception(s) to any portion of the RFP, unless an exception(s) is specifically noted in the proposal.

	For Clarification of this Offer contact:
Proposer Name	Name
Address	Title
City State ZIP	Phone
Signature of Person Authorized to Sign/Date	Fax
Printed Name	Email
Title	

Appendix A

MARANA AZ

N

0 75 150 225 300 Feet

W Grier Rd

217370120 217370110 217370090 217370080 217370070 217370060 2173700

217370700 217370680

ZONE AO 1

217370500

217370693B

21737071B

217370510

El Paso Natural Gas Line

21737067A

21737053A

21737073C

N Marana Main St

217370540

W Bill Gaudette Dr

217370630

ZONE AO 1

ZONE X - SHADED

217370850

ZONE X - SHADED

W Civic Center Dr

217370870

217370940

217370600

Default Folder: U:\Town_Attorney\2024\El_Paso_Gas_FEMA_Zones

RFP 2024-015

Prepared for	Town of Marana
Submittal Date	07.11.2024
Submitted by	Marana Urban

Lease and Development of Town-Owned Property Located at Marana Main Street and Civic Center Drive



Table of Contents

1 Project Description

2 Qualifications & Experience

3 Project Delivery Approach

4 Business Plan

5 Lease and Rent Proposal

1 Project Description

1. a. Executive Summary

“Our downtown”

Our desire is to design and deliver a world-class, full-service downtown. It will capture Marana’s rich history and highlight Marana’s bright future. At its core will be a curved, brick covered street that is framed by an arch with Marana proudly sitting at the top. Stepping through the arch begins the experience of downtown Marana.

The road to creating a ground up downtown of this caliber will be incremental. Every phase is a building block for the next. Corners cannot be cut. Building materials will be carefully selected so they age properly adding value as the years pass. The scale must provide the precise balance of high density tempered by soft landings and charming streets. Art is essential. It is the glue that stitches the buildings, the streets and the story together.

Our firm has controlled 40 acres to the north of the Town’s 19 acres for the past 15 years. We see this request as an opportunity to jointly develop our properties. This increases the probability of self-sufficiency within the neighborhood. A key governor of our success is determining the appropriate size of each phase. Current, local demand exists. The catalyst for subsequent phases will come from demand that will be increased by a downtown that acts and feels like home.

1. b. Land Use / Site Plan

The proposed project is envisioned as the first step on a journey towards a vibrant new entertainment district.

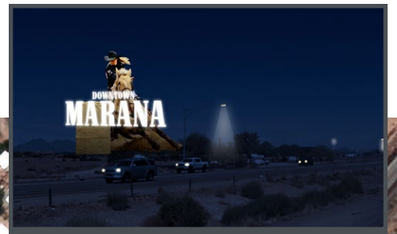
This proposed phase one begins with the first portion of an arcing street, extending from Bill Gaudette Drive towards the northeast; in time this street should extend to loop back to meet N Marana Main Street south of W Grier Rd.

A sense of arrival is to be established by an arch spanning the street, proclaiming the town's name in lights and demarcating the transition from the public road network to a primarily pedestrian environment. Eventually, this arch should be joined by another at the north end of the street, bookending the entertainment quarter. In the era of social media, this landmark arch also creates an opportunity for news of this emerging phenomenon to be spread by enthusiastic visitors to their friends and followers.

This development is encumbered by a substantial easement, but the proposed project seeks to turn this constraint into an opportunity. The proposed first phase comprises two buildings of modest size, in conversation across the easement, re-imagined as a public plaza. The project seeks to deploy native trees and shade structures to temper the heat naturally, including trees in removable planters where necessary atop the easement.

The proposed buildings, both in the first phase and the eventual full build-out, will be designed to be flexible in their use, and to reflect the best of southern Arizona architecture through traditional forms and a palette of durable, hard wearing materials; primarily red brick.

In the short term, a gravel lot to the south of the new street will provide ample parking for visitors. In the long term, two large parking lots are envisioned, one each at the north and south entrances to the district. A multi-use path which allows for a continuous loop around the perimeter of the 20 acres is planned, with connections to the businesses and amenities at key locations.



