ASSOCIATED GROCERS OF COLORADO FILING NO. 2

PRELIMINARY DRAINAGE REPORT

Project:
PARCEL A: LOT 1, BLOCK 1
PARCEL B
PARCEL C
Aurora, Colorado

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Prepared: **April 18, 2024**
Revised: **April 30, 2024**

APPROVED FOR ONE YEAR FROM THIS DATE _____
_____ _____ **Aurora Water – Drainage Division** **Date**

ENGINEER'S CERTIFICATION

This report and plan for the drainage design of the Project Lowry was prepared by me (or under my direct supervision) in accordance with the provisions of City of Aurora Storm Drainage Design and Technical Criteria and was designed to comply with the provisions thereof.

Michael Hart, P.E.
Registered Professional Engineer
State of Colorado No. 58724

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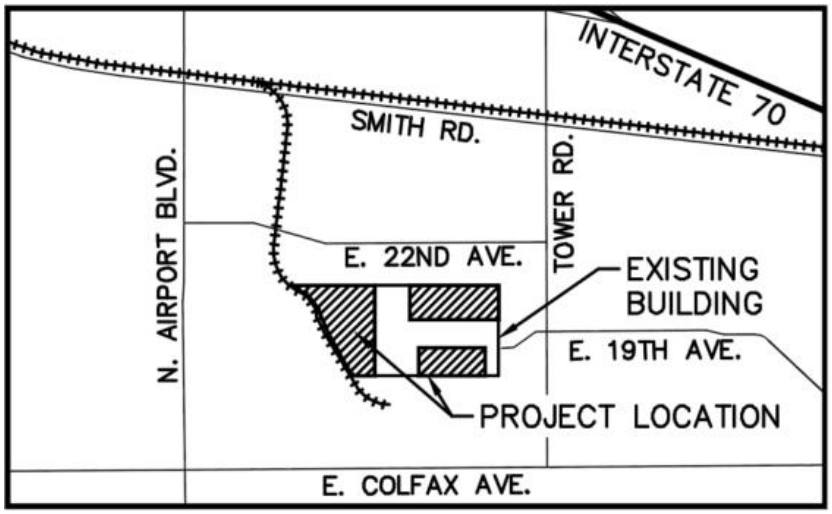
INTRODUCTION

Location

The Site is located on Tower Road, situated in the south half of Section 33, Township 3 South, Range 66 West of the 6th Principal Meridian, City of Aurora, County of Adams, State of Colorado. The proposed expansion is located on the west and north side of the existing Kroger Distribution Center, and a new building is proposed south of the existing building. The Site is bounded by businesses to the north, an industrial distribution center to the south, and the Woodshire East residential community to the west. The ±16.6 acre project site is currently developed, consisting of existing buildings, parking lots, drives and native grasses in pervious areas.

A vicinity map is provided below for reference (north is up):



Proposed Development

The Proposed project (the 'Site' or 'Project') is made up of improvements located immediately west, north and south of the existing distribution center. The development proposes to expand the existing distribution center on the north and west sides. South of the existing facility, a new salvage building is proposed with parking, drives and landscaping around the structure.

Preliminary Drainage Report shall be approved prior to receiving Civil Plan approval.

Changes to MDR

There is no approved MDR associated with this Project; however, the existing ponds designed with the Original Report have been analyzed using the currently adopted City Criteria.

Variances

No variances are requested at this time.

HISTORIC DRAINAGE

Description of Property and Drainage Basin

The project site is currently developed. The site is generally sloped varying between 0% - 4%. Runoff from the existing site drains away from the existing structures splitting to the north and south towards the existing concrete channels within easements along the north and south property lines. There are two existing ponds on-site that were previously designed and constructed with *Lot 1, Block 1 Associated Grocers of Colorado Subdivision, Filing No. 1 Final Drainage Report* (the '*Original Report',* EDN 218104). The existing North Pond constructed with the Original Report will be referred to as Existing Pond A, and the South Pond will be referred to as Existing Pond B within this report. The existing ponds will be utilized for water quality and detention treatment for runoff generated as part of this project and is further described within this report.

An NRCS soil study for the project area was obtained to determine the soil characteristics of the site, showing that 47.8% of the site is soil type A, and 52.2% of the site is soil type B. The NRCS study can be found in **Appendix A** of this report.

The Site is not part of any Master Drainage Report, but this report is an amendment to the approved *Final Drainage Report for the Associated Grovers of Colorado Filing No. 2* (the 'Original Report', EDN 218104). Excerpts of this approved final drainage report have been included in Appendix E.

The site is located within FEMA Flood Insurance Rate Map (FIRM) Number 08005C0182K effective 12/17/2010 and 08005C0181L effective 9/4/2020. The north and south expansions are located in Zone X, which is deemed an area of minimum flood hazard, but the west expansion is located within an area with 0.2% annual chance flood hazard or area of 1% annual chance flood with average depth less than one foot according to the FIRM Maps included in Appendix A.

The expansion project site does not accept flows from off-site basins. The existing development to the east drains north and south to the existing concrete channels. The area east of the project site drains directly to Sand Creek.

Existing runoff on the north half of the site sheet flows to the north and is captures by the existing concrete channel along the northern property line. Existing runoff on the south half of the site sheet flows south to the existing concrete channel along the southern property line. Both the existing concrete channels discharge to Sand Creek.

Runoff from the proposed improvements will be conveyed to one of four locations within the project site for water quality and detention treatment. Each pond will have an outlet structure attenuating the developed runoff for ultimate conveyance to the existing northern and southern concrete channels. Refer to the specific sub-basin descriptions for details related to the runoff and treatment of the newly disturbed areas within the Site.

DESIGN CRITERIA

Hydrologic Criteria

Per the Criteria, the design storms for the Project are the 2-year and 100-year frequency events. In addition, Chapter 5.00 of the Criteria was used to determine the time of concentrations, rainfall intensities, and runoff coefficients to calculate the peak runoff for each storm event. The Manual,

adopted by the City of Aurora, was used to calculate runoff using the Rational Method for sub-basins less than 160 acres in size. The latest UD-Detention spreadsheet (version 4.06) found on the software resources page of the Mile High Flood District website was used to calculate the required detention volume for the Site.

