Kiowa Engineering Corporation

Memorandum

To: Brad Walters, El Paso County

From: Andrew W. McCord, P.E.

Date: January 19, 2021

Project: Glen at Widefield Filing 9

Subject: El Paso County Concerns from January 4, 2021 Field Inspection

COLORADO LICENSED ANDREW W. McCORD 25057 Jan. 19, 2021 PROFESSIONAL ENGINEER

1. Detention Basin Emergency Spillway Width

A. Original approved plans call for a spillway length of 66 feet on plan sheet 18, Detail O/19. The 66-foot dimension was labeled incorrectly and should be 15 feet in accordance with the approved Drainage Report (see Exhibit 1).

2. Detention Basin Outlet Structure WQCV Well Screen

A. Original approved plans call for a stainless-steel wire well screen on plan sheet 17, Detail J/18.

B. A field change was made to an EPC approved "diamond" plate and is noted on the As Constructed Documents (see Exhibit 2).

3. Buried Riprap at 30-inch Detention Basin Outlet

A. Original approved plans call for "EXPOSED TYPE M SOIL RIPRAP FOR CHANNEL BOTTOM" on plan sheet 18, Detail D/19. The word "EXPOSED" is incorrect and should be eliminated. Soil riprap is buried and not exposed. Existing field condition is correct.

4. Emergency Spillway Runout is "Curved"

A. The emergency spillway runout was graded, as a field change, to direct emergency flows to the grass-lined swale from detention pond A. This condition is preferred over emergency flows sheet flowing across "level" ground, ultimately into the grass-lined swale approximately 230 feet downstream of the emergency spillway. This condition provides for better containment of the flows and is acceptable for this site.

5. 24-inch Culvert Pipes in Existing Channels Under the Gravel Trail

A. Analyses of the east and west grass-lined swales and 24-inch culverts under the gravel trail was completed.

B. Analysis of the east channel (flow from detention pond A) indicates that the installed 24-inch PVC culvert under the gravel trail has enough capacity to pass 5-year and 100-year detained flows from detention pond A. (see Exhibit 3). However, if the detention pond A outlet structure ever became 100 percent clogged (no discharge), emergency flows will overtop the emergency spillway and enter the grass-lined swale, then continue to flow to the 24" PVC culvert under the gravel trail. In this condition the 24-inch culvert will create a

1604 South 21st Street, Colorado Springs, Colorado 80904-4208
Ph: (719) 630-7342 Fax: (719) 630-0406 www.kiowaengineering.com

backwater condition where flows will overtop the gravel trail at a depth of approximately 3¾ inches (see Exhibit 4), which is an acceptable condition.

C. Analysis of the west channel (flow from 48-inch RCP) indicates that the installed 24-inch PVC culvert under the gravel trail does not have enough capacity to pass the 100-year flow from the upstream 48-inch RCP (see Exhibit 5). The 24-inch culvert will create a backwater condition where flows will overtop the west channel at a depth of approximately 6 inches (see Exhibit 6). It should be noted that this area will be inundated during a 100-year event, per FEMA Map No. 0804C0956G (see Exhibit 7), therefore lessening the erosion potential in the overtopping. This is an acceptable condition.

6. Installation of Emergency Spillway Cut-off Wall

A. The emergency spillway cut-off wall was installed per approved plan (see Exhibit 8).

7. Installation of Cut-off Walls at 48-inch and 30-inch Pipe Outlets

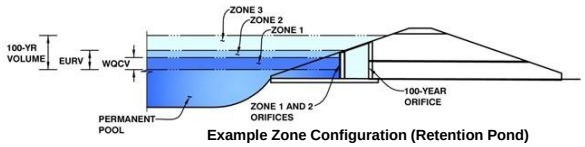
A. According to the field representative for Widefield Investment Group, cut-off walls were installed in accordance with the approved plans.