Billboard



North 40 Acres



South 20 Acres

I-10

N Lon Adams

W Civic Center Dr

Police Department

City Hall

N Marana Main St

Fire Station

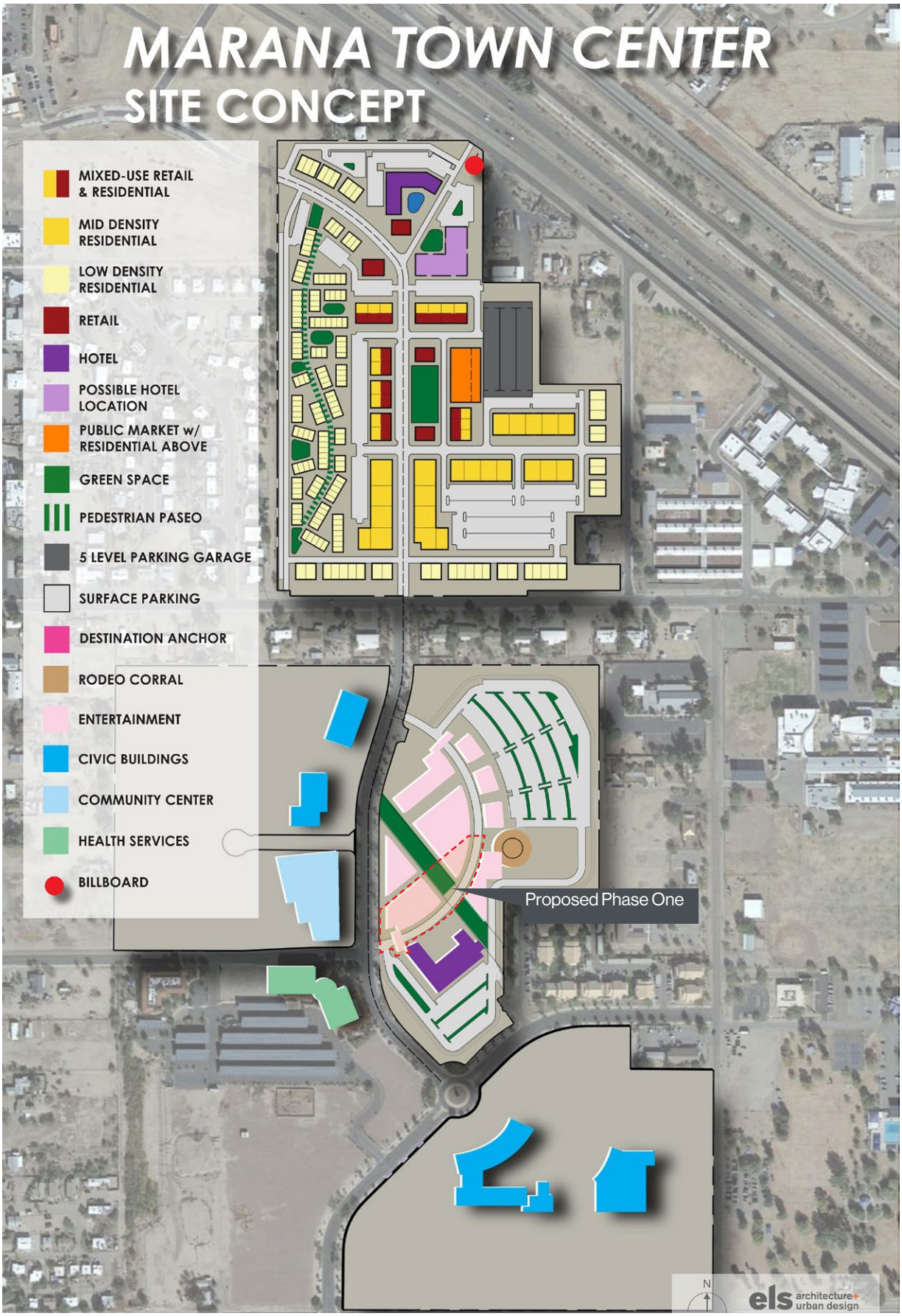
Community Center

W Grier Rd

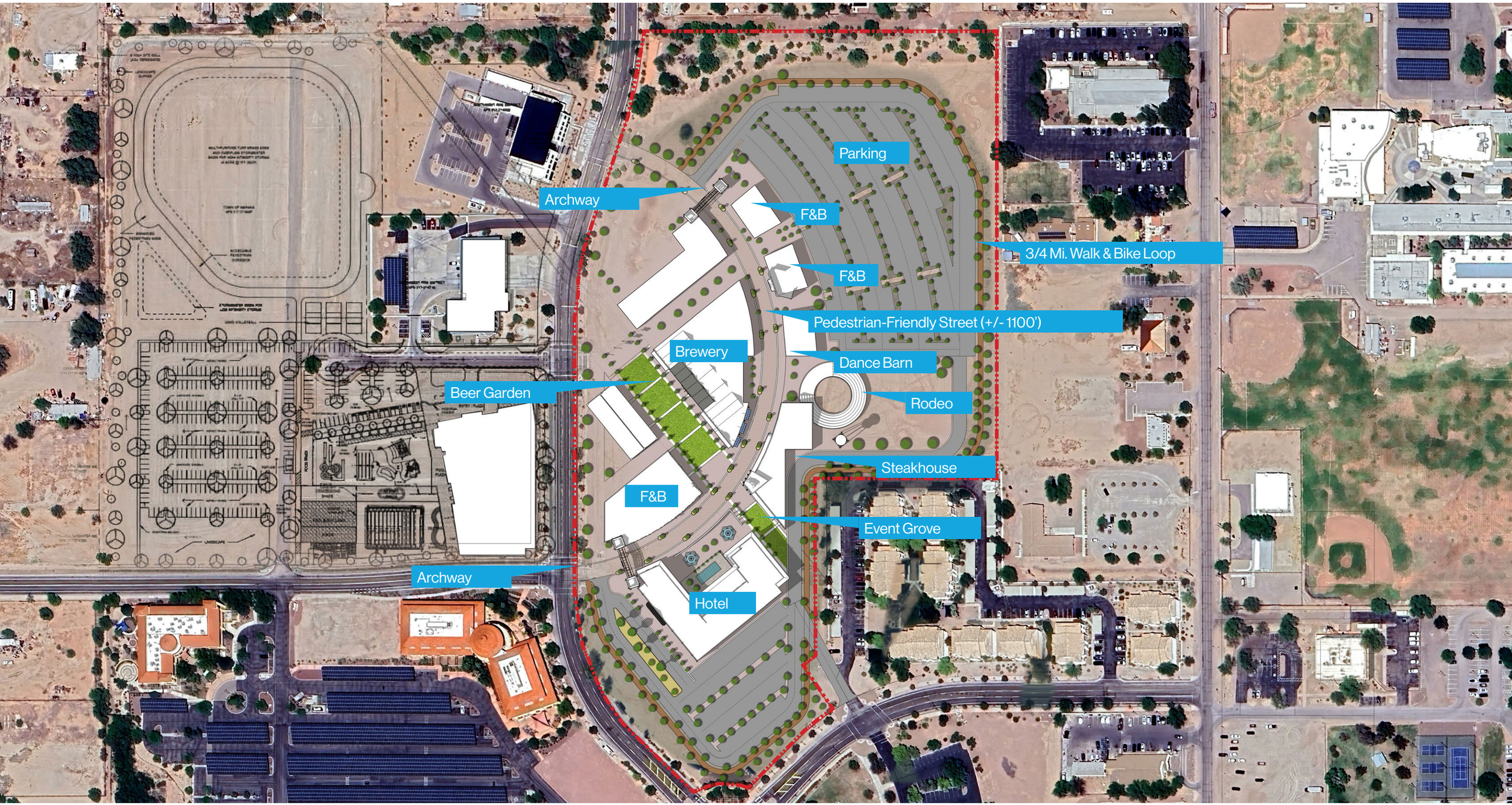
Bill Gaudette Dr

N Sandario Rd

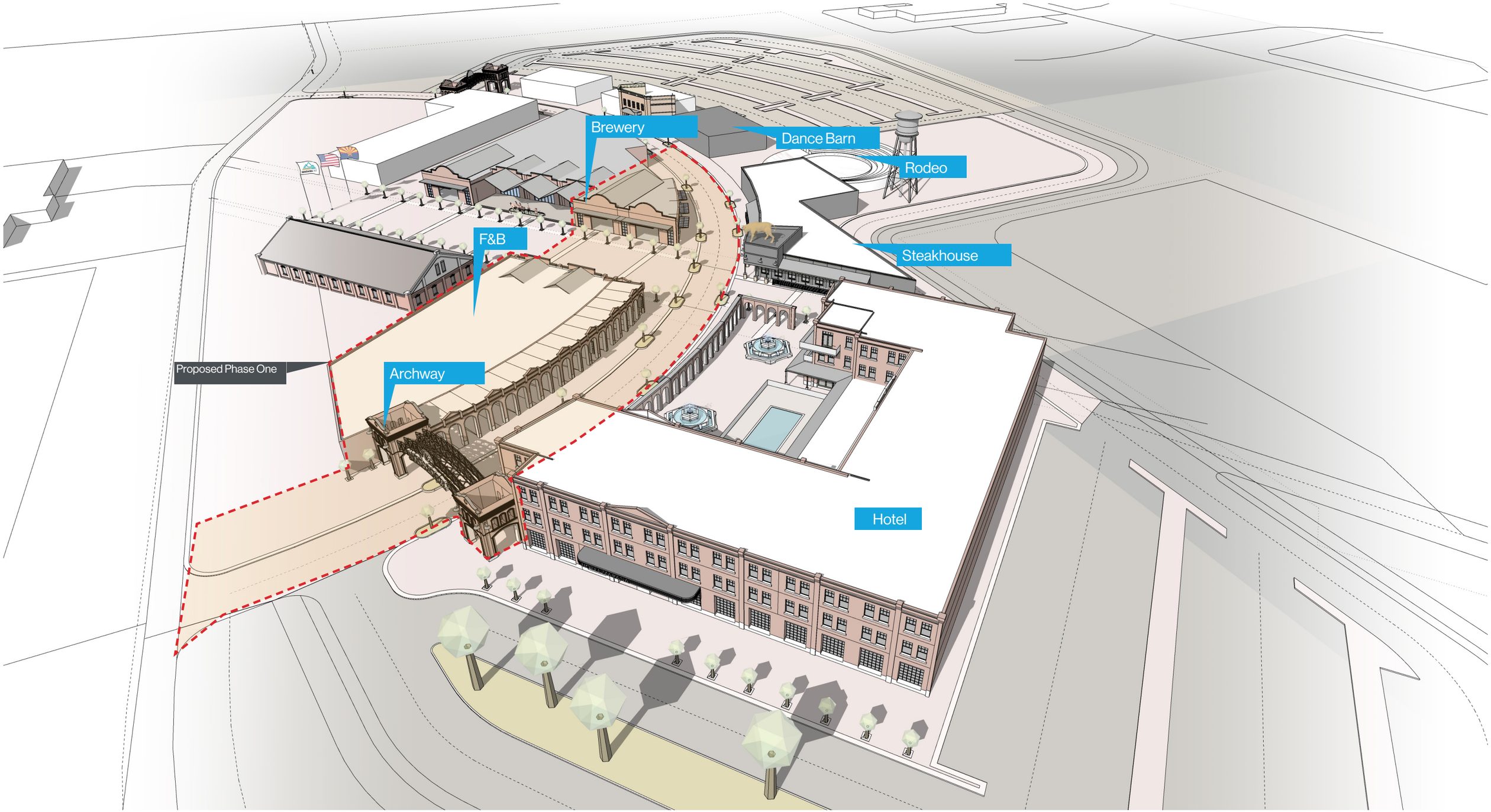
Pictured Above: Site orientation diagram.



Site Concept Graphic by ELS Architecture and Urban Design, modified by AXIS Architecture + Design



Pictured Above: Conceptual site plan of full development.



Pictured Above: Conceptual overview of full development.



In due course, it is envisioned that additional buildings will join the first phase, including food and beverage, entertainment, select retail, and a hotel. The desire is to create a place where the spaces between buildings are as lively and active, if not more so, than the buildings themselves. Architectural, landscape, and urban design seek to accommodate indoor-outdoor connections, curbside, covered, and outdoor dining, and entertainment programming including live music, parades and national holidays, public art, and gymkhana barrel racing.

The project seeks to leverage thoughtful design, a tremendous opportunity afforded by the Town and the setting, and demand for future development stoked by a purposeful initial investment, to create a uniquely vibrant and walkable entertainment district for the community.

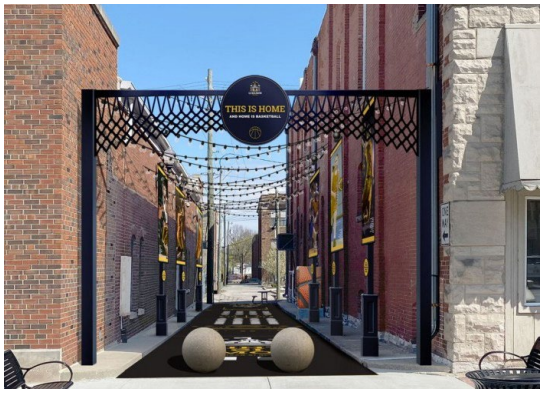
Pictured above: Artist's impression of billboard.















Design Inspiration and Reference Imagery







Design Inspiration and Reference Imagery



Pictured Above: Conceptual rendering of Marana Arch, curved street, and future Hotel.



Pictured Above: Conceptual rendering of curved street, phase one food and beverage (page right) and future additional food and beverage (page left).

1. c. Proposed Development Elements

The attached conceptual site plan includes a design for 59 acres. Our intent is to begin phase one on the Town's 19 acres.

The adage, "walk before we run" will be a guidepost. Each phase will provide critical experience to determine what future phases will be. Each phase will be a teacher.

The attached plan will undoubtedly change. The goal for a downtown built form the ground up of this caliber is ambitious. We cannot say with any certainty what the final chapter will be. We can focus on each step and build a foundation, together.

Phase one is illustrated in the attached plans. Marana Arch, a portion of the curved brick road, two restaurants with courtyards, parking and the beginning of the El Paso easement softscape will be how we would like to start. An iconic, well lit, entry monument/sign clearly visible from I-10 is a crucial part of phase 1. It will likely sit on the northeast corner of the north parcel. It is too early to build hotel, residential or larger entertainment/hospitality without sacrificing quality.

Each restaurant in phase one will be approximately 7,500 square feet including the courtyard. Approximately 200 surface parking spaces will be located nearby. The Marana arch is critical to setting the stage for the entrance to downtown. The columns and arch will tell a story.

We will leverage off the success of phase one into phase two with a heightened level of design integrity. It will likely include more commercial along the brick road, a hotel and additional parking. This phase will set the stage for a larger, destination focused entertainment experience along with residential on the north parcel. Quality design comes with an additional cost and expected return. Each phase needs to solidify the strategic investment in quality.

We are in a unique position to deliver high quality operators. Our company has concepted, built and currently operates several restaurants and businesses in Tucson and Marana. We also have relationships with dozens of operators who we believe will compete to have a chance to be part of our downtown.

1. d. Circulation

See site concept graphics.

1. e. Infrastructure

Will be determined as design unfolds.

1. f. Local Impacts

The Town's investment in high quality, public buildings has set the stage for the first phase of downtown. Demand already exists in the buildings surrounding this parcel. The time has come to provide more dining options for the immediate neighborhood. Tangerine Farms Loop connection opens up Gladden Farms and the surrounding communities. Established annual celebrations provide another anchor for full service restaurants.