Rainfall data provided by the Criteria were used to determine the P1 values for the rainfall intensity values. One-hour rainfall depths used for the calculations at the site are as outlined below:

Table 2: One-hour Rainfall Depths					
2-year	5-year	10-year	25-year	50-year	100-year
0.86”	1.14”	1.40”	1.79”	2.11”	2.46”

The “City of Aurora Storm Drainage Design and Technical Criteria”, revised November 2023 (the Criteria), the Aurora Water “Water, Sanitary Sewer & Storm Drainage Infrastructure Standards & Specifications” (the Aurora Water Specification), and the “Urban Storm Drainage Criteria Manual” Volumes 1, 2, and 3 (The Manual), with latest revisions, were used when preparing the storm calculations for the northern and southern expansions.

Hydraulic Criteria

Detailed evaluation of the hydraulic modeling, swale analysis and inlet analysis for the 2-year and 100-year runoff from the disturbed area of the project site will be provided with the forthcoming Final Drainage Report. The required 100-year detention volume and water quality capture volume were calculated using the MHFD UD-Detention spreadsheet. Street and inlet capacities will be based on the City of Aurora and MHFD Criteria.

Establishing a drainageway corridor width is not applicable to this project.

The a portion of the Project Site is located within the 500-year mapped floodplain. No LOMCs are anticipated to be required for this development.

Proposed storm infrastructure is proposed to be privately owned and maintained by Ownership. No storm infrastructure is proposed to be temporary.

The hydraulic criteria used for the proposed storm design complies with the Criteria, the Aurora Water Specification, and the Manual stated above.

DRAINAGE PLAN

General Concept

The overall drainage pattern is consistent with the existing condition, where the north portion of the Project Site is ultimately tributary to the existing Northern Concrete Channel, and the south portion of the Project Site is ultimately tributary to the existing Southern Concrete Channel.

The overall drainage design for the site consists of utilizing two existing ponds and two new ponds for stormwater treatment of the newly disturbed areas of the Site. The original design of the two existing ponds (Ponds A and B) had planned for a future building expansion. As part of this report, it will be demonstrated the as-built condition of Ponds A and B are adequate for the treatment of the stormwater runoff from the western building expansion.

There are no approved Public Improvement Plans or MDRs associated with this project, however, the proposed drainage design is consistent with the approved Original Report as discussed below.

West Expansion
The planned west expansion drainage design consists of runoff being collected by a series of roof drains tying into the existing roof drain system for discharge to Pond A via a swale and to Pond B via storm sewer designed as part of the Original Report. **Table 3** below provides a summary of the design parameters established for Ponds A and B with the Original Report and the current proposed site design.

It is important to note the following Design Criteria have changed as part of updates made by the City which impact the compliance calculations associated with these ponds:

- Landscape Cover Imperviousness increased from 2% to 20%
- 1-hour Rainfall Depths decreased

Both of the above design criteria changes have been incorporated into the revised Pond A and B calculations included in **Appendix C** and the rational calculations for the existing Sub-Basins A-3, A-1F, A-2F and A-5F included in **Appendix B**.

Table 3: Pond Design Comparison

	Planned Building Expansion (sf)	*Proposed West Building Expansion (sf)*	*Planned Basin Imperviousness*	*Proposed Basin Imperviousness*
North Pond	43,851	45,229	40.87%	51.05%
South Pond	43,851	45,037	53.77%	63.28%

For the purposes of demonstrating compliance, the detention and outlet structure calculations for Ponds A and B have been included in **Appendix C** of this report. These calculations have been based on the as-built data for each pond with the new proposed impervious values and 1-hour rainfall data.

North Expansion
The north expansion improvements will consist of new private storm sewer conveying runoff to a new water quality and detention pond, which will serve the disturbed area associated with the northern expansion. The northern expansion disturbs approximately ±13.16-acres and has a weighted imperviousness of 75%. Runoff will be collected via proposed private storm sewer, and ultimately discharge into the new proposed North Pond ('Pond C'), where it will be treated for water quality, EURV, and 100-year stormwater treatment and attenuation. Stormwater runoff treated within new Pond C, will discharge to the existing concrete channel north of the project site via an outlet structure.

South Expansion
The south expansion improvements will consist of new private storm sewer conveying runoff to a new water quality and detention pond, which will be sized for the disturbed area associated with the southern expansion. The flows developed from the disturbed area of the south expansion will be conveyed to the proposed South Pond ('Pond D') via new and existing private storm sewer infrastructure. Historically, the runoff from this area sheet flows to the existing concrete channel along the southern boundary of the site. Due to existing grades and existing storm sewer infrastructure, runoff from undisturbed developed portions of the site will naturally be conveyed to new Pond D. Approximately ±12.30-acres will be disturbed with the South Expansion.

Approximately ±10.56-acres of area upstream of the expansion area is anticipated to be conveyed to Pond D.

Runoff from the upstream disturbed area will not be treated within the pond and are classified as bypass flow. The spillway of Pond D will be sized to convey this additional runoff to the existing concrete channel, consistent with historic drainage patterns. The Pond D Outlet structure and spillway calculations will be designed for only the disturbed area. These calculations will be provided with the forthcoming Final Drainage Report.

Specific Details

The construction of this development will not be phased. Below is a detailed summary of the drainage sub-basins on the site. Individual sub-basin details such as runoff coefficients and imperviousness percentages are provided in **Appendix B**, including the estimated 2-year and 100-year peak flows. A summary of each of the basin parameters is included in **Table 4** at the end of this section and in **Appendix B**.

West Expansion

Sub-basin A-1F is located west of the western building expansion. This sub-basin was delineated with the Original Report and the calculations have been revised with this report to account for the west expansion improvements associated with this project and the changes to the ground cover impervious values for landscape. The improvements within this basin consist of concrete paths leading up to the building and a 3-ft gravel rodent strip along the perimeter of the building expansion. The Original Report accounted for the existing drive aisle and landscaping within this basin, however as noted previously, all calculations have been revised with the current adopted storm criteria set forth by the City.

Runoff from this basin will sheet flow west to existing Swale A1, which will convey stormwater northwest into the existing Pond A for water quality and detention treatment, consistent with historic drainage patterns.

Sub-basin A-2F is located north of the western building expansion. This sub-basin was delineated with the Original Report and the calculations have been revised with this report to account for the west expansion improvements associated with this project. The improvements within this basin consist of a 3-ft gravel rodent strip along the perimeter of the building expansion. The Original Report accounted for the existing drive aisle and landscaping within this basin, however as noted previously, all calculations have been revised with the current adopted storm criteria set forth by the City.

Runoff from this basin will sheet flow west to existing Swale A2, which will convey stormwater northwest into the existing Pond A for water quality and detention treatment, consistent with historic drainage patterns.

