Engineer Certification

I, Charles Easterling, do hereby certify that this report and the analyses which were done in its production were prepared by me or under my direction and that I am a duly registered Professional Engineer under the laws of the State of New Mexico.

Charles M. Easterling, P.E. #6411

11-5-14

Date

CHARLES M. EASTERLING
NEW MEXICO
6411
REGISTERED PROFESSIONAL ENGINEER

I-40 South and Unser

Mini Drainage Master Plan

Prepared for:

I-40 SOUTH LLC

c/o Tom Keleher
P.O. Box AA
Albuquerque, NM 87103

Prepared by:
Easterling Consultants LLC
3613 NM 528
Suite E-2
Albuquerque, NM 87114

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A. Introduction

Easterling Consultants was commissioned by I-40 South LLC to perform a Mini-Drainage Management Plan for an area bounded by I-40 on the north, on the west by the large sand hill located west of 98th Street, on the east by the Unser Diversion Channel, and on the south by Los Volcanes Road. The watershed area is approximately 119 acres or 0.186 square miles and is largely undeveloped land consistent with the semi-arid environment of suburban Albuquerque's west side. **Figure 1** shows the vicinity map. This watershed drains into a series of 6 ponds known as the Unser Diversion Channel (UDC).

Figure 1- Vicinity Map

B. Background

Historically, this watershed received flows from the north side of I-40 from a tributary of the Mirehaven Arroyo (Trib C). However, after the construction of the I-40 Interceptor on the north side of I-40, the offsite flows from the north are now diverted east via an AMAFCA channel that runs parallel to I-40.

The Unser Diversion Drainage Analysis Report in 1993 by Easterling and Associates (EA) was the foundation for the design of the UDC.

The original EA study modeled fully developed conditions using AHYMO in order to design the UDC system of interconnected ponds. A second drainage master plan was completed in 2001 by Smith Engineering Company (SEC) in support of the City's Westside Transit Center design.

The major premise for developed conditions in both these reports and subsequent construction of facilities was that the West I-40 interceptor would be in place diverting the off-site flows from the north and that Pond 5, which is a temporary sedimentation basin, would no longer be part of the system. Pond 5 of the UDC was constructed as a temporary sediment pond with a reversion clause in the easement that dedicated it. The easement and pond anticipated the removal of flows from north of I-40 and elimination of the pond, easement and resulting flood plain upon completion of the channel north of I-40. Both studies used AHYMO as the primary hydrologic modeling software with developed subbasin zoning conditions assumed to be R-LT (high density residential). Digital copies of these reports are included in **Appendix C**.

However with the construction of the Westside Transit Center and Bruckner's Truck Sales facility on the north side of Daytona Rd and rezoning of the RLT lands to commercial, the watershed is most likely going to develop as commercial/light industrial area. Currently, FedEx is proposing to buy and develop Tracts 4 and 5 as their FedEx Ground service facility.

C. Purpose

In light of the proposed FedEx Ground site and zone changes affecting the watershed, **the primary purpose of this Mini Drainage Master Plan is to analyze and determine an equitable distribution of the downstream capacity of the UDC Ponds 6 and 4 and the final disposition of Pond 5 under fully developed conditions with the assumption that there is no off site flow from north of I-40 and that the watershed develops as a commercial/light industrial area as opposed to R-LT.**

Natural Resources Conservation Service (NRCS) Runoff Curve Number method as described in TR-55 was applied to the hydrologic analysis in conjunction with the Army Corp of Engineers HEC-HMS V.3.5 hydrologic software.

D. Hydrology

Existing Conditions

Subbasins within the watershed were delineated using Bernalillo County LIDAR topography from 2012. **Plate 1** shows the existing conditions subbasins. The Majority of the subbasin boundaries were adopted from The Drainage Master Plan for West Side Transit Facility by Smith Engineering.

These boundaries were field verified and the following changes were made:

- Roadway basins were added for Daytona and Los Volcanes Road because both have a significant right-of-way that is currently unpaved. Under developed conditions, these subbasins were modeled as fully paved.
- Subbasins A-3D and A-4D were merged as one subbasin A-3D due the construction of the West Side Transit Center and its onsite storm drains.
- Subbasin C-2D was broken into two subbasins called C-2D.1 and C-2D.2 due to the impending replatting of tracts 5 and 6 associated with the proposed FedEx facility.
- The previous studies included four offsite basins from I-40 contribute runoff to the watershed through a series of median drop inlets and culvert pipes. The offsite I-40 subbasins were included in this DMP and are shown on Plates 1 and 2 along with where the median drop inlets are located.