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project:

Basin ID:



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.58	0.222	Orifice Plate
Zone 2 (EURV)	2.56	0.322	Orifice Plate
(100+1/2WQCV)	4.38	0.722	Weir&Pipe (Restrict)
		1.266	Total

0

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft²
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	8.819E-03	ft²
Depth at top of Zone using Orifice Plate =	2.56	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	10.20	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.27	sq. inches (diameter = 1-1/4 inches)	Elliptical Slot Area =	N/A	ft²

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.85	1.71					
Orifice Area (sq. inches)	1.27	1.27	1.27					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft²
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Calculated Parameters for Vertical Orifice

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.56	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.81	N/A	feet
Overflow Weir Front Edge Length =	6.25	N/A	feet	Over Flow Weir Slope Length =	5.15	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)	Grate Open Area / 100-yr Orifice Area =	9.51	N/A	should be ≥ 4
Horiz. Length of Weir Sides =	5.00	N/A	feet	Overflow Grate Open Area w/o Debris =	22.55	N/A	ft²
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area	Overflow Grate Open Area w/ Debris =	11.27	N/A	ft²
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.33	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	2.37	N/A	ft²
Outlet Pipe Diameter =	30.00	N/A	inches	Outlet Orifice Centroid =	0.70	N/A	feet
Restrictor Plate Height Above Pipe Invert =	14.60		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.54	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.40	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.88	feet
Spillway Crest Length =	15.00	feet	Stage at Top of Freeboard =	6.28	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.52	acres
Freeboard above Max Water Surface =	1.00	feet			

Calculated Parameters for Spillway

Routed Hydrograph Results

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.20
Calculated Runoff Volume (acre-ft) =	0.222	0.544	0.506	0.790	1.066	1.560	1.921	2.374	3.327
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.222	0.543	0.505	0.789	1.065	1.559	1.919	2.373	3.325
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.02	0.15	0.41	0.93	1.23	1.59	2.34
Predevelopment Peak Q (cfs) =	0.0	0.0	0.3	2.3	6.1	14.0	18.5	23.9	35.2
Peak Inflow Q (cfs) =	4.3	10.4	9.7	15.1	20.3	29.6	36.3	44.8	62.5
Peak Outflow Q (cfs) =	0.1	0.2	0.2	2.5	6.6	14.4	20.2	22.1	37.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.1	1.1	1.0	1.1	0.9	1.1
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.1	0.3	0.6	0.9	1.0	1.1
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	67	64	69	67	64	62	59	54
Time to Drain 99% of Inflow Volume (hours) =	41	70	68	74	73	71	70	69	67
Maximum Ponding Depth (ft) =	1.54	2.49	2.38	2.89	3.17	3.51	3.70	4.11	4.82
Area at Maximum Ponding Depth (acres) =	0.31	0.35	0.34	0.37	0.38	0.40	0.41	0.43	0.46
Maximum Volume Stored (acre-ft) =	0.207	0.519	0.485	0.663	0.767	0.899	0.979	1.149	1.459

EXHIBIT 1

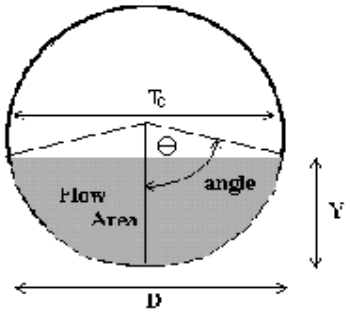
EXHIBIT 2

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Glen At Widefield Filing 9

Pipe ID: East grass-lined swale 24" culvert under gravel trail (100 yr detained flow)



Design Information (Input)			
Pipe Invert Slope	So =	0.0097	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	24.00	inches
Design discharge	Q =	10.70	cfs

Full-Flow Capacity (Calculated)			
Full-flow area	Af =	3.14	sq ft
Full-flow wetted perimeter	Pf =	6.28	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	22.34	cfs

Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	2.26	radians
Flow area	An =	2.76	sq ft
Top width	Tn =	1.54	ft
Wetted perimeter	Pn =	4.53	ft
Flow depth	Yn =	1.64	ft
Flow velocity	Vn =	8.11	fps
Discharge	Qn =	22.34	cfs
Percent of Full Flow	Flow =	100.0%	of full flow
Normal Depth Froude Number	Fr_n =	1.07	supercritical

Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.33	radians
Critical flow area	Ac =	2.83	sq ft
Critical top width	Tc =	1.46	ft
Critical flow depth	Yc =	1.69	ft
Critical flow velocity	Vc =	3.79	fps
Critical Depth Froude Number	Fr_c =	0.48	

EXHIBIT 3

East Grass-Lined Swale Wier Calculation for Over Topping of Gravel Trail
(Detention Basin Outlet Structure and 24" Culvert 100% Clogged)

Approximate Length of Wier	92.50 ft
Wier Elevation	69.00

Water Elevation	Head / Flow Depth, d	Weir Flow, Q
69.0	0.00 ft	0.0 cfs
69.1	0.10 ft	8.8 cfs
69.2	0.20 ft	24.8 cfs
69.3	0.31 ft	48.8 cfs

(Approx. 3¾" water depth over top of gravel trail)

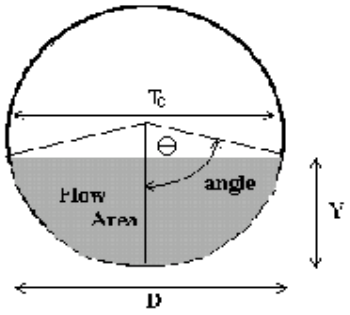
EXHIBIT 4

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Glen at Widefield Filing 9

Pipe ID: West grass-lined swale 24" culvert under gravel trail



Design Information (Input)			
Pipe Invert Slope	So =	0.0018	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	24.00	inches
Design discharge	Q =	9.62	cfs

Full-Flow Capacity (Calculated)			
Full-flow area	Af =	3.14	sq ft
Full-flow wetted perimeter	Pf =	6.28	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	9.62	cfs

Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	2.26	radians
Flow area	An =	2.75	sq ft
Top width	Tn =	1.54	ft
Wetted perimeter	Pn =	4.53	ft
Flow depth	Yn =	1.64	ft
Flow velocity	Vn =	3.49	fps
Discharge	Qn =	9.62	cfs
Percent of Full Flow	Flow =	100.0%	of full flow
Normal Depth Froude Number	Fr_n =	0.46	subcritical

Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.68	radians
Critical flow area	Ac =	1.79	sq ft
Critical top width	Tc =	1.99	ft
Critical flow depth	Yc =	1.11	ft
Critical flow velocity	Vc =	5.38	fps
Critical Depth Froude Number	Fr_c =	1.00	