Sub-basin A-3 is located southwest of the western building expansion. This sub-basin was delineated with the Original Report and the calculations have been revised with this report to account for the west expansion improvements associated with this project. The improvements within this basin consist of concrete paths leading up to the building and a 3-ft gravel rodent strip along the perimeter of the building. The Original Report accounted for the existing drive aisle and landscaping within this basin, however as noted previously, all calculations have been revised with the current adopted storm criteria set forth by the City.

Runoff from this basin will sheet flow west to existing Swale A2, which will convey stormwater northwest into the existing Pond B for water quality and detention treatment, consistent with historic drainage patterns.

Sub-basin A4 is located south of the western building expansion. No improvements are proposed in this sub-basin; however, the basin analysis has been brought to current code standards.
Sub-basin A-5F is located south of the western building expansion. This sub-basin was delineated with the Original Report, and the delineation and calculations have been revised with this report to account for the west expansion improvements associated with this project. The improvements within this basin consist of truck docks south of the building expansion. All calculations have been revised with the current adopted storm criteria set forth by the City.

Runoff from this basin will sheet flow west to existing sump inlet, which will convey stormwater northwest into the existing Pond B for water quality and detention treatment, consistent with historic drainage patterns.

North Expansion
Sub-basin N-R1 is located north of the existing distribution center and consists of the northern building expansion proposed with this Project. Runoff from this sub-basin will be collected in a building roof drain system discharging via lambs' tongues to proposed area inlets in the parking lot and drive aisles. Proposed private storm sewer will convey captured flows from this basin to the proposed Pond C for water quality and detention treatment.

Sub-basin N1 is located north of the proposed building expansion and consists proposed trailer parking, drive aisles, landscaping, concrete paths, and a 3-ft rodent strip adjacent to the building expansion. Stormwater runoff from this sub-basin will sheet flow to the center of the basin, where it is captured by a proposed sump area inlet denoted by design point N1. Proposed private storm sewer will convey captured flows from this basin to the proposed Pond C for water quality and detention treatment.

Sub-basin N2 is located north of the proposed building expansion and consists proposed trailer parking, drive aisles, landscaping, concrete paths, and a 3-ft rodent strip adjacent to the building expansion. Stormwater runoff from this sub-basin will sheet flow to the center of the basin, where it is captured by a proposed sump area inlet denoted by design point N2. Proposed private storm sewer will convey captured flows from this basin to the proposed Pond C for water quality and detention treatment.

Sub-basin N3 is located north of the proposed building expansion and consists proposed trailer parking, drive aisles, landscaping, concrete paths, and a 3-ft rodent strip adjacent to the building expansion. Stormwater runoff from this sub-basin will sheet flow to the center of the basin, where it is captured by a proposed sump area inlet denoted by design point N3. Proposed private storm sewer will convey captured flows from this basin to the proposed Pond C for water quality and detention treatment.

Sub-basin N4 is located north of the proposed building expansion and consists proposed trailer parking, drive aisles, landscaping, concrete paths, and a 3-ft rodent strip adjacent to the building expansion. Stormwater runoff from this sub-basin will sheet flow to the center of the basin, where it is captured by a proposed sump area inlet denoted by design point N4. Proposed private storm sewer will convey captured flows from this basin to the proposed Pond C for water quality and detention treatment.

Sub-basin N5 is located north of the proposed building expansion and consists proposed trailer parking, drive aisles, landscaping, concrete paths, and a 3-ft rodent strip adjacent to the building expansion. Stormwater runoff from this sub-basin will sheet flow to the center of the basin, where it is captured by a proposed sump area inlet denoted by design point N5. Proposed private storm sewer will convey captured flows from this basin to the proposed Pond C for water quality and detention treatment.

Sub-basin N6 is located north of the existing distribution center and consists proposed trailer parking, drive aisles, and landscaping. Stormwater runoff from this sub-basin will sheet flow across the basin, for conveyance via curb and gutter to the proposed sump Type R inlet denoted by design point N6 on the preliminary drainage map. Proposed private storm sewer will convey captured flows from this basin to the proposed Pond C for water quality and detention treatment.

Sub-basin Pond C is located north of the existing distribution center and expansion. The sub-basin consists of the pond area with landscaping and concrete trickle channels. Stormwater runoff will sheet flow into Pond C for water quality and detention treatment. A pond outfall structure will treat and attenuate stormwater prior to discharging to the existing northern concrete channel.

Sub-basin Swale-N is located along the northern property line and consists of a grass-lined swale, which will convey flows to the proposed Pond C for water quality and detention treatment.

Sub-basin EX-1 is located north of the existing distribution center and consists of a concreate pad with electrical equipment. This basin will not be disturbed as part of the building expansion, however stormwater runoff from this basin will be treated within Pond C. Existing runoff from this area sheet flow north to the proposed Pond C for water quality and detention treatment

South Expansion

Sub-basin S-R1 is located within the currently undeveloped land south of the existing distribution center and consists of a new salvage building for the Project Site. Stormwater runoff from this sub-basin will be collected via a roof drain system and discharge to grade to surface drain to a series of proposed sump area inlets north and south of the proposed building. Stormwater will then be conveyed via proposed private storm sewer to the new Pond D for water quality and detention treatment.

Sub-basin S1 is located in the northern portion of the salvage building and consists of drive aisle and landscaping. Stormwater from this basin surface flows to a sump area inlet in the center of the basin at design point S1 conveying stormwater via private storm sewer to Pond D for water quality and detention treatment.

Sub-basin S2 is located in the northern portion of the salvage building and consists of drive aisle and landscaping. Stormwater from this basin surface flows to a sump area inlet in the center of the basin at design point S2 conveying stormwater via private storm sewer to Pond D for water quality and detention treatment.

Sub-basin S3 is located north of the proposed salvage building and consists of a drive aisle, truck docks, and landscaping. Flows from this basin will sheet flow across the pavement to the center of the basin, where it is collected by a proposed area inlet denoted by design point S3 on the proposed drainage map.

Sub-basin S4 is located northeast of the proposed salvage building and consists of a drive aisle and landscaping. Stormwater runoff from this basin will sheet flow across the pavement where it is then conveyed via curb and gutter to the proposed Type R inlet denoted by design point S4 on the proposed drainage map. Stormwater will then be conveyed via proposed private storm sewer to the new Pond D for water quality and detention treatment.