The 100-yr-24-Hr rainfall depth was obtained from NOAA Atlas 14 Data Server using the latitude and longitude coordinates from the approximate centroid of the watershed.

This depth was 2.52 inches compared to the 2.66 inches used in the study done by Smith in 2003 from NOAA Atlas 2. A copy of the rainfall data is included in **Appendix A.1.**

The NRCS TR-55 method uses the curve numbers to estimate runoff. The curve numbers are directly related to the physical characteristics of the watershed such as the Hydrologic Soil Groups (HSG), type of cover, level of urbanization, and the percent of the watershed that would be considered impervious. Based on the soil groups present and level of cover, a composite curve number for each subbasin was calculated. The curve numbers are derived from Tables 2-2a and 2-2d in the NRCS Urban Hydrology for Small Watersheds manual. Relevant tables and charts used for this study are included in **Appendix A.2.**

The NRCS Web Soil Survey online resource was used to obtain soils data for the various subbasins. Based on field observation, the undeveloped parts of the watershed have primarily well drained sandy soils. This was confirmed by the NRCS soils report. Copies of the soils reports are included in **Appendix A.3.**

Time of concentration, (T_c) values were calculated based on the methods outlined in both TR 55 and Chapter 22 of the City of Albuquerque Development Process Manual (DPM). T_c flow paths for each subbasin are delineated on **Plate 1**. The parameters used to compute T_c and the composite curve numbers for each subbasin are summarized in Table 1 that is included in **Appendix A.4**.

The elevation-storage-discharge data for Ponds 4, 5, and 6 were taken directly from the Master Drainage Plan for the West Side Transit Facility by Smith Engineering Company. These ponds were also inspected to verify that they had not been significantly regraded since the topo was developed. The tabulated data is presented on **Plate 1** and also in **Appendix A.5.**

Since Pond 5 was primarily designed as a sedimentation pond, it was not modeled in the existing conditions model. Pond 6 is the upstream-most pond that receives flows from I-40, Bruckners and West Side Transit Center and all the other subbasins designated with an 'A' via the Daytona storm drain system.

The storm drain diameter varies from a 36 inch RCP at the upstream end of Daytona and to a 60 inch RCP at its terminus in Pond 6.

Appendix C includes the as-built drawings for existing infrastructure in the watershed. Pond 6 has a standard trash rack type outlet structure that outfalls through and connects to Pond 4 via a 36 inch RCP storm drain. This storm drain transitions to a 48 inch pipe south of Pond 5.

Pond 5 has a sediment control outlet structure that outfalls via a 42 inch pipe which then connects to the 48 inch storm drain from Pond 6 and that outfalls into Pond 4.

Routing reaches were defined for the storm drains in Daytona Road. As-built data was used to define slopes, Manning's "n" values, and storm drain diameter.

Street surface routing was used for routing reaches in Los Volcanes Road. All record drawings referenced in this study are included digitally in **Appendix C**.

HEC-HMS version 3.5 was used to model the hydrology for the watershed using the SCS Unit Hydrograph method. The Atlas 14 Frequency Storm at 25% Intensity Position was used for rainfall distribution.

<u>Fully Developed Conditions (DEVEX)</u>

Four models were created for fully developed (DEVEX) conditions.

1. The first model used all the developed conditions flow direction, land treatment assumptions and rainfall data used by Smith Engineering Company. This was called the I-40 South_DEVEX_SMITH basin model. This model was used to perform a sensitivity analysis in order to understand how the different methods would affect runoff volume and peak discharge throughout the watershed compared to what had been computed in the Smith Engineering DMP using AHYMO_94.
2. The second model, called DEVEX 1, uses parameters computed based on the most appropriate data available. This model utilized land treatments for subbasins that are fully developed as commercial/light industrial areas, assuming a very conservative 90 percent imperviousness. This model still matches the Smith developed conditions where Pond 5 is not part of the system and Basin C-2D.2 drains into Pond 4. The primary objective of this model was to generate a like to like comparison of how the system functions using TR-55 hydrology method relative to the Smith AHYMO model, in particular the capacity of Pond 4 and Pond 6.