1. g. Schedule

Entitlement, design, and construction drawings will start after terms for a lease are accepted. This design phase will take approximately 15 months followed by construction lasting approximately 18 months. Coordination of simultaneous public and private improvements will allow for efficiencies.

Ideally, design and approval of a monument sign at Marana Road and I-10 will happen in the first phase.

1. h. Economic Impact to Town

Gross taxable revenue from the first phase of construction should exceed $12M in the first year and increase more than the inflation rate annually. Most importantly, the first phase of downtown Marana will establish an elevated design aesthetic that future phases can build from.

2 Qualifications & Experience

2. a. Identification of the Lead Entity

i. Legal Name And Address Of Organization

Marana Urban LLC
30 South 5th Avenue
Tucson, AZ 85701

ii. Legal Form Of Organization

Limited Liability Company, EIN 99-3865313
Articles of Organization available under separate cover.

iii. Parent Company

N/A

iv. Physical Address of Office Working on This Project

Marana Urban LLC
30 South 5th Avenue
Tucson, AZ 85701

v. Project Manager and Proposal Contact

Scott Stiteler
Manager
415-259-8844

Marana Urban LLC
30 South 5th Avenue
Tucson, AZ 85701

2. b. Experience



ii.

Our team played an integral role in the redevelopment of downtown Tucson. We purchased and renovated the former MLK building at 5th and Congress. We added street level retail. We quietly provided financial support and guidance for the first phase of the Mercado District. The homes we built at Mercado established the design quality that exists today with the core part of the development. We purchased and renovated the historic Rialto building in downtown Tucson. We purchased and renovated the 200 block of Congress adding several restaurants and an AC by Marriott hotel. We purchased and renovated the historic Corbett building on 6th Avenue in the warehouse district in downtown Tucson. The Corbett project includes indoor and outdoor pickleball, a beer garden, and outdoor live music venue and restaurant/bar. We own and operate all of the projects.

Our team has a long history in Marana including development of Sky Ranch, a complicated workout of Saguaro Ranch on behalf of the lender, and the development of Marana Mortuary and Cemetery.

Pictured above: AC Hotel Tucson



Marana Urban has engaged AXIS Architecture + Design to provide design services for this proposed project. Other design and professionals will be engaged as required.

With studios in San Francisco, Seattle, and Los Angeles, as well as satellite offices in Hawaii, and Boston, AXIS is able to deliver accessible and responsive expertise across the continent. Proudly having helped our client partners launch successful projects across the United States.

AXIS's award-winning hotel and hospitality architectural design practice sets us apart. With over twenty years of experience helping hospitality investors and hotel brands maximize their investment potential, we've proudly earned our reputation as one of the United States' most practiced and experienced hospitality architectural design firms.

Pictured above: AXIS was the executive architect of La Peer boutique hotel by Kimpton Hotels in Los Angeles



With over 20 years of proven experience, and a list of international award-winning projects as part of our design portfolio, AXIS Architecture + Design has a demonstrated record of leading word-class developments and architectural design projects to success. As a project stakeholder, AXIS has a proven reputation acting as project manager, coordinating project partners and sub-contractors, and advising stakeholders on best practices to ensure project success.

Pictured above: *AXIS has designed a new 21-story multi-family residential and boutique hotel high rise in the heart of trendy Koreatown, Los Angeles.*



iii.

If awarded the opportunity, our intent is to begin negotiations on the lease without delay. We have successfully purchased, designed, developed, and operate dozens of businesses and real estate projects over several decades in Southern Arizona.

Our team has focused on this opportunity as our priority for the coming years. We have not accepted new business offers in anticipation of the opportunity to be a part of building downtown Marana.

Pictured above: The Corbett Site, one of this group's premier development projects in Tucson.

iv. Resumes of Key Personnel



Scott Stiteler

Scott Stiteler is the principal owner of Marana Urban LLC, Tucson Urban LLC, and several related entities. He received a BS in Economics from Santa Clara University in 1989 and a MBA from Santa Clara University in 1992. In 1990 Mr. Stiteler formed Stellar Homes, Inc. to build urban, infill, residential projects in the San Francisco Bay Area. In 1994 Mr. Stiteler expanded development activities to Tucson, Arizona. He has developed approximately twenty-five projects in the Tucson area and continues with those endeavors. While in Tucson, Mr. Stiteler diversified his development focus, expanding into income producing properties and redevelopment of vintage buildings in downtown Tucson.

In 2012, Mr. Stiteler partnered with Rudy Dabdoub and his family on a variety of endeavors. In 2023, Mr. Stiteler partnered with Regan Jasper to provide hospitality experience. In the past sixteen years, projects in downtown Tucson include redevelopment and renovation of three city blocks at the intersection of 5th Avenue and Congress Street and recently the renovation of the Corbett block at 6th Avenue and 7th Street. Notable downtown projects include One North Fifth apartments, the Hub Restaurant, Connect Coworking at Rialto, Hub Ice Cream Factory, Playground, Good Oak Bar, Love Burger, Corbett's and AC Tucson Hotel by Marriott. Future projects include Moxy Hotel by Marriott, a joint venture on the Ronstadt Transit Center, and main street in downtown Marana.

In addition to real estate development, he is an early-stage investor in several consumer product companies.

Mr. Stiteler currently resides in Belvedere, California with his wife, Jane, two daughters and two sons. He is a founder and board member at Del Bac in Tucson along with the Wiener Friendship Cup in Tiburon, California. In his free time, Mr. Stiteler enjoys open water swimming, triathlon, travel with family, and taking pictures of urban settings.



Rudy Dabdoub

Rudy Dabdoub has had a long-standing career in real estate development and hospitality management, primarily based in Southern Arizona and Sonora, Mexico. After earning his BS in Business Administration from Northern Arizona University in 1990, Rudy joined his family's business, DAB Developers, contributing to significant industrial, commercial, and residential projects in Nogales, Sonora. In 1994, he expanded the family's business interests into the United States, where he founded D&D Properties and ventured into the gasoline station & convenience store sector.

In 1998, Rudy redirected the U.S. side of the family business towards developing office and industrial buildings, before shifting focus to residential projects in 2017. Simultaneously, since 2001, he has managed the development and operation of several hotel projects across Arizona under North Face Investments L.L.C and associated companies. Through NFI and in partnership with Scott Stiteler, he has also managed a diverse portfolio including restaurants, bars, retail spaces, and a large mixed-use project all in the Downtown Tucson area. Under his direction, NFI has acquired multiple sites in Arizona for future development.

Further, Rudy founded Cima Enterprises L.L.C. in 2003, a full-service management firm overseeing many of the aforementioned businesses and employing over 250 staff members. He has also explored other real estate endeavors through the years, ranging from student housing and co-working office space to mixed-use commercial projects. Beyond his professional pursuits, Rudy is an active community member, serving on multiple boards and receiving accolades for his contributions.

Rudy is a proud Tucsonan, husband, and father of five. He spends his free time with his family, attending University of Arizona sporting events, traveling, exercising, and sailing.



Regan Jasper

Regan Jasper, current partner at Corbett's and Seven Corners Management and founding partner of Fox Restaurant Concepts, discovered Tucson Arizona through the University of Arizona as a Sophomore, fell in love with the sunshine, and never returned to the Pacific Northwest. He has worked his way through the restaurant industry focusing on his passion for wine and hospitality. As a partner in Fox Restaurants Concepts from 1999 until its sale in October 2019, he helped grow the company from Wildflower to 135 restaurants with over 15 unique concepts.

In 2020, Jasper stepped away from FRC and Cheesecake Factory and was woo'd by the possibilities of a new project that would later be called Corbett's. This led to the formation of Seven Corners Management to oversee multiple restaurant operations in downtown and downtown-adjacent Tucson.

Jasper has most recently partnered with Scott Stiteler and Rudy Dabdoub to plan and develop a 40 acre parcel in downtown Marana.



Cory Creath

As President and CEO of AXIS, Cory works closely with fellow firm principals to set the strategic vision for the company. Under his leadership, AXIS has grown to be one of the pre-eminent hospitality and multi-family design firms in the western US, serving owners and developers on ground-up, renovation/reposition, value add, and adaptive re-use projects.

Mr. Creath is a licensed Architect with forty years of experience in the design industry. In addition to managing projects, Cory's responsibilities consist of overseeing business development and administration. He expertly guides projects from the feasibility stage through the design and entitlement phases, and brings focused attention to the integration of design concepts with the budget, schedule and approval realm.

Prior to the formation of AXIS in September 2001, Mr. Creath was a studio director and senior project manager with Gensler's San Francisco office. Mr. Creath has managed large-scale architecture, building renovation and interior projects. He has proven his ability to coordinate consultants, interface with general contractors and approval agencies. His focus is bringing the whole design team together to deliver quality design that is within the Client's budget.

Major clients have included: Prism Hotels, Kensington Management, Lotus Management, HOST, Carlyle Group, Blackstone/LXR, Montclair Hotel Investors, Reneson Hotels, Blackridge, K2 Development, Sunstone, Chelsea, Z&L Properties, Paradigm Hotels, Westbrook Realty, Hong Kong Shanghai Hotel Group, United Pacific Hotel Group, and Tucson North.



Ruairi O'Connell

Ruairi joined AXIS at the beginning of 2019, bringing experience of diverse project types across market sectors and five continents, gleamed from over a decade working at and with design firms large and small in the San Francisco Bay Area.

As the firm's Design Director, Ruairi works closely with stakeholders and the design team to develop and ensure functional, programmatic, and aesthetic criteria are defined and met or exceeded.

Major clients have included federal, state, and municipal government agencies, institutional clients, and private developers including Reneson Hotels and Newcrest. Ruairi has led design for the successful entitlement of approximately $345 million in new hospitality and mixed use projects, has delivered $47 million in new construction as lead designer, and almost half a billion as part of larger collaborative efforts.

3 Project Delivery Approach

3. a. Proposed Method to Accomplish the Work

i.