Sub-basin S5 is located southeast of the proposed salvage building and consists of trailer parking, drive aisle and landscaping. Stormwater runoff from this basin will sheet flow across the pavement where it is then conveyed via curb and gutter to the proposed Type R inlet denoted by design point S5 on the proposed drainage map. Runoff will then be conveyed via proposed storm sewer to Pond D.

Sub-basin S6 is located south of the proposed salvage building and consists of a drive aisle, trailer parking, and landscaping. Flows from this basin will sheet flow across the pavement and will be collected by a proposed area inlet denoted by design point S6 on the proposed drainage map. Flows will be conveyed via proposed storm sewer to Pond D.

Sub-basin S7 is located south of the proposed salvage building and consists of drive aisles, loading docks and landscaping. Stormwater from this basin surface flows to a sump area inlet in the center of the basin at design point S7 conveying stormwater via private storm sewer to Pond D for water quality and detention treatment.

Sub-basin S8 is located south of the proposed salvage building and consists of drive aisles, loading docks and landscaping. Stormwater from this basin surface flows to a sump area inlet in the center of the basin at design point S8 conveying stormwater via private storm sewer to Pond D for water quality and detention treatment.

Sub-basin S9 is located west of Pond D and consists of restriping existing pavement, new concrete dolly pads, and new landscape islands. The proposed improvements generally do not impact the existing asphalt and the overall impervious value of the basin remains unchanged.

Stormwater from this basin will sheet flow south across the existing pavement to the existing southern concrete channel following existing drainage patterns. The restriping improvements for this basin is not being classified as disturbed area as the subgrade will not be impacted; therefore, areas of restriping shall not require water quality treatment and detention. The disturbed areas within this basin are areas where a concrete dolly pad and landscape islands are proposed to be installed. These areas have been accounted for in the sizing of the proposed Pond D. Refer to **Appendix B** for the breakdown summary for the disturbed areas on site.

Stormwater runoff from the disturbed areas of this basin will not be routed to the proposed Pond D due to grade differences and lack of ability to differentiate the disturbed versus non-disturbed runoff. To account for runoff not being conveyed to the pond, this basin area and weighted imperviousness is accounted for in the detention design of Pond D. Pond D has been designed to over-detain and under-release from the outlet structure. The total 100-year runoff from this basin, has been deducted from the allowable pond release rate.

Sub-basin S10 is located east of the proposed salvage building and consists of a paved parking lot. Runoff rom this basin will sheet flow west across the pavement and into a proposed Type R inlet. Stormwater runoff will be routed via storm sewer to proposed Pond D.

Sub-basin S11 is located east of the existing distribution center and consists of a drive aisle, truck dock, a 3-ft rodent strip directly adjacent to the building, and landscaping. Flows from this basin will sheet flow southwest across the pavement and will be collected by an existing area inlet located in basin S13, which is denoted by design point S13 on the proposed drainage map. Flows will be conveyed via proposed storm sewer to Pond D.

Sub-basin S12 is located south of the proposed salvage building and consists of landscaping and a sidewalk. Flows from this basin will sheet flow south and into the existing southern concrete channel, consistent with existing drainage patterns. Due to the tie-in to existing grade along the southern edge of this basin, it is not feasible to capture this runoff and route it to Pond D.

To account for runoff not being conveyed to the pond, this basin area and weighted imperviousness is accounted for in the detention design of Pond D. Pond D has been designed to over-detain and under-release from the outlet structure. The total 100-year runoff from this basin, has been deducted from the allowable pond release rate.

Sub-basin S13 is located south of the existing distribution center and consist of existing pavement. The existing pavement will be re-striped for truck parking, with the addition of concrete dolly pads. The re-striping is not considered disturbed area, as it will not change the existing subgrade; however, the installation of the concrete dolly pad will affect the existing subgrade; therefore, these areas are considered as disturbed area. This disturbed area has been accounted for in the sizing of Pond D. Flows from this basin will flow to the existing area inlet denoted by design point S13 on the proposed drainage map. Flows will be conveyed via proposed storm sewer to the proposed Pond D. The existing flows from the undisturbed area will not be accounted for in the sizing for the proposed Pond. Existing flows will be considered by-pass flows. The spillway for the proposed pond will be sized to convey the 100-year peak outflow of the disturbed area, in addition to the existing 100-year bypass flows that are tributary to the proposed Pond. A table summarizing the disturbed areas for each basin is included within Appendix B.

Sub-basin S14 is located south of the existing distribution center and consist of existing pavement, as well as a proposed landscape island with concrete sidewalk. The existing pavement will be re-striped for truck parking, with the addition of concrete dolly pads. The restriping improvements for this basin is not being classified as disturbed area as the subgrade will not be impacted; therefore, areas of restriping shall not require water quality treatment and detention. The disturbed areas within this basin are areas where a concrete dolly pad and landscape islands are proposed to be installed. This disturbed area has been accounted for in the sizing of Pond D. Refer to **Appendix B** for the breakdown summary for the disturbed areas on site.
Runoff from this basin will sheet flow to the existing area inlet denoted by design point S14 on the proposed drainage map. Flows will be conveyed via proposed storm sewer to the proposed Pond D. The existing flows from the undisturbed area will not be accounted for in the sizing for the proposed Pond.

Sub-basin S15 is located south of the existing distribution center and consist of existing pavement, as well as a proposed within the proposed landscape island. The existing pavement will be re-striped for trailer parking, with the addition of concrete dolly pads.

Stormwater from this basin will sheet flow south across the existing pavement to the existing southern concrete channel following existing drainage patterns. The restriping improvements for this basin is not being classified as disturbed area as the subgrade will not be impacted; therefore, areas of restriping shall not require water quality treatment and detention. The disturbed areas within this basin are areas where a concrete dolly pad and landscape islands are proposed to be

installed. These areas have been accounted for in the sizing of the proposed Pond D. Refer to **Appendix B** for the breakdown summary for the disturbed areas on site.

Stormwater runoff from the disturbed areas of this basin will not be routed to the proposed Pond D due to grade differences and lack of ability to differentiate the disturbed versus non-disturbed runoff. To account for runoff not being conveyed to the pond, this basin area and weighted imperviousness is accounted for in the detention design of Pond D. Pond D has been designed to over-detain and under-release from the outlet structure. The total 100-year runoff from this basin, has been deducted from the allowable pond release rate.

Sub-basin S16 is located south of the existing distribution center and consist of existing pavement. The existing pavement will be re-striped for trailer parking, with the addition of concrete dolly pads.