3. The third model, called DEVEX 2 incorporates the developed conditions as they will be per the proposed FedEx Ground site plan. This model simulates Pond 5 as part of the system with subbasin C-2D.2 draining directly to it. Pond 5 is simulated with existing outfall structure elevation-storage-discharge curves as outlined in Smith DMP. The remainder of the ‘C’ basins designated is assumed to drain into Pond 4 along with the fully developed Los Volcanes Road basins. Developed conditions drainage basins are shown on **Plate 2** along with modified subbasin curve numbers and T_c values.
4. The final model DEVEX, Option 1, basically is identical to DEVEX 2 with the exception that the discharge rating curve for Pond 5 is modified to restrict the outflow from the pond. Under this scenario, both the 100-yr-24-Hr and the 100-yr-24-Hr storms were simulated. The 6 hour storm was simulated to compare peak flows and determine storm drain size that would be required to convey developed conditions flows from subbasin C-1D, C-2D.1 and the fully paved Los Volcanes Road.

Tables are included in **Appendix A.4.** Full size versions of **Plates 1 and 2** and are included digitally on the DVD in **Appendix D**.

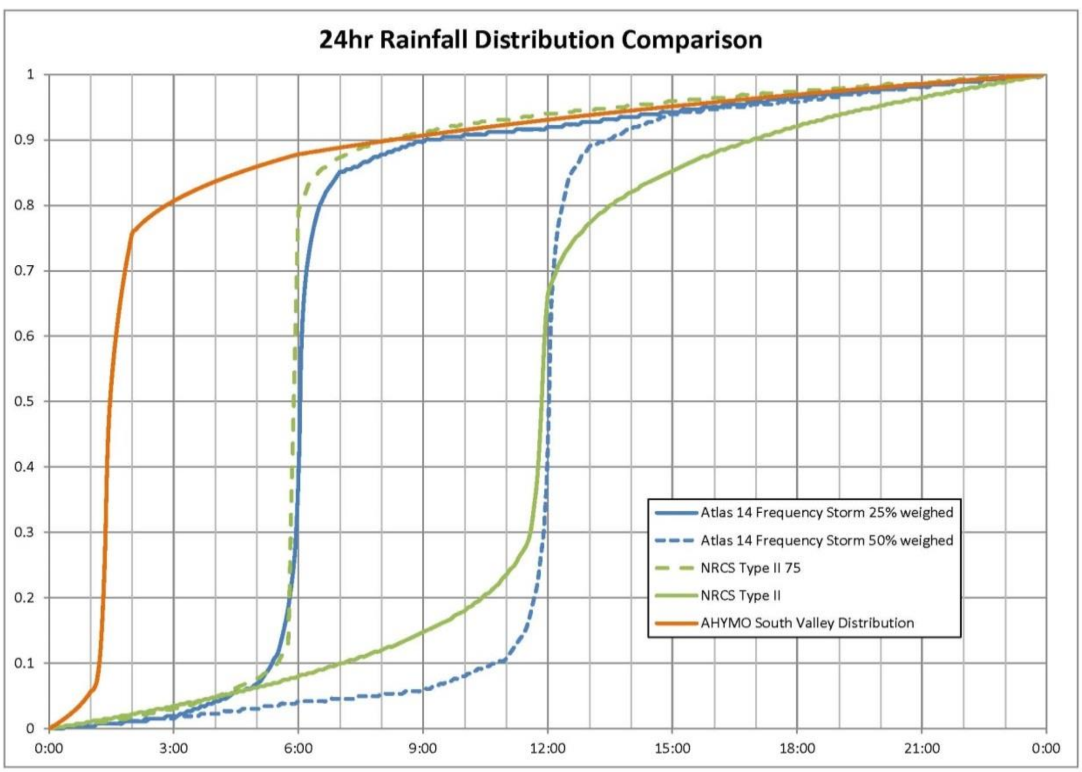
Basic HEC-HMS Functions and Definitions

HEC-HMS V3.5 was used for this DPM. Some basic parameters that have to be specified are as follows:

- Subbasin area - Area of each subbasin in square miles
- SCS Curve number (CN) - TR-55 hydrology method uses a composite/weighted curve number to define the hydrological soil conditions and cover for the watershed thereby determining initial losses and runoff. Table 2-2a and 2-2D are setup to be able to compute composite/weighted CN’s for urban and semi-arid rangelands. Based on the tables it is clear that the CN is a function of the cover type and the hydrological soil group in a subbasin. The cover can be determined based on the various descriptions outlined in the tables for urban or semi-arid rangelands. The hydrological soil groups were derived from the NRCS Websoil Survey website. Detailed soils reports are presented in the back up Appendix A.3. The CN **does not** include the portion of the subbasin that is impervious.
- Percent Imperviousness - This is the percentage of the subbasin that is considered impervious such as asphalt, rooftops and so forth. When using the TR-55 method in HEC-HMS, the program allows the impervious part of the subbasin to be specified directly. When this option is chosen, no rainfall losses are allocated to the portion of the subbasin specified as impervious. In other words, HEC-HMS treats all precipitation on impervious areas to direct runoff. As a result, runoff rates and volumes for urbanized conditions modeled herein are very conservative. In contrast, the DPM and AHYMO allocate 0.1 inches of initial abstraction to impervious areas.

- HEC-HMS uses the SCS Unit Hydrograph method to generate runoff. The parameter that has to be specified is the lag time. The City of Albuquerque outlines detailed methods to compute time of concentration and lag time (which follow NRCS TR 55 guidelines).
- Based on the frequency storm being analyzed, HEC-HMS requires that the rainfall depths be specified. These depths are derived from the NOAA 14 website by specifying the coordinates of the centroid of the watershed.
- The hyetograph is generated by using the Atlas 14 Frequency Storm at 25% intensity position. **Figure 2** compares the rainfall mass curve of the various distributions including the distribution embedded in AHYMO.
- Routings – HEC-HMS uses the Muskingum-Cunge routing methods. The reaches can be conformed to match open channels, storm drains or user defined 8 point sections.
- Pond Routing – Pond routings are done by specifying elevation-storage-discharge rating curves.
- Model simulation time – Model was simulated for 96 hours in order to observe how the ponds drained. The simulation time is different from the storm duration which only lasts for 24 hours.

Figure 2



E. Results

It is clear that the Unser Diversion Channel System has sufficient capacity to accept the runoff from the existing undeveloped drainage area for all reasonable development scenarios. Very conservative assumptions were used in this effort in order to establish the maximum allowable. DEVEX option 1 had to be simulated because the existing discharge rating curve for Pond 5 was not restricting the peak inflow in the DEVEX 2 model. The peak inflow was 98.2 cfs and the peak outflow was 78.4 cfs meaning the pond only stored 1.59 ac-ft. of water. As a result the rating curve was modified to simulate a 12 inch orifice in order to achieve storage higher efficiency in Pond 5.

The pond routing results for Existing and DEVEX_Option 1 are summarized below. A detailed pond routing summary for all options is included in **Appendix B.3**.

The effects of modifying the discharge rating curve for Pond 5 are quite clear in Table 1. The peak inflow is 98.2 cfs and the peak discharge is 10.5 cfs. Consequently the storage in Pond 5 increases from 1.59 ac-ft. to 3.14 ac-ft. Consequently the storage in Pond 4 goes down from 5.69 ac-ft. to 4.93 ac-ft.

This leaves an excess of 3.58 ac-ft. of capacity in Pond 4.

Table 1

Summary of Pond Routings

Pond	Model Description	Design Volume	100 Yr-24 Hr Peak Storage Volume	100 Yr-24 Hr Inflow Volume	100 Yr-24 Hr Outflow Volume	100 Yr-24 Hr Inflow	100 Yr-24 Hr Outflow	Elevation of Emergency Spillway	100 Yr-24 Hr Peak Water Surface Elevation	Freeboard from Emergency Spillway	Available Storage	Comments
		ac-ft	ac-ft	ac-ft	cfs	cfs	cfs	ft	ft	ft	ac-ft	
		a						a		b		
Pond 4	*Smith DEVEX Conditions Results from Report*	*8.51*	*4.50*	--	--	--	--	*5155.1*	*5152.9*	*2.2*	*4.01*	*All values reported on this table are taken directly from The Master Drainage Plan for the West Side Transit Facility by Smith Engineering Company, 2001.*
Pond 6	"	*9.01*	*6.20*	--	--	--	--	*5177.9*	*5176.7*	*1.2*	*2.81*	
Pond 4	DEVEX Option 1	8.51	4.93	23.5	23.5	147.1	96.4	5155.1	5153.33	1.8	3.58	Watershed modeled as fully developed commercial/business site at 90% impervious, using latest NOAA 14 100-Yr-24Hr rainfall depth of 2.52 in. Basin C-2D.2 drains to Pond 5 with modified outfall restricting discharge using a 12" outlet pipe as principal spillway
Pond 5	DEVEX Option 1	4.73	3.14	5.43	5.43	98.2	10.5	5168.8	5167.66	1.1	1.59	
Pond 6	DEVEX Option 1	9.01	6.90	13.8	13.8	231.4	83.1	5177.9	5177.5	0.4	2.11	