Building a downtown from the ground up is obviously a large endeavor. With expectations of delivering a genuine downtown so high on the public and private side of this relationship, the objective rises toward unprecedented. Our passion to design and construct structures that have charm, strength and deliver experience is the reason we have been successful with our part of rebuilding downtown Tucson. It is the reason we will deliver for downtown Marana. Thankfully, we enjoy a trusting relationship with the Town of Marana and its leaders based on our work in the past.

This is a partnership that requires all participants to enter the relationship wanting to give more than is received.

ii.

Every business and tenant that becomes a part of downtown Marana will be part of setting a high standard. Our company has adhered to this principle since its founding. The projects we have completed in downtown Tucson reflect this important requirement. There will be nothing that qualifies as mediocre in our downtown.

iii.

One of the main attractions to this opportunity is based on traditions the Town of Marana has successfully established. Founder's Day, Marana Holiday Festival and Christmas Tree Lighting, and Marana Pumpkin Patch are only a few examples of community pride and respect for history. We will fully engage with the Town to leverage and grow these and other special events.

3. b. Knowledge and Understanding of the Local Environment

i.

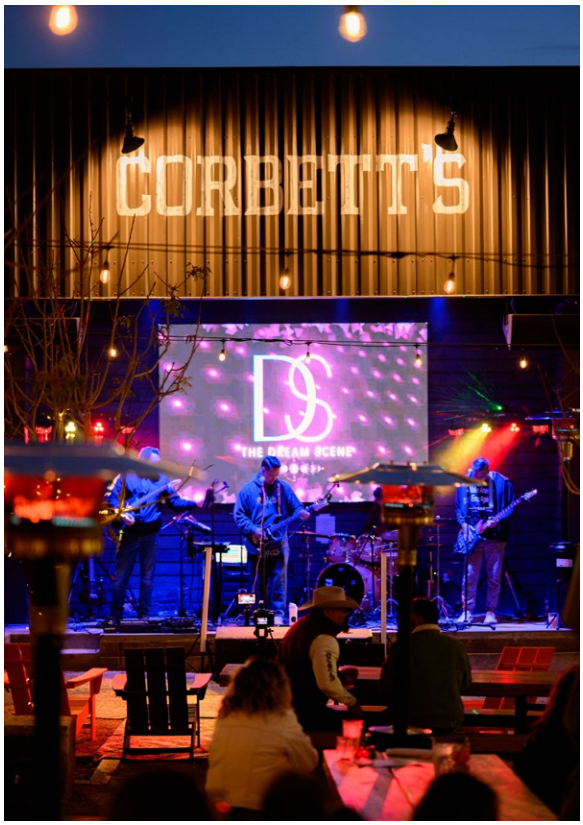
Our company has been involved starting and finishing dozens of real estate developments in southern Arizona. We have immersed ourselves in the community with how we approach design, materials and experience. We have consistently been part of supporting entities from non profit to cultural and look forward to continuing this duty in the future.

ii.

Main street and Marana arch will deliver an experience that makes residents and visitors want to come back. The streets and surrounding buildings will be clean, charming, interesting and vibrant. They will have personality during the day and night. They will feel comfortable and safe. They will attract business owners that want to maintain this feel knowing that it is not easy to find and requires personal pride to maintain it.

4 Business and Financial Plan







Pictured Above: Past success in activating an urban environment; the Corbett Site in Tucson.

4. a. Preliminary Project Business Plan

i.

It is too early in the process to provide a fully developed business plan. The spreadsheet included here outlines the scale and timing of what we believe is appropriate for the combined parcels.

ii.

We have designed, entitled, built and currently own several, substantial real estate assets in southern Arizona. We have been active in the region for over thirty years. We have finished every project we started. Our combined assets are suitable to deliver on a project of this scale. Bank references are provided in this proposal.

iii.

Please see 4.a.i. above.

iv.

The project will be built in phases. Each phase will be a building block for the next. The complexity and scope of this project makes it difficult to predict timing. A key driver of timing will be increased local employers with rising salaries. As soon as the lease and development agreement are in place, our focus will be on the design, construction and opening of the entry of Marana Arch with restaurants, parking, courtyard seating, and quality art. The success of this first phase is critical to the elevated experience we want throughout downtown and the surrounding area.

PHASE / MILESTONE	SIZE, UNITS, KEYS, SPACES	SOUTH 19	NORTH 40	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
PHASE ZERO																
SELECT APPLICANT (MARANA URBAN "MU")				X												
LEASE AND DEVELOPMENT AGREEEMENT				X												
PHASE ONE																
TOWN PARKING	200 SPACES	X			X	X	X									
TOWN PARTIAL ROAD AND ARCH	400 LINEAL FEET	X			X	X	X									
TOWN SIGN @ I-10	30 FEET		X		X	X	X									
MU COMMERCIAL	15,000 SQUARE FEET	X			X	X	X									
PHASE TWO																
TOWN PARKING	500 SPACES	X						X	X	X						
EXTEND ROAD AND SECOND ARCH	700 LINEAL FEET	X						X	X	X						
MU COMMERCIAL 25K	25,000 SQUARE FEET	X						X	X	X						
MU HOTEL	175 KEYS	X							X	X	X					
PHASE THREE																
TOWN PARKING	700 SPACES		X							X						
MAIN STREET	2,000 FEET		X							X						
MU COMMERCIAL	25,000 SQUARE FEET	X	X								X	X				
MU RESIDENTIAL	450 UNITS		X								X	X	X			
MU HOTEL	150 KEYS		X								X	X	X			
PHASE FOUR																
TOWN PARKING	900 SPACES										X					
MU COMMERCIAL	15,000 SQUARE FEET											X	X			
MU RESIDENTIAL	650 UNITS											X	X	X		
PHASE FIVE																
TOWN PARKING	800 SPACES		X										X			
MU COMMERCIAL	15,000 SQUARE FEET	X	X											X	X	
MU RESIDENTIAL	700 UNITS		X											X	X	X
MU HOTEL	150 KEYS		X												X	X
TOTALS		**9**	**10**	**2**	**4**	**4**	**4**	**3**	**4**	**6**	**5**	**5**	**5**	**3**	**3**	**2**

PROJECT SUMMARY	UNITS
PARKING	3,100 SPACES
COMMERCIAL	95,000 SQUARE FEET
RESIDENTIAL	1,800 UNITS
HOTEL	475 KEYS

PROJECT SUMMARY	UNITS	# UNITS	PER UNIT	TOTAL COST
ESTIMATED COST IN 2024 $				
ROADS AND UTILITIES				$ 23,000,000
MONUMENT SIGN				$ 1,375,000
ART, ROW IMPROVEMENTS, OPEN SPACE				$ 7,000,000
PARKING	3,100 SPACES	3100	$ 12,000	$ 37,200,000
COMMERCIAL	95,000 SQUARE FEET	95000	$ 445	$ 42,275,000
RESIDENTIAL	1,800 UNITS	1800	$ 330,000	$ 594,000,000
HOTEL	475 KEYS	475	$ 350,000	$ 166,250,000
TOTAL				**$ 871,100,000**

4. b. Financial Capacity

i. Financial Capacity

See response in 4a ii

ii. Credit and Business References

Dave Lyons National Bank of Arizona	Sandra Barton Alliance Bank	Fletcher McCusker Rio Nuevo Board
520-584-4140 David.Lyons@nbarizona.com	520-784-6037 sbarton@ alliancebankofarizona.com	fjmccusker@gmail.com

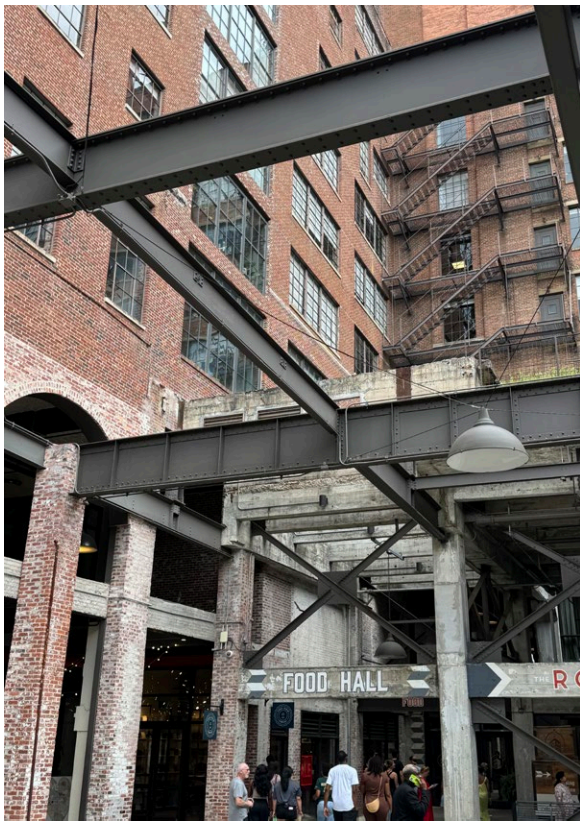
4. c. Business Revenue Risk

i. & ii.

Long term success will be based on humility, focus, tenacity, realistic expectations and decades of experience from our team building in the region. Managing cashflows and resources will obviously play a vital role. Our success will be bolstered by a strong and trusting relationship between the Town, the Community and our group.

5 Lease and Rent Proposal







Design Inspiration from research expeditions.

5. a. Lease Proposal

i. Proposed Lease Term

50 years with mutually agreeable extensions

ii. Public Improvements the Developer Proposes the Town Complete

Utilities with adequate capacity to perimeter of each parcel.

Right of way improvements including Main Street.

Surface and structured parking to support demand.

Open space improvements to support neighborhood.

Marana arch at entry to curved walking street.

Billboard that anchors and announces downtown Marana visible from I-10.

iii. Other Terms or Conditions

Sales tax rebates until minimum acceptable return on investment occurs.

Fee offset from design spend.

5. b. Rent Proposal

i. Rent Proposal & ii. Rent Structure

Rent timing and rate tied to minimum acceptable return on investment. Ideally, the minimum return is reached in the first half of the term and the Town receives a higher return than the developer going forward.