Stormwater from this basin will sheet flow northwest across the existing pavement to an existing inlet, following existing drainage patterns. The restriping improvements for this basin is not being classified as disturbed area as the subgrade will not be impacted; therefore, areas of restriping shall not require water quality treatment and detention. The disturbed areas within this basin are areas where a concrete dolly pad is proposed to be installed. These areas have been accounted for in the sizing of the proposed Pond D. Refer to **Appendix B** for the breakdown summary for the disturbed areas on site.

Stormwater runoff from the disturbed areas of this basin will not be routed to the proposed Pond D due to grade differences and lack of ability to differentiate the disturbed versus non-disturbed runoff. To account for runoff not being conveyed to the pond, this basin area and weighted imperviousness is accounted for in the detention design of Pond D. Pond D has been designed to over-detain and under-release from the outlet structure. The total 100-year runoff from this basin, has been deducted from the allowable pond release rate.

Sub-basin Pond D is located west of the proposed salvage building and consists of a concrete sidewalk path, landscaping, and proposed Pond D. Flows from this basin will sheet flow into the pond and then conveyed via concrete trickle channel to the proposed outlet structure. The outlet structure will control the release of the flows back into existing southern concrete channel.

Refer to Appendix B for the revised Grocer's of Colorado rational calculations, as well as the proposed Project Lowry rational calculations for the West, North, and South expansions.

RATIONAL CALCULATIONS SUMMARY							
DESIGN POINT	TRIBUTARY BASINS	TRIBUTARY AREA (AC)	IMPERVIOUSNESS %	PEAK FLOWS (CFS)		CUMULATIVE FLOWS (CFS)	
				Q2	Q100	Q2	Q100
On-Site North Basins							
N1	N1	0.85	85%	1.46	4.90	9.62	32.18
N2	N2	0.91	87%	1.63	5.41	8.23	34.33
N3	N3	1.39	86%	2.45	8.17	6.71	22.44
N4	N4	1.41	86%	2.36	7.87	4.39	14.71
N5	N5	1.24	85%	2.15	7.21		
N6	N6	1.97	82%	2.94	10.11		
N-R1	N-R1	2.41	95%	5.33	16.82		
POND C	POND C	1.25	21%	0.40	4.44	11.04	40.07
SWALE-N	SWALE-N	1.23	20%	0.22	2.50		
EX-1	EX-1	0.51	95%	1.07	3.37		
TOTAL		**13.16**	**75%**	**19.99**	**70.80**		
On-Site South Basins							
S1	S1	0.19	95%	0.42	1.32		
S2	S2	0.79	91%	1.75	5.63	7.01	26.20
S3	S3	0.54	95%	1.24	3.90	5.83	22.41
S4	S4	1.14	88%	2.02	6.65	5.00	19.78
S5	S5	0.63	79%	0.97	3.40		
S6	S6	1.18	83%	2.05	7.02	2.87	9.90
S7	S7	0.29	83%	0.57	1.95		
S8	S8	0.49	93%	1.10	3.50	3.76	12.76
S9	S9	2.83	89%	6.07	19.88		
S10	S10	3.66	58%	3.36	14.41		
S11	S11	1.42	83%	2.59	8.83		
S12	S12	0.17	75%	0.30	1.10		
S13	S13	2.40	95%	4.52	14.27	6.84	22.15
S14	S14	2.20	87%	3.63	12.03		
S15	S15	1.35	83%	2.17	7.39		
S16	S16	0.57	95%	1.23	3.88		
S-R1	S-R1	0.69	95%	1.31	4.14		
POND D	POND D	1.65	24%	0.59	5.50	16.18	55.87
EX-R1	EX-R1	2.41	95%	4.89	15.42		
TOTAL		**24.59**	**80%**	**40.77**	**140.21**		

Table 5: Rational Calculation Summary (W Expansion)

				Direct Flows		Cumulative Flows	
DESIGN POINT	DRAIN BASIN	AREA Ac	IMP %	Q_2 CFS	Q_{100} CFS	Q_2 CFS	Q_{100} CFS
A-1	A-1	6.24	24%	1.4	13.0		
A-2	A-2	1.08	43%	0.5	2.7	7.6	9.5

A-3	A-3	1.72	42%	0.9	4.6		
A-4	A-4	3.00	46%	2.1	10.5		
R-1	R-1	0.61	95%	1.3	4.1		
R-2	R-2	0.68	95%	1.4	4.5		
R-3	R-3	0.33	95%	0.7	2.2	4.2	4.6
R-4	R-4	0.37	95%	0.8	2.5	12.0	13.2
R-5	R-5	0.30	95%	0.6	2.0		
R-6	R-6	0.29	95%	0.6	1.9	3.5	3.9
R-7	R-7	0.24	95%	0.5	1.6	4.9	5.5
R-8	R-8	0.27	95%	0.6	1.8	6.5	7.2
R-9	R-9	0.27	95%	0.6	1.8	8.2	9.0
R-10	R-10	0.27	95%	0.6	1.8		
R-11	R-11	0.36	95%	0.8	2.4	12.0	13.2
A-5	A-5	0.62	23%	0.2	1.4		
A-1 (future)	A-1 (future)	4.84	25%	1.2	11.1		
A-2 (future)	A-2 (future)	0.90	48%	0.9	4.5		
A-5 (future)	A-5 (future)	0.16	94%	0.4	1.1		
R-12 (future)	R-12 (future)	1.04	95%	2.2	6.9		
R-13 (future)	R-13 (future)	1.03	95%	2.2	6.9		
OS-1	OS-1	0.64	20%	0.2	8.5		
OS-2	OS-2	0.27	95%	0.6	4.5		
OS-3	OS-3	0.62	20%	0.2	4.9		

Water Quality and Detention

Compliant with the current criteria, runoff from the newly disturbed and developed areas on site is generally conveyed to one of four on-site private detention pond for water quality and detention treatment and attenuation. **Tables 6 & Table 7** below, provides a summary of the existing and proposed pond design criteria, volume and allowable release rates.

	Table 6: Pond Summary								
	Area (ac)	*Imp (%)*	V_{WQCV} *(ac-ft)*	V_{EURV} *(ac-ft)*	V_{100} *(ac-ft)*	$V_{Total\ Detention}$ *(ac-ft)*	$WSEL_{WQCV}$ *(ac-ft)*	$WSEL_{EURV}$ *(ac-ft)*	$WSEL_{100}$ *(ac-ft)*
Pond A	8.78	51.05%	0.153	0.358	0.294	0.805	5412.93	5413.72	5414.25
Pond B	7.90	63.28%	0.163	0.436	0.293	0.892	5416.34	5417.10	5417.55
Pond C	13.16	75%	0.328	0.850	0.539	1.718	5419.29	5420.94	5422.18

Pond D	12.24	76%	0.311	0.717	0.517	1.546	5417.24	5418.60	5419.86

Table 7: Allowable Release Rates (CFS)	
Pond A	4.4
Pond B	4.2
Pond C	6.1
Pond D	5.2

The descriptions below provide more information related to each of the basin areas and pond designs.