a- All values reported on this table are taken directly from The Master Drainage Plan for the West Side Transit Facility
100 Yr 24 Hr rainfall depth based on lates NOAA Atlas 14 data
b - Freeboard = Elevation of Emergency Spillway - Peak Water Surface Elevation

The peak flow at AP-7 was 72 cfs in the 100-yr-24 hr. storm. This flow was used to size the proposed storm drain in Los Volcanes Road as it was higher than the 100-yr-6 hr. storm. It was determined that a 36 inch storm drain would be sufficient to convey fully developed flows in Los Volcanes Road. See **Appendix B.4** for detailed calculations.

F. Conclusions/Discussion

The general conclusion of this DMP is that the UDC ponds will have sufficient capacity to handle the developed conditions 100-yr-24-Hr runoff volume. In other words, subbasins C-1.D and C-2D.1 should be able to free discharge into Pond 4 without compromising the downstream capacity of the UDC. By making Pond 5 into a permanent pond and modifying its outfall structure to restrict the outflow, the entire system is able to operate well within the bounds of COA guidelines for the design and function of ponds.

The reductions in Pond 5 outflow provide flexibility to the future development of the subbasins C-1 and C-2D.1 as the Smith Master plan as well as this DMP indicates that these subbasins assume to drain to Pond 4.

A recently completed 1 ft. interval topographic survey indicates that the side slopes of Pond 5 are much steeper than the 1V:3H slopes shown on the as-builts. This means that there is more storage available at Pond 5 than what is being modeled. This also provides a lot of flexibility to the final design of Pond 5 in terms of incorporating water quality features (if required or desired) while restricting the discharge in order to maximize the available storage in the pond and minimize the cost of any required modifications to the outlet structure.

Manning's Equation was used to determine the appropriate storm drain pipe size to the developed conditions from C-1, C-2D.1 and fully paved Los Volcanes Rd. A 36 inch RCP will safely convey the 72 cfs. See detailed calculations in Appendix B.4.

Using HEC-HMS with TR 55 CN hydrology rather than the traditional AHYMO'97 raises the question as to its effect on the modeling results compared to what was previously generated using AHYMO. Referring to **Table 1** , it is clear that the net results are almost identical in terms of the resulting impact on downstream facilities as determined by volumes stored and freeboard retained in Ponds 4 and 6 when compared to the developed conditions Smith Westside Transit Facility model and that any differences found are not significant. **Note that the modeling performed for this study assumed 100% of the runoff from the future impervious areas south of Daytona (assumed at 90% impervious) is an extremely conservative assumption,** particularly given that the proposed FedEx development plans are in the 75% range.

A further consideration is that the Smith DMP simulated only Ponds 4 and 6 with a higher rainfall depth under fully developed conditions.

The most significant impact of this DMP is the demonstration that Ponds 4, 5, and 6 have significant additional capacity when modeled with the lower NOAA 14 rainfall depth. For a volume-bound system like the UDC, using a lower design/evaluation rainfall depth has the effect of increasing downstream capacity for the benefit of the upstream properties, whose owners contributed to the construction of the UDC for that very purpose. The choice of a hydrologic modeling system (HEC-HMS with TR 55 vs AHYMO’97) had a less significant impact.

G. References

City of Albuquerque DMP Manual, Chapter 22

NOAA Atlas 14, Volume 1, Version 5

USDA Urban Hydrology for Small Watersheds TR-55, June 1986

US Army Corps of Engineers Hydrologic Modeling System HEC-HMS, August 2010

Design Analysis Report for the Albuquerque Metropolitan Arroyo Flood Control Authority-Unser Diversion-Prepared by Easterling & Associates, September 1993

Master Drainage Plan for the West Side Transit Facility City of Albuquerque, New Mexico-Prepared by Smith Engineering Company, February 2011