All returns shall be independently audited on an annual basis to satisfy any concerns regarding gift clause requirements or unfair sharing of public and private investment.

5. c. Gift Clause Considerations

i.

We do not believe the gift clause is implicated by this proposal.

As a preliminary matter, the Town's performance under our proposal consists of expenditures improving and benefiting the Town's own land, or incentives to reimburse the developer for improvements on Town land. As noted by the Arizona appellate court in Stuart v City of Scottsdale, CACV 18-154 (Arizona App December 8, 2020), the gift clause isn't generally violated by improvements by a governmental body to its own property. Additionally, (i) the lease will generate actual rental receipts to the Town (we propose a percentage rent arrangement whereby the Town's share of net profit from the development increases as the developer's costs have been returned with a reasonable rate of return), and (ii) at the end of the lease term, all improvements revert to the Town. As a result, while general "economic impact" is anticipated to be large, there are direct and tangible financial benefits to the Town through the payment of the rent and the reversionary interest in the improvements, contrary to the situation in Shires.

Although we are not privy to any competing responses to the RFP, we argue that our proposal will be more compelling because of the ability to develop our 40 acres alongside the Town's 19 acres, providing a larger, more integrated and more compelling downtown; we assume, in connection with the Neptune Swimming Foundation case, the Town will consider that "*the Gift Clause does not prevent a public entity from considering nonpecuniary factors in deciding what arrangement terms are most advantageous, even if more financially profitable deals exist*." (Neptune, ¶36).

RFP Signature Page

The proposer must sign this Signature Page.

In the absence of any exceptions identified in the proposal, the proposer will be bound by all of the terms and conditions outlined in the RFP.

TO THE TOWN OF MARANA:
The undersigned represents that he or she:

1. Is duly authorized to make binding offers on behalf of the proposer.
2. Has read and understands all information, terms, and conditions in the RFP.
3. Has not engaged in any collusive actions with any other potential proposers for this RFP.
4. Hereby certifies that the proposer takes no exception(s) to any portion of the RFP, unless an exception(s) is specifically noted in the proposal.

Proposer Name

Address

City State ZIP

Signature of Person Authorized to Sign/Date

Printed Name

Title

For Clarification of this Offer contact:

Name

Title

Phone

Fax

Email

Thank You

RFP Signature Page

The proposer must sign this Signature Page.

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The undersigned represents that he or she:

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4. Hereby certifies that the proposer takes no exception(s) to any portion of the RFP, unless an exception(s) is specifically noted in the proposal.

Marana Urban LLC
Proposer Name

30 South 5th Ave
Address

Tucson Az 85701
City State ZIP

Signature of Person Authorized to Sign/Date 7/10/24

Scott Stiteler
Printed Name

Manager
Title

For Clarification of this Offer contact:

Scott Stiteler
Name

Manager
Title

415 259 8844
Phone

Fax

tucsonurban@gmail.com
Email

September 10, 2024

Vicky Edwards
Procurement Officer | Finance
Town of Marana
11555 W Civic Center Dr
Marana, AZ 85653

RE: 2024-015 Lease and Development of Downtown Marana 19 Acres

Dear Vicky Edwards,

We appreciate your follow-up questions and are pleased to provide the following responses to address the information you requested.

We hope these responses further clarify our proposal, and we remain fully committed to the success of this project. If there are any additional questions or if further clarification is needed, please do not hesitate to contact us.

We look forward to working with the Town of Marana on this exciting project.

Sincerely,

Scott Stiteler
Partner | Marana Urban LLC
30 S 5th Ave Tucson, AZ 85701
Phone: 415.259.8844
Email: tucsonurban@gmail.com

Jay A. Ramos
Senior Director, Real Estate Development | Opus Development Company, L.L.C.
2555 E Camelback Road, Phoenix, AZ 85016
Phone: 602.648.5065
Email: Jay.Ramos@opus-group.com

Q1) Business & Financial Plan –

Based on the spreadsheet provided for Section 4.a. Preliminary Project Business Plan on page 33 of your proposal, provide a detailed breakdown of estimated revenue and expenses for each phase of the project to include the following:

- Expected timeline defined by each phase
- Detailed preliminary revenue and expense projections

RESPONSE

This project presents a unique and valuable opportunity for the Town of Marana to invest in long-term economic growth and community development. By partnering on the infrastructure buildout and offering incentives such as the initial ground lease rent-free period, sales tax rebates, Marana will unlock substantial future tax revenues from a vibrant retail center spanning 95,000 square feet, a hotel with 175 keys and 700 parking spaces. While the financial benefits may not be immediate, the long-term payoff after the 10-year buildout will provide a significant boost to the town's tax base, enhance job creation, and stimulate local economic activity. Additionally, once Marana Urban LLC and Opus meet their investment hurdles, the town will share in all project revenues ensuring a steady stream of income. This public-private partnership will set the stage for Marana's sustained growth, making it an attractive destination for both residents and visitors.

See next spreadsheet named "Operating Cash Flows".

		YEAR	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
	Hotel Cost $/Room	$350,000				$61,250,000							
	Retail Cost $/SF	$310											
	Cumulative SF Built		6,000	15,000	15,000	106,500	114,500	119,500	125,000	135,000	150,000	165,000	180,000
	SF Built Per Period		6,000	9,000	0	6,500	8,000	5,000	5,500	10,000	15,000	15,000	15,000
	Cost Per Period		$1,860,000	$2,790,000	$0	$2,015,000	$2,480,000	$1,550,000	$1,705,000	$3,100,000	$4,650,000	$4,650,000	$4,650,000
	Cumulative Costs			$4,650,000	$4,650,000	$67,915,000	$70,395,000	$71,945,000	$73,650,000	$76,750,000	$81,400,000	$86,050,000	$90,700,000
						OPERATING CASH FLOWS							
Space	**Rental Rate $/SF/YR**	**SF**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
Brewery	$35.00	6,000	$180,000	$185,400	$190,962	$196,691	$202,592	$208,669	$214,929	$221,377	$228,019	$234,859	$241,905
F&B 1	$35.00	5,000		$175,000	$180,250	$185,658	$191,227	$196,964	$202,873	$208,959	$215,228	$221,685	$228,335
F&B 2	$35.00	4,000		$140,000	$144,200	$148,526	$152,982	$157,571	$162,298	$167,167	$172,182	$177,348	$182,668
F&B 3	$35.00	3,500				$122,500	$126,175	$129,960	$133,859	$137,875	$142,011	$146,271	$150,660
Dance Barn	$30.00	3,000				$90,000	$92,700	$95,481	$98,345	$101,296	$104,335	$107,465	$110,689
Rodeo	$30.00	8,000					$240,000	$247,200	$254,616	$262,254	$270,122	$278,226	$286,573
Steakhouse	$35.00	5,000						$175,000	$180,250	$185,658	$191,227	$196,964	$202,873
F&B 4	$36.00	5,500							$192,500	$198,275	$204,223	$210,350	$216,660
General Retail	$36.00	5,000								$180,000	$185,400	$190,962	$196,691
General Retail	$36.00	5,000								$180,000	$185,400	$190,962	$196,691
General Retail	$36.00	5,000									$180,000	$185,400	$190,962
General Retail	$36.00	5,000									$180,000	$185,400	$190,962
General Retail	$36.00	5,000									$180,000	$185,400	$190,962
General Retail	$36.00	5,000										$180,000	$185,400
General Retail	$36.00	5,000										$180,000	$185,400
General Retail	$36.00	5,000										$180,000	$185,400
General Retail	$36.00	5,000											$180,000
General Retail	$36.00	5,000											$180,000
General Retail	$36.00	5,000											$180,000
	Total SF	95,000											
Rental Income			$180,000	$500,400	$515,412	$743,374	$1,005,676	$1,210,846	$1,439,671	$1,842,861	$2,438,147	$3,051,292	$3,682,830
Expense Recovery Income			$74,106	$185,265	$185,265	$265,547	$364,355	$467,354	$541,860	$677,325	$799,244	$880,523	$1,083,720
POTENTIAL GROSS INCOME			$254,106	$685,665	$700,677	$1,008,921	$1,370,031	$1,678,200	$1,981,531	$2,520,186	$3,237,391	$3,931,814	$4,766,550
Vacancy @ 5%			$9,000	$25,020	$25,771	$37,169	$50,284	$60,542	$71,984	$92,143	$121,907	$152,565	$184,142
EFFECTIVE GROSS INCOME	Per SF		$245,106	$660,645	$674,907	$971,753	$1,319,747	$1,617,658	$1,909,548	$2,428,043	$3,115,483	$3,779,250	$4,582,409
Common Area Maintenance	$5.00		$30,000	$75,000	$75,000	$532,500	$572,500	$597,500	$625,000	$675,000	$750,000	$825,000	$900,000
Management Fee	3%		$7,353	$19,819	$20,247	$29,153	$39,592	$48,530	$57,286	$72,841	$93,465	$113,377	$137,472
Insurance	$2.00		$12,000	$30,000	$30,000	$43,000	$59,000	$69,000	$80,000	$100,000	$130,000	$160,000	$190,000
Ground Rent	$1.20		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$216,000
Property Taxes													
TOTAL OPERATING EXPENSES			$49,353	$124,819	$125,247	$604,653	$671,092	$715,030	$762,286	$847,841	$973,465	$1,098,377	$1,443,472
RETAIL NET OPERATING INCOME			$195,753	$535,826	$549,660	$367,100	$648,655	$902,628	$1,147,261	$1,580,202	$2,142,019	$2,680,872	$3,138,937
HOTEL NET OPERATING INCOME			$0.00	$0.00	$0.00	$0	$3,481,433	$4,724,344	$4,856,110	$5,006,699	$5,161,817	$5,333,450	$5,481,796
Total Net Operating Income			$195,753	$535,826	$549,660	$367,100	$4,130,088	$5,626,972	$6,003,371	$6,586,901	$7,303,836	$8,014,322	$8,620,733
Retail Sales Tax Benefit			$52,500	$131,250	$131,250	$188,125	$258,125	$301,875	$350,000	$437,500	$568,750	$700,000	$831,250
Parking Revenue			$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000
Less Leasing Costs	$90		$540,000	$810,000	$0	$585,000	$720,000	$450,000	$495,000	$900,000	$1,350,000	$1,350,000	$1,350,000
NET Revenue			**($211,747)**	**($62,924)**	**$760,910**	**$50,225**	**$3,748,213**	**$5,558,847**	**$5,938,371**	**$6,204,401**	**$6,602,586**	**$7,444,322**	**$8,181,983**
	Yield on Costs		**-11.4%**	**-1.4%**	**16.4%**	**0.1%**	**5.3%**	**7.7%**	**8.1%**	**8.1%**	**8.1%**	**8.7%**	**9.0%**