West Expansion
Water quality and detention for the West Expansion is provided by existing Ponds A and B on-site. Although the weighted imperviousness for this western expansion increased as detailed in **Table 3** of this report, the existing ponds have been determined to have capacity for the proposed improvements for this development. The *Original Report* designed both ponds to detain the 100-year + ½ EURV volume. The "+ ½ EURV" is no longer a requirement by the City of Aurora Criteria and the 1-hr rainfall depths have been decreased. Thus, as discussed previously in this report, the existing as-built ponds have been analyzed using the currently adopted Code.

Existing Pond A was designed and constructed to detain a total of 0.834 ac-ft per the approved *Original Report* and as-built analysis of the pond. Since the 100-year + ½ EURV volume is no longer required, the existing pond was analyzed using the current City standards in order to verify the existing pond has the capacity to detain the additional runoff produced by this Project. In the proposed condition for the west expansion, the required 100-year volume for Pond A is 0.805 ac-ft, which is less than 0.834 ac-ft; therefore, Existing Pond A has sufficient capacity for the proposed west expansion. Modification to the existing orifice plate on the outlet structure will need to be made in order for the pond to function within the allowable drain times for the WQCV and 5-year storm event. The radius of the orifices will need to be enlarged from 1.23 inches to 1.36 inches. In order to demonstrate compliance and capacity, the outlet structure calculations for this existing pond based on the as-built information has been included in this report.

Flows from this existing pond will discharge into the existing northern concrete swale, consistent with the approved Original Final Drainage Report.

Existing Pond B was designed and constructed to detain a total of 0.994 ac-ft. In the proposed condition for this development, the 100-year volume required is 0.892 ac-ft. Since the 100-year detention volume in the proposed condition is less than the provided 0.994 ac-ft, Existing Pond B has sufficient capacity for the proposed west expansion. To demonstrate compliance and capacity, the outlet structure calculations for this existing pond based on the as-built information has been included in this report.

Treated runoff from both existing ponds will discharge into the existing Concrete Swales. Based on the new analysis, minor modifications to the outlet structure of Pond A and no improvements to Pond B are anticipated for the existing ponds on-site.

Refer to **Appendix C** for the revised detention calculations for the existing Ponds A and B.

North Expansion

Detention and water quality for the North Expansion is provided for the developed flows within the proposed Pond C. All onsite flows within this area of the improvements will be conveyed to Pond C located north of the existing distribution center. The pond will be designed with forebays, trickle channels, maintenance access, emergency overflow spillway and an outlet structure. The outlet structure calculations will be provided with the submission of the forthcoming final drainage report.

All stormwater systems proposed with this northern expansion will be designed for the 2-year and 100-year storm events. In the event that the detention facility outfall storm sewer fails, the emergency spillway will control and convey overflows to the existing northern concrete channel.

Refer to **Appendix C** for the detention calculation for Pond C.

South Expansion

Detention and water quality is provided for the majority of the developed flows from the South Expansion improvements via proposed Pond D, which is located south of the existing distribution center. As described previously, runoff from sub-basins S9, S11, S12, S13, S14, S15, S16 are not able to be conveyed to the pond, thus the total 100-year runoff generated by these basins has been deducted from the total allowable 100-year release rate.

As noted previously in this report, runoff from undisturbed areas of the site are directed into this proposed pond, however Pond D will only be sized for the disturbed areas associated with the southern expansion. The runoff from undisturbed areas will be considered bypass flows and will be conveyed to the existing southern concrete channel via the emergency spillway and not treated within the pond. The emergency spillway of this pond will be sized for the total flows tributary to the Pond.

The pond will be designed with forebays, trickle channels, maintenance access, emergency overflow spillway and an outlet structure. The outlet structure and spillway calculations will be provided with the submission of the forthcoming final drainage report.

All stormwater systems proposed with this southern expansion will be designed for the 2-year and 100-year storm event. In the event that the detention facility outfall storm sewer fails, an emergency spillway will control and convey overflows to the existing southern concrete channel.

Refer to **Appendix C** for the detention calculations for Pond D.

Existing Concrete Channels

There are two existing concrete channels designed and constructed with the Final Drainage Report for Associated Grocers of Colorado Warehouse, dated November 3, 1982. The existing channels are located north and south of the Project Site, and have been sized for the 100-year storm event. Ponds A and C are tributary to the north concrete channel and Ponds B and D are tributary to the south concrete channel.

Per the Tower Road Center for Industry Filing No. 1 Construction Plans (EDN C8-2-1320) prepared by Stearns-Roger Architects LTD on June 17, 1981 the existing north concrete channel was designed to have a normal dept of 3.57 ft in the 100-year storm event. The south channel is designed to have a flow depth of 3.60 ft in the 100-year storm event.

CONCLUSIONS

Compliance with Standards

The project complies with the City of Aurora criteria for storm drainage design. City of Aurora Storm Drainage Design and Technical Criteria and the Urban Storm Drainage Criteria Manual Volumes 1, 2, and 3 have been adhered to in the design of the storm sewer system as well as Best Management Practices.

This project will comply with the state law regarding requisite release rates and times and will be uploaded to the state at the time of completion.

Summary of Concept

The project's runoff generated within the west expansion will be collected by existing Swales A1, A2, and A3 similar to the existing conditions, and will be routed to existing Ponds A and B. These existing ponds will detain and treat the proposed improvements associated with the west expansion. The previously approved Grocer's of Colorado Filing No. 2 calculations have been revised to comply with the current storm criteria set forth by the City of Aurora. The existing ponds have sufficient capacity for the additional expansion runoff.

The project's runoff generated within the north and south expansion sites will be collected using curb and gutter, private roof drains, and private storm sewer systems that will convey stormwater runoff to new Ponds C and D for water quality and detention treatment. Improvement areas not able to be conveyed to the ponds for treatment and attenuation have been accounted for in the drainage design by deducting the 100-year runoff from the allowable release rates from the pond.