EXHIBIT 5

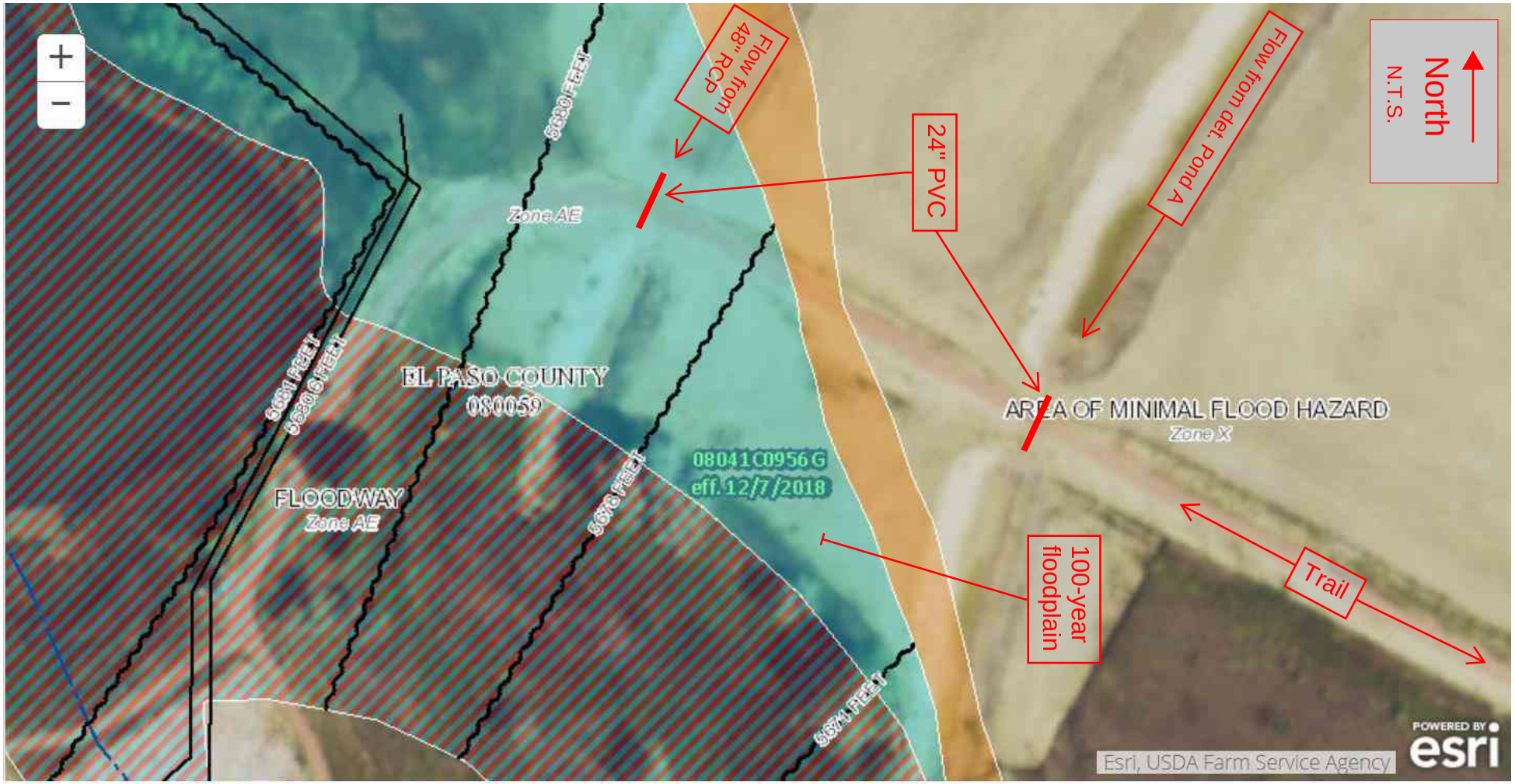
West Grass-Lined Swale Wier Calculation for Over Topping of Channel
(100 year flows)

Approximate Length of Wier	110.00 ft
Wier Elevation	70.00

Water Elevation	Head / Flow Depth, d	Weir Flow, Q
70.10	0.10 ft	0.0 cfs
70.20	0.20 ft	29.5 cfs
70.30	0.30 ft	54.2 cfs
70.40	0.40 ft	83.5 cfs
70.50	0.50 ft	116.7 cfs
70.56	0.56 ft	137.7 cfs

(Approx. 6" water depth over top of channel)

EXHIBIT 6



PIN
Approximate location based on user input and does not represent an authoritative property location

MAP PANELS
Selected FloodMap Boundary
Digital Data Available
No Digital Data Available
Unmapped

OTHER AREAS
NO SCREEN Area of Minimal Flood Hazard Zone X
Effective LOMRs
Area of Undetermined Flood Hazard Zone D
Otherwise Protected Area
Coastal Barrier Resource System Area

SPECIAL FLOOD HAZARD AREAS
Without Base Flood Elevation (BFE) Zone A, V, A99
With BFE or Depth
Regulatory Floodway Zone AE, AO, AH, VE, AR

OTHER AREAS OF FLOOD HAZARD
0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
Future Conditions 1% Annual Chance Flood Hazard Zone X
Area with Reduced Flood Risk due to Levee. See Notes. Zone X
Area with Flood Risk due to Levee Zone D

OTHER FEATURES
20.2 Cross Sections with 1% Annual Chance
17.5 Water Surface Elevation
Coastal Transect
Base Flood Elevation Line (BFE)
Limit of Study
Jurisdiction Boundary
Coastal Transect Baseline
Profile Baseline
Hydrographic Feature

GENERAL STRUCTURES
Channel, Culvert, or Storm Sewer
Levee, Dike, or Floodwall

EXHIBIT 7

EXHIBIT 8