Annual Sales Per Year $/SF Average	$350	$2,100,000	$5,250,000	$5,250,000	$7,525,000	$10,325,000	$12,075,000	$14,000,000	$17,500,000	$22,750,000	$28,000,000	$33,250,000
Town of Marana Sales Tax Rate	2.50%	$52,500	$131,250	$131,250	$188,125	$258,125	$301,875	$350,000	$437,500	$568,750	$700,000	$831,250

Marana Hotel - Tucson, AZ - Version v1.57

Operating Cash Flow

	Year 1		Year 2		Year 3		Year 4		Year 5		Year 6		Year 7		Year 8		Year 9		Year 10		Year 11	
	Year Ending December		Year Ending December		Year Ending December		Year Ending December		Year Ending December		Year Ending December		Year Ending December		Year Ending December		Year Ending December		Year Ending December		Year Ending December	
Year	2027		2028		2029		2030		2031		2032		2033		2034		2035		2036		2037	
Rooms	175		175		175		175		175		175		175		175		175		175		175	
Days	365		366		365		365		365		366		365		365		365		366		365	
Available Rooms	63,875		64,050		63,875		63,875		63,875		64,050		63,875		63,875		63,875		64,050		63,875	
Occupied Rooms	34,108		43,554		43,435		43,435		43,435		43,554		43,435		43,435		43,435		43,554		43,435	
Occupancy	53.4%		68.0%		68.0%		68.0%		68.0%		68.0%		68.0%		68.0%		68.0%		68.0%		68.0%	
ADR	$175.00		$180.25		$185.66		$191.23		$196.96		$202.87		$208.96		$215.23		$221.68		$228.34		$235.19	
ADR Growth	N/A		3.00%		3.00%		3.00%		3.00%		3.00%		3.00%		3.00%		3.00%		3.00%		3.00%	
RevPAR	$93.45		$122.57		$126.25		$130.03		$133.94		$137.95		$142.09		$146.35		$150.75		$155.27		$159.93	
RevPAR Growth	N/A		31.17%		3.00%		3.00%		3.00%		3.00%		3.00%		3.00%		3.00%		3.00%		3.00%	
TRevPAR	$82.60		$109.67		$112.94		$116.33		$119.82		$123.43		$127.12		$130.93		$134.86		$138.92		$143.07	
TRevPAR Growth	N/A		32.76%		2.99%		3.00%		3.00%		3.01%		2.99%		3.00%		3.00%		3.01%		2.99%	
	$	%	$	%	$	%	$	%	$	%	$	%	$	%	$	%	$	%	$	%	$	%
Departmental Revenues																						
Rooms	5,968,813	97.8%	7,850,609	97.8%	8,064,034	97.8%	8,305,955	97.8%	8,555,133	97.8%	8,835,929	97.8%	9,076,141	97.8%	9,348,425	97.8%	9,628,878	97.8%	9,944,916	97.8%	10,215,276	97.8%
Food & Beverage	68,215	1.1%	89,721	1.1%	92,160	1.1%	94,925	1.1%	97,773	1.1%	100,982	1.1%	103,727	1.1%	106,839	1.1%	110,044	1.1%	113,656	1.1%	116,746	1.1%
Other Operated Departments	17,054	0.3%	22,430	0.3%	23,040	0.3%	23,731	0.3%	24,443	0.3%	25,246	0.3%	25,932	0.3%	26,710	0.3%	27,511	0.3%	28,414	0.3%	29,187	0.3%
Parking Income	51,161	0.8%	67,291	0.8%	69,120	0.8%	71,194	0.8%	73,330	0.8%	75,737	0.8%	77,795	0.8%	80,129	0.8%	82,533	0.8%	85,242	0.8%	87,560	0.8%
Total Revenue	6,105,243	100.0%	8,030,051	100.0%	8,248,354	100.0%	8,495,805	100.0%	8,750,679	100.0%	9,037,893	100.0%	9,283,595	100.0%	9,562,103	100.0%	9,848,966	100.0%	10,172,228	100.0%	10,448,768	100.0%
Departmental Expenses																						
Rooms	800,000	13.4%	970,059	12.4%	997,414	12.4%	1,027,336	12.4%	1,058,156	12.4%	1,091,812	12.4%	1,122,600	12.4%	1,156,278	12.4%	1,190,966	12.4%	1,228,846	12.4%	1,263,498	12.4%
Food & Beverage	20,465	30.0%	25,223	28.1%	25,930	28.1%	26,708	28.1%	27,509	28.1%	28,389	28.1%	29,184	28.1%	30,060	28.1%	30,961	28.1%	31,952	28.1%	32,847	28.1%
Other Operated Departments	8,527	50.0%	10,607	47.3%	10,903	47.3%	11,230	47.3%	11,567	47.3%	11,938	47.3%	12,271	47.3%	12,639	47.3%	13,019	47.3%	13,437	47.3%	13,811	47.3%
Total Departmental Expenses	828,991	13.6%	1,005,889	12.5%	1,034,246	12.5%	1,065,273	12.5%	1,097,232	12.5%	1,132,139	12.5%	1,164,055	12.5%	1,198,977	12.5%	1,234,946	12.5%	1,274,235	12.5%	1,310,157	12.5%
DEPARTMENTAL PROFIT	**5,276,251**	**86.4%**	**7,024,162**	**87.5%**	**7,214,108**	**87.5%**	**7,430,531**	**87.5%**	**7,653,447**	**87.5%**	**7,905,754**	**87.5%**	**8,119,540**	**87.5%**	**8,363,127**	**87.5%**	**8,614,020**	**87.5%**	**8,897,993**	**87.5%**	**9,138,612**	**87.5%**
Undistributed Expenses																						
Admin. & General	341,075	5.6%	448,606	5.6%	460,802	5.6%	474,626	5.6%	488,865	5.6%	504,910	5.6%	518,637	5.6%	534,196	5.6%	550,222	5.6%	568,281	5.6%	583,730	5.6%
Information and Telecommunications Systems	51,161	0.8%	67,291	0.8%	69,120	0.8%	71,194	0.8%	73,330	0.8%	75,737	0.8%	77,795	0.8%	80,129	0.8%	82,533	0.8%	85,242	0.8%	87,560	0.8%
Sales, Marketing & Franchise Fee	511,613	8.4%	672,909	8.4%	691,203	8.4%	711,939	8.4%	733,297	8.4%	757,365	8.4%	777,955	8.4%	801,294	8.4%	825,332	8.4%	852,421	8.4%	875,595	8.4%
Prop. Op. & Maintenance	272,860	4.5%	358,885	4.5%	368,642	4.5%	379,701	4.5%	391,092	4.5%	403,928	4.5%	414,909	4.5%	427,357	4.5%	440,177	4.5%	454,625	4.5%	466,984	4.5%
Utilities	238,753	3.9%	314,024	3.9%	322,561	3.9%	332,238	3.9%	342,205	3.9%	353,437	3.9%	363,046	3.9%	373,937	3.9%	385,155	3.9%	397,797	3.9%	408,611	3.9%
Total Undistributed Expenses	1,415,461	23.2%	1,861,716	23.2%	1,912,328	23.2%	1,969,698	23.2%	2,028,789	23.2%	2,095,377	23.2%	2,152,342	23.2%	2,216,912	23.2%	2,283,420	23.2%	2,358,366	23.2%	2,422,480	23.2%
GROSS OPERATING PROFIT	**3,860,790**	**63.2%**	**5,162,446**	**64.3%**	**5,301,780**	**64.3%**	**5,460,834**	**64.3%**	**5,624,659**	**64.3%**	**5,810,376**	**64.3%**	**5,967,198**	**64.3%**	**6,146,214**	**64.3%**	**6,330,601**	**64.3%**	**6,539,628**	**64.3%**	**6,716,132**	**64.3%**
Management Fee	183,157	3.0%	240,902	3.0%	247,451	3.0%	254,874	3.0%	262,520	3.0%	271,137	3.0%	278,508	3.0%	286,863	3.0%	295,469	3.0%	305,167	3.0%	313,463	3.0%
INCOME BEFORE FIXED EXPENSES	**3,677,633**	**60.2%**	**4,921,544**	**61.3%**	**5,054,330**	**61.3%**	**5,205,959**	**61.3%**	**5,362,138**	**61.3%**	**5,539,240**	**61.3%**	**5,688,690**	**61.3%**	**5,859,351**	**61.3%**	**6,035,132**	**61.3%**	**6,234,461**	**61.3%**	**6,402,669**	**61.3%**
Fixed Expenses																						
Property Taxes	146,200	2.4%	146,200	1.8%	146,200	1.8%	146,200	1.7%	146,200	1.7%	150,586	1.7%	150,586	1.6%	150,586	1.6%	150,586	1.5%	150,586	1.5%	150,586	1.4%
Insurance	50,000	0.8%	51,000	0.6%	52,020	0.6%	53,060	0.6%	54,122	0.6%	55,204	0.6%	56,308	0.6%	57,434	0.6%	58,583	0.6%	59,755	0.6%	60,950	0.6%
Lease & Rental Expense	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%
Total Fixed Expenses	196,200	3.2%	197,200	2.5%	198,220	2.4%	199,260	2.3%	200,322	2.3%	205,790	2.3%	206,894	2.2%	208,020	2.2%	209,169	2.1%	210,341	2.1%	211,536	2.0%
EBITDA	**3,481,433**	**57.0%**	**4,724,344**	**58.8%**	**4,856,110**	**58.9%**	**5,006,699**	**58.9%**	**5,161,817**	**59.0%**	**5,333,450**	**59.0%**	**5,481,796**	**59.0%**	**5,651,331**	**59.1%**	**5,825,963**	**59.2%**	**6,024,120**	**59.2%**	**6,191,133**	**59.3%**
Reserve for Replacement	122,105	2.0%	160,601	2.0%	164,967	2.0%	169,916	2.0%	175,014	2.0%	180,758	2.0%	185,672	2.0%	191,242	2.0%	196,979	2.0%	203,445	2.0%	208,975	2.0%
NET OPERATING INCOME	**3,359,328**	**55.0%**	**4,563,743**	**56.8%**	**4,691,143**	**56.9%**	**4,836,783**	**56.9%**	**4,986,803**	**57.0%**	**5,152,692**	**57.0%**	**5,296,124**	**57.0%**	**5,460,089**	**57.1%**	**5,628,983**	**57.2%**	**5,820,676**	**57.2%**	**5,982,158**	**57.3%**

Q2) Business Plan/Financial Resources –

Identify the sources of capital for the project and provide initial financial projections to include key assumptions underlying these projections.