Stormwater will be detained and treated within the pond through the use of forebays, trickle channels, and micropools consistent with MHFD requirements. The detention ponds will release stormwater at rates consistent with MHFD and City of Aurora Criteria Manual to the existing concrete channels.

LIST OF REFERENCES

Flood Insurance Rate Map 08005C0182K, Federal Emergency Management Agency; December 17, 2010

Flood Insurance Rate Map 08005C0181L, Federal Emergency Management Agency; September 4, 2010

Storm Drainage Design and Technical Criteria, City of Aurora; November 2023

Water, Sanitary Sewer & Storm Drainage Infrastructure Standards & Specifications, Aurora Water; February 2024

Urban Storm Drainage Criteria Manual, Volumes 1-3, Urban Drainage and Flood Control District, June 2001 with latest revisions.

Grocer's of Colorado Filing No. 2 Final Drainage Report (COA 218104), Kimley-Horn and Associates, July 2018

Appendix A

FIRM Maps 08005C0182K & 08005C018L
Soil Map

National Flood Hazard Layer FIRMette

FEMA

104°46'57"W 39°45'1"N

104°46'20"W 39°44'33"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

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

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 AREAS
- NO SCREEN — Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

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

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

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 3/28/2024 at 9:58 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

National Flood Hazard Layer FIRMette

FEMA

104°47'16"W 39°45'N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

104°46'39"W 39°44'33"N

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

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

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 AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

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

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

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 3/28/2024 at 10:02 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Adams County Area, Parts of Adams and Denver Counties, Colorado

March 28, 2024

Custom Soil Resource Report
Soil Map

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Adams County Area, Parts of Adams and Denver Counties, Colorado
Survey Area Data: Version 20, Aug 24, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 1, 2023—Sep 1, 2023

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
EgA	Ellicott-Glenberg complex, 0 to 3 percent slopes, occasionally flooded	13.4	20.3%
Lu	Loamy alluvial land	34.5	52.2%
TuB	Truckton sandy loam, 0 to 3 percent slopes	18.2	27.5%
Totals for Area of Interest		**66.1**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or

landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Adams County Area, Parts of Adams and Denver Counties, Colorado

EgA—Ellicott-Glenberg complex, 0 to 3 percent slopes, occasionally flooded

Map Unit Setting

National map unit symbol: 2x0j6
Elevation: 3,950 to 5,960 feet
Mean annual precipitation: 13 to 17 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 135 to 165 days
Farmland classification: Not prime farmland

Map Unit Composition

Ellicott, occasionally flooded, and similar soils: 65 percent
Glenberg, rarely flooded, and similar soils: 20 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ellicott, Occasionally Flooded

Setting

Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Noncalcareous, stratified sandy alluvium

Typical profile

A - 0 to 4 inches: sand
AC - 4 to 13 inches: sand
C1 - 13 to 30 inches: sand
C2 - 30 to 44 inches: sand
C3 - 44 to 80 inches: coarse sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 39.96 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very low (about 2.1 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: R067BY031CO - Sandy Bottomland
Hydric soil rating: No

Description of Glenberg, Rarely Flooded

Setting

Landform: Ephemeral streams, flood-plain steps
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Stratified, calcareous alluvium

Typical profile

A - 0 to 6 inches: sandy loam
AC - 6 to 18 inches: sandy loam
C1 - 18 to 45 inches: sandy loam
C2 - 45 to 80 inches: loamy coarse sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 2.0
Available water supply, 0 to 60 inches: Low (about 5.6 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: A
Ecological site: R067BY031CO - Sandy Bottomland
Hydric soil rating: No

Minor Components

Las animas, occasionally flooded

Percent of map unit: 10 percent
Landform: Flood plains, ephemeral streams
Down-slope shape: Linear
Across-slope shape: Linear, concave
Ecological site: R067BY038CO - Wet Meadow
Hydric soil rating: No

Ellicott sandy-skeletal, occasionally flooded

Percent of map unit: 5 percent
Landform: Channels, flood plains
Down-slope shape: Linear
Across-slope shape: Concave, linear
Ecological site: R067BY031CO - Sandy Bottomland
Hydric soil rating: No

Lu—Loamy alluvial land

Map Unit Setting

National map unit symbol: 34w3
Elevation: 4,000 to 6,000 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 165 days
Farmland classification: Not prime farmland

Map Unit Composition

Loamy alluvial land: 75 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Loamy Alluvial Land

Setting

Landform: Drainageways
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from mixed

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 60 inches: stratified loam to clay loam

Properties and qualities

Slope: 0 to 3 percent
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Frequency of flooding: Occasional
Calcium carbonate, maximum content: 15 percent
Gypsum, maximum content: 1 percent
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 10.6 inches)

Interpretive groups

Land capability classification (irrigated): 2w
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: B
Ecological site: R067BY036CO - Overflow
Hydric soil rating: No

Minor Components

Nunn
Percent of map unit: 10 percent
Hydric soil rating: No

Satanta
Percent of map unit: 10 percent
Landform: Paleoterraces
Hydric soil rating: No

Loveland
Percent of map unit: 5 percent
Landform: Terraces
Ecological site: R067BY036CO - Overflow
Hydric soil rating: Yes

TuB—Truckton sandy loam, 0 to 3 percent slopes

Map Unit Setting
National map unit symbol: 2yvrf
Elevation: 4,600 to 6,100 feet
Mean annual precipitation: 12 to 17 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 125 to 155 days
Farmland classification: Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60

Map Unit Composition
Truckton and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Truckton

Setting
Landform: Interfluves, terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Wind re-worked alluvium derived from arkose

Typical profile
A - 0 to 6 inches: sandy loam
Bt1 - 6 to 10 inches: sandy loam
Bt2 - 10 to 16 inches: sandy loam
C - 16 to 80 inches: loamy coarse sand

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches

Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Maximum salinity: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Minor Components

Bresser

Percent of map unit: 4 percent
Landform: Interfluves, terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Vona

Percent of map unit: 4 percent
Landform: Dunes, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Ecological site: R067BY015CO - Deep Sand
Hydric soil rating: No

Blakeland

Percent of map unit: 3 percent
Landform: Interfluves, hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Ecological site: R067BY015CO - Deep Sand
Hydric soil rating: No

Pleasant, frequently ponded

Percent of map unit: 2 percent
Landform: Closed depressions
Down-slope shape: Concave, linear
Across-slope shape: Concave
Ecological site: R067BY010CO - Closed Depression
Hydric soil rating: Yes