RESPONSE

Business Plan/Financial Resources

Sources of Capital:

Marana Urban LLC's project will be funded through a well-balanced capital stack, comprising 60% debt financing and 40% equity. The primary sources of capital include:

1. Equity Partners:

We have various existing relationships with Institutional investors, that will provide the equity portion of the capital stack, contributing 40% of the total project cost. These partners bring a wealth of experience and capital resources to support the project's long-term success.

2. Debt Financing:

The remaining 60% of the capital stack will come from debt financing. We will leverage our strong relationships with both regional and national banks. The construction loan will transition to permanent financing upon stabilization of the project, ensuring favorable loan terms throughout the development process.

3. Additional Funding Opportunities:

We are exploring additional funding opportunities, including local grants and tax incentives available through city, county and state, which could further reduce the overall capital needs.

Initial Financial Projections:

The financial projections for the project are based on key assumptions related to development costs, revenue generation, and the timeline for stabilization.

Development Costs:

- Land Acquisition: from the Town of Marana, will be a 50-year ground lease at a fair market rent of $0.26 PSF, with abated rent for the first 10 years of the project with CPI adjustments every 5 years.
- Construction Costs: Total construction costs, for the phases are estimated at $871M. However, Phase 1 will incur most offsite costs including roads and utilities estimated at $23M. The retail portion on the 19-acre parcel including the hotel will have a total estimated cost of $91M.
- Contingency: A 5% contingency fund will be set aside for unforeseen expenses.

Revenue Projections:

Hotel Component:

With an Average Daily Rate (ADR) of $175 per night and a projected 68% occupancy rate, the 175-key hotel component is expected to generate annual gross room revenues of $7.8M by Year 2, following a stabilization period of 18 months. Net revenues are estimated at $4.5M.

Retail Component:

Retail tenants will be offered rental rates ranging from $30 to $36 per square foot, with NNN expenses at $9.00 per square foot. During the initial 18 months, rent concessions will be provided to attract high-quality tenants. Once stabilized, the retail component will contribute approximately $4.7M Gross Rent annually and $3.1M net.

Operating Expenses:

- Hotel Operating Expenses: Operating expenses for the hotel will account for 30-35% of total revenue, including staffing, utilities, and maintenance costs.

- Retail Operating Expenses: Retail tenants will cover NNN expenses, estimated at $9.00 per square foot.

Key Assumptions:

Stabilization Timeline: The hotel is expected to stabilize within 18 months, and each phase of the retail component will stabilize within 18 months of its construction date.

Occupancy Rates: Hotel occupancy is projected to stabilize at 68%, while retail occupancy is expected to stabilize at 95%.

Rental Rates: Retail rental rates will range from $30 to $36 per square foot, with a 3% annual increase post-stabilization. It is to early to calculate, however, a percentage rent will also be collected from the majority of the tenants.

Financing Terms: We expect to secure a construction loan at market interest for the 60% debt portion, with permanent financing terms transitioning after stabilization.

Profitability:

Yield on Costs(YOC): We aim for a minimum Yield on Cost of 8%.

Internal Rate of Return (IRR): The project is expected to achieve an IRR of 18% over a 10-year period, supported by steady cash flow from the hotel and retail components.

Q3) Detailed Rent Proposal/Structure –

Provide a detailed rent proposal to include the following:

- Given the appraiser's opinion of fair market rental value of $0.26 per square foot, specify whether you will request any flexible pricing or reduced rates during any phases of the project.
- Define Marana Urban LLC's minimum acceptable return on investment and provide clarification on how this will be reached in the first half of the term.

RESPONSE

Detailed Rent Proposal/Structure

Marana Urban LLC acknowledges the appraiser's assessment of the fair market rental value at $0.26 per square foot. To ensure the successful launch and stabilization of our project, we are requesting free rent for the first 10 years of the project. This approach is necessary to provide competitive rent concessions to our retail tenants and to support the hotel's stabilization.

Phase 1 (Initial 60 Months):

Free Rent Period

During the first 60 months, we request a complete rent waiver. This period is critical for establishing strong relationships with our retail tenants by offering attractive rent concessions, which will help achieve high occupancy rates and foster a vibrant retail environment. Additionally, this timeframe allows the hotel to stabilize its operations without the immediate financial pressure of ground rent obligations.

Phase 2 (Subsequent 60 Months):

Continued Free Rent

To maintain tenant retention and ensure ongoing operational stability, we propose extending the free rent period through the subsequent 60 months. This extension supports sustained occupancy levels and provides the hotel ample time to achieve full operational efficiency and profitability.

Yield on Cost (YOC):

Marana Urban LLC's minimum acceptable Yield on Cost is 8%. To achieve this target, we will implement the following strategies:

1. Tenant Attraction and Retention:

By offering free rent during both phases, we create an attractive proposition for high-quality retail tenants, ensuring rapid lease-up and sustained occupancy. High occupancy rates will generate steady revenue streams, which are crucial for meeting our YOC objectives.

2. Operational Stabilization:

The 10-year free ground rent period for the hotel allows for a focused effort on operational efficiency and service excellence without the immediate burden of rent costs. As the hotel stabilizes and begins to

generate consistent revenue, we will be well-positioned to transition to standard rental terms, thereby enhancing overall profitability.

3. Cost Management:

Effective management of development and operational costs during the free rent periods will enable us to maintain financial health and allocate resources efficiently. This disciplined approach ensures that we can achieve our YOC targets even with the initial rent concessions.

4. Revenue Growth:

As the hotel stabilizes and the retail component reaches full occupancy, we anticipate significant revenue growth. This growth, combined with the eventual transition to market rent, will drive the overall internal rate of return (IRR), ensuring that Marana Urban LLC meets or exceeds the minimum 18% IRR by the end of the 10-year period.

Q4) Business Attraction Approach –

Describe your plan to attract and retain businesses and tenants for the development by providing the following:

- Detail the strategies to attract businesses to the development and how you plan to maintain high occupancy rates.
- Outline your approach to working with the Town to promote local programs and special events to maximize community engagement.

RESPONSE

We will follow the same approach we successfully used in downtown Tucson to attract and retain quality operators. Today the intersection is 100% leased with a diverse group of businesses. We focused on three blocks at one intersection. We fully renovated existing historic structures with high quality materials. Rusted steel, heritage woods, hand-built leaded glass, reused brick, and local art turned a boarded-up intersection into an anchor for downtown. Our intersection is adjacent to the historic Train Depot that went through a comprehensive renovation from the city. Every part of the aesthetic was planned to elevate the area. With help from incentives provided by the city and the TIF district, we provided significant support to operators to open businesses in an area that had been blighted for decades. Reduced rent, free parking, sales tax rebates, generous tenant improvement allowances, and zero property tax pass throughs were instrumental in our pursuit of successful businesses and high occupancy. In the middle of the redevelopment, we were awarded an AC Hotel by Marriott franchise. This was one of the first AC Hotels approved in North America.

With our downtown Tucson blocks, we provided support or partnered with dozens of local groups and regular events including the historic Rialto Theater, the Tucson Jazz Festival, the Tucson Film Festival, Second Saturdays, Meet me at Maynard's, Ben's Bells, the January 8th Memorial, and many others. These partnerships are required to deliver a lasting and lively downtown. We will continue this strategy with Marana Main Street.

The Irvine Company has a development model that is one we respect. They consistently build neighborhoods that look established as soon as construction is completed. Every tree, wall, light fixture, sign, and building design guideline are excellent. They invite a short list of the most respected builders and businesses to tour each of their blocks when an opportunity is released. Because of the constant commitment to quality materials, design, and management it is common for the Irvine Company to receive an offer from every invited prospect. Creating this type of experience and demand is our goal.

Q5) Public Infrastructure –

Provide a comprehensive overview of the necessary public infrastructure for the project.

RESPONSE

When developing a specialty retail center, several types of public infrastructure are typically required to support the site and ensure connectivity and accessibility. These include:

1. Roadways and Access Points: Upgrading or constructing new roads to handle increased traffic is essential. This can include widening existing streets, creating new access points, signalization, turn lanes, and potentially roundabouts to facilitate smooth vehicle movement.

2. Utilities: Power retail centers require access to sufficient utilities, such as:
    - Water supply: Adequate capacity for fire protection, irrigation, and domestic use.
    - Sewer systems: Including stormwater drainage to prevent flooding and proper waste management.
    - Electricity and Gas: Extensions of electrical grids or gas lines to meet the needs of large retail outlets and related amenities.

3. Parking: Large parking lots with appropriate drainage and lighting are essential for customer convenience and safety. Infrastructure for electric vehicle (EV) charging stations may also be required.

4. Public Transit Connectivity: In some cases, nearby bus stops or shuttle services, access may be developed or enhanced to encourage alternative transportation options for customers and employees.

5. Pedestrian and Bike Infrastructure: Sidewalks, bike lanes, crosswalks, and pedestrian bridges to safely connect the center with surrounding neighborhoods or other retail areas.

6. Stormwater Management: Detention ponds, green spaces, permeable paving, and other infrastructure to manage runoff and meet environmental requirements.

7. Landscaping and Green Spaces: Often required to create a more aesthetically pleasing environment and contribute to sustainability efforts.

8. Signage and Wayfinding: For both vehicles and pedestrians, ensuring that directional and informational signage is well-placed.

Jane Fairall

From: Scott Stiteler <tucsonurban@gmail.com>
Sent: Thursday, October 31, 2024 2:42 PM
To: Vicky Edwards
Cc: Ramos, Jay; Rudy Dabdoub; Regan Jasper; Terry Rozema; Jane Fairall; Werner J. Meyer
Subject: Re: Lease and Development Downtown Marana response

PLEASE BE CAUTIOUS
THIS MESSAGE AND SENDER COME FROM OUTSIDE THE TOWN OF MARANA. IF YOU DID NOT EXPECT THIS MESSAGE, PROCEED WITH CAUTION. VERIFY THE SENDER'S IDENTITY BEFORE PERFORMING ANY ACTION, SUCH AS CLICKING ON A LINK OR OPENING AN ATTACHMENT.

Vicky,

Attached letter and response should be dated 10/31 🎃 Happy Halloween!

On Thu, Oct 31, 2024 at 2:39 PM Scott Stiteler <tucsonurban@gmail.com> wrote:

> Vicky,
>
> Thanks for requesting more clarity on this opportunity.
>
> 1. Yes, we support a fee structure that meets the requirements of the Gift Clause and demonstrates mutual benefit for Marana Urban and the Town. Ideally, the structure should favor the Town of Marana more than Marana Urban over the duration of the lease.
>
> 2. I've attached the response from Opus and Maran Urban regarding phase one costs.
>
> Thanks and please reach out anytime,
>
> Scott
>
> --
> Scott Stiteler

Tucson Urban LLC
Stellar Homes Inc.
415 259 8844

--
Scott Stiteler
Tucson Urban LLC
Stellar Homes Inc.
415 259 8844

September 10, 2024

Vicky Edwards
Procurement Officer | Finance
Town of Marana
11555 W Civic Center Dr
Marana, AZ 85653

RE: Preliminary Infrastructure Cost Estimate for Downtown Marana Development

Dear Vicky Edwards,

Thank you for the opportunity to submit a preliminary infrastructure cost estimate for the Downtown Marana development. Below, we provide cost estimates for the key infrastructure components requested, which the Town of Marana will be supporting.

We appreciate the Town of Marana's partnership in this development and look forward to furthering the vision for Downtown Marana. Should there be any questions or additional details required, please feel free to reach out.

Sincerely,

Scott Stiteler
Partner | Marana Urban LLC
30 S 5th Ave Tucson, AZ 85701
Phone: 415.259.8844
Email: tucsonurban@gmail.com

Jay A. Ramos
Senior Director, Real Estate Development
Opus Development Company, L.L.C.
2555 E Camelback Road, Phoenix, AZ 85016
Phone: 602.648.5065
Email: Jay.Ramos@opusgroup.com

Preliminary Infrastructure Cost Estimate

1. Temporary Parking Lot

Description: A 600+/ space temporary parking lot spanning approximately 182,000 square feet, intended to support initial traffic demands for Phase One. The surface will use crushed gravel or similar temporary material to help control dust and ensure adequate parking in the early phases of development.

Specifications: Dust mitigation and minimal grading for even surfaces are prioritized to create a functional, yet cost effective parking solution.

Cost Estimate: $835,700
Includes: Site grading, gravel installation, and dust control measures.

2. Marana Illuminated Arches

Description: Two striking, largescale illuminated arches bearing the "MARANA" name in bold, letters, set in a vintage industrial style. Inspired by early 20th century architectural designs, the arch will feature decorative circular elements above the lettering, echoing a rustic wagon wheel or gear motif. This visually prominent gateway will anchor each end of the brick paved roadway, elevating the town square ambiance.

Specifications: Constructed from steel or metal, the arches include an elevated design that spans two brick buildings, creating a bridge like effect. String lights will be suspended around the area, contributing to a warm, inviting glow over the plaza setting below.

Cost Estimate: $365,000 for each arch. Decision on one or two arches in phase one to be determined on cost savings.
Includes: Structural materials, lighting installation, and labor.

Brick-Paved Roadway (Phase One)

Description: A pedestrian-friendly brick-paved roadway covering approximately 14,000 square feet for the initial phase, with sidewalks on both sides to encourage community interaction. This distinctive herringbone-patterned street will bring a historic charm, using warm, earthy tones that seamlessly complement adjacent brick architecture.

Street Lighting: The street lighting will feature minimalist, industrial-style pole lights that add to the vintage charm of the brick-paved street and surrounding architecture. Each slender, dark-colored pole has a single fixture extending outward, casting a focused, warm light downward. Mounted at a medium height, these lights provide a cozy, inviting glow that enhances the brickwork and landscaping. Additional string lights overhead contribute a festive ambiance, creating a lively, communal atmosphere.

Specifications: Curbs and brick-paver sidewalks will border both sides, providing a cohesive and accessible space for residents and visitors. The completed roadway will double this area in future phases, expanding this welcoming town square setting.

Cost Estimate: $815,000

Includes: Paving, sidewalk installation, curbs, street lighting, and related labor.

4. Open-Air Easement Garden
Description: This 9,000 square foot open-air garden serves as a social hub, featuring artificial turf to create a comfortable gathering space, bordered by breweries on both ends. Patrons can enjoy the casual atmosphere with seating areas on the turf and various venues surrounding the garden, forming a vibrant central attraction within the development.

Specifications: Artificial turf provides a low maintenance solution, while tables and seating options enhance the inviting, communal setting. Surrounded by other venues, this beer garden will be a focal point for socializing and entertainment.

Cost Estimate: $450,000
Includes: Artificial turf, seating, landscaping, and installation.

5. Monument Sign Along Interstate 10
Description: A large, attention-grabbing monument sign designed to be visible from Interstate 10, welcoming travelers and locals into Downtown Marana. This 40-foot high by 18-foot-wide sign will feature bold, distinctive elements—potentially including unique imagery or figures that represent Marana's identity—illuminated with neon or LED lighting to make it visible day and night.

Specifications: Inspired by iconic signs such as the Hard Rock Cafe guitar, Pike Place Market sign in Seattle and Vegas Vic, this structure is intended to become a memorable landmark for Marana, standing out with vibrant lighting and a creative design that embodies the town's character.

Cost Estimate: $1,375,000
Includes: Structural materials, lighting, electrical work, engineering, and installation.

6. Utilities Connection to Site
Description: This infrastructure component involves establishing essential utility connections to support the site's initial and ongoing operations, including water, sewer, electricity, gas, and telecommunications. These connections are necessary to meet the demands of the planned development and ensure reliable, efficient service for all facilities on-site.

Specifications: Water and Sewer: Includes installation of main water and sewer lines with capacity for fire protection, irrigation, and domestic use, meeting both current and future demands of the development. Appropriate stormwater management measures will be implemented to prevent flooding and manage runoff effectively.

Electricity and Gas: Extension of electrical and gas lines to provide power and heating for buildings, public spaces, and lighting, ensuring reliable energy distribution across the development.

Telecommunications: High-speed internet and telecommunications infrastructure will be extended to the site, enabling modern connectivity for residents, visitors, and businesses.

Cost Estimate: $700,000

Includes: Installation of main water and sewer lines, electrical and gas line extensions, stormwater management infrastructure, and telecommunications setup.

7. Landscaping

Description: The landscaping for this development is designed to enhance the aesthetic appeal, create natural shade, and foster a welcoming atmosphere for visitors. It includes a combination of trees, shrubs, ground cover, and irrigation infrastructure to maintain the greenery throughout the first phase of the development.

Specifications:

- **Trees:** A total of 2,000 trees will be purchased, comprising 1,500 15-gallon trees and 500 24-inch box trees. These trees are strategically placed to provide shade, define pathways, and beautify the surroundings. The trees will be in planter boxes to allow them to grow and increase value before planting in a permanent location.
- **Shrubs and Ground Cover:** Additional shrubs and ground cover will be installed to add visual interest, soften hardscape areas, and contribute to the overall greenery of the site.
- **Irrigation:** An efficient irrigation system will be implemented to ensure sustainable water usage and maintain the health of all landscaping elements. The system will include automated controls for water conservation and efficient distribution across all landscaped areas.

Cost Estimate: $612,500
Includes: Tree planting, shrubs and ground cover, irrigation system installation, and landscaping materials and labor.

Infrastructure Component	Cost Estimate ($)
Temporary Parking Lot	$835,700.00
Marana Illuminated Arches (2)	$730,000.00
Brick-Paved Roadway (Phase-One)	$815,000.00
Open-Air Beer Garden (Turf)	$450,000.00
Utilities Connection to Site	$700,000.00
Landscaping	$612,500.00
Monument Sign Along Interstate 10	$1,375,000.00
Total	$5,518,200.00

Appendix A

MARANA AZ

N

0 75 150 225 300 Feet

W Grier Rd

217370120 217370110 217370090 217370080 217370070 217370060 2173700

217370700 217370680

ZONE AO 1

217370500

217370693B

21737071B

217370510

El Paso Natural Gas Line

21737067A

21737053A

N Marana Main St

21737073C

217370540

W Bill Gaudette Dr

217370630

217370850

ZONE AO 1

ZONE X - SHADED

ZONE X - SHADED

W Civic Center Dr

217370870

217370940

217370600

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