Urban land

Percent of map unit: 2 percent
Hydric soil rating: No

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Appendix B

Table 1 Runoff Coefficients
Rainfall Intensity
Preliminary Rational Runoff Calculations

RAINFALL INTENSITY

$$I = \frac{28.5\ P_1}{(10+T_C)^{0.786}}$$

Where:

I = rainfall intensity (inches per hour)

P_1 = one-hour rainfall depth (inches) from Table 5-1 of the City of Au
Storm Draiange Design and Technical Criteria

T_C = time of concentration (minutes)

	2-yr	5-yr	10-yr	100-yr
P_1 =	0.86	1.14	1.40	2.46

Time Intensity Frequency Tabulation

TIME	2 YR	5 YR	10 YR	100 YR
5	2.92	3.87	4.75	8.34
10	2.33	3.08	3.79	6.66
15	1.95	2.59	3.18	5.58
20	1.69	2.24	2.75	4.84
25	1.50	1.99	2.44	4.29
30	1.35	1.79	2.20	3.86
40	1.13	1.50	1.84	3.24
50	0.98	1.30	1.60	2.81
60	0.87	1.15	1.41	2.49
120	0.53	0.71	0.87	1.53

Associated Grocers of Colorado Filing No.2
Amendment No. 1 (Project Lowry) - West Expansion

BASIN IMPERVIOUSNESS AND RUNOFF COEFFICIENT

	Imp.	C2	C5	C10	C100
Landscape	20%	0.13	0.15	0.22	0.52
Light Industrial	75%	0.63	0.63	0.66	0.78
Roof	95%	0.79	0.81	0.83	0.87
Concrete	95%	0.79	0.81	0.83	0.87
Street - Paved	95%	0.79	0.81	0.83	0.87
Gravel (packed)	40%	0.29	0.32	0.38	0.61

ON SITE BASINS

Basin ID	Roof (SF)	Landscape (SF)	Concrete (SF)	Street - Paved (SF)	Gravel (packed) (SF)	Total Basin Area (SF)	Total Basin Area (Acres)	Basin Imperviousness*	C2	C5	C100
A-1	0	257749		13130	906	271785	6.24	24%	0.16	0.18	0.54
A-2	0	31062	400	13489	1905	46856	1.08	43%	0.33	0.35	0.63
A-3	0	51553	1206	20750	1531	75040	1.72	42%	0.33	0.35	0.61
A-4	0	83061	9136	35533	2927	130657	3.00	46%	0.36	0.38	0.63
R-1	26614	0	0	0	0	26614	0.61	95%	0.79	0.81	0.87
R-2	29815	0	0	0	0	29815	0.68	95%	0.79	0.81	0.87
R-3	14310	0	0	0	0	14310	0.33	95%	0.79	0.81	0.87
R-4	16157	0	0	0	0	16157	0.37	95%	0.79	0.81	0.87
R-5	12853	0	0	0	0	12853	0.30	95%	0.79	0.81	0.87
R-6	12482	0	0	0	0	12482	0.29	95%	0.79	0.81	0.87
R-7	10499	0	0	0	0	10499	0.24	95%	0.79	0.81	0.87
R-8	11588	0	0	0	0	11588	0.27	95%	0.79	0.81	0.87
R-9	11717	0	0	0	0	11717	0.27	95%	0.79	0.81	0.87
R-10	11872	0	0	0	0	11872	0.27	95%	0.79	0.81	0.87
R-11	15885	0	0	0	0	15885	0.36	95%	0.79	0.81	0.87
A-5	0	22890	0	0	4271	27161	0.62	23%	0.15	0.18	0.44
A-1 (future)	0	195042	633	13130	2183	210988	4.84	25%	0.17	0.19	0.54
A-2 (future)	0	21984	400	13489	3393	39266	0.90	48%	0.38	0.40	0.65
A-5 (future)	0	118	7019	0	0	7137	0.16	94%	0.78	0.80	0.87
R-12 (future)	45229	0	0	0	0	45229	1.04	95%	0.79	0.81	0.87
R-13 (future)	45037	0	0	0	0	45037	1.03	95%	0.79	0.81	0.87
Total	173792	446315	10742	82902	11540	725291	16.65	48%	0.38	0.40	0.65

OFFSITE BASINS

OS-1	0	27711	0	0	0	27711	0.64	20%	0.13	0.15	0.52
OS-2	0	0	3926	7632	0	11558	0.27	95%	0.79	0.81	0.87
OS-3	0	27055	0	0	0	27055	0.62	20%	0.13	0.15	0.52

POND SIZING (for future conditions)

North	132125.16	217025.9	1032.51	26619	5576.59	382379.16	8.778	51.05%	0.40	0.43	0.66
South	119080.33	134732.19	17361.43	56282.64	4457.65	331914.24	7.915	63.28%	0.51	0.54	0.72

Associated Grocers of Colorado Filing No.2
Amendment No. 1 (Project Lowry) - West Expansion

TIME OF CONCENTRATION

Watercourse Coefficient

Forest & Meadow	2.50	Short Grass Pasture & Lawns	7.00	Grassed Waterway	15.00	$t_c = (26 - 17i) + \frac{L_t}{60(14i+9)\sqrt{S_t}}$
Fallow or Cultivation	5.00	Nearly Bare Ground	10.00	Paved Area & Shallow Gutter	20.00	

SUB-BASIN DATA					INITIAL / OVERLAND 0.00			TRAVEL TIME T(t)					T(c) CHECK (URBANIZED BASINS)					FINAL T(c)*
DESIGN POINT	DRAIN BASIN	AREA sq. ft.	AREA ac.	COEFF C5	Length ft.	Slope ft/ft	T(i) min	Length ft.	Slope ft/ft	Coeff.	Velocity fps	T(t) min.	IMP %	TOTAL SLOPE	COMP. T(c)	TOTAL LENGTH	T(C) CHECK	min.
A-1	A-1	271,785	6.24	0.18	430	0.020	27.7	380	0.020	20	2.8	2.2	24%	2%	29.9	810	29.7	29.7
A-2	A-2	46,856	1.08	0.35	50	0.020	7.7	690	0.005	20	1.4	8.1	43%	1%	15.8	740	29.3	29.3
A-3	A-3	75,040	1.72	0.35	180	0.015	16.2	670	0.005	20	1.4	7.9	42%	1%	24.1	850	30.0	24.1
A-4	A-4	130,657	3.00	0.38	75	0.010	11.4	320	0.005	20	1.4	3.8	46%	1%	15.2	395	23.7	15.2
R-1	R-1	26,614	0.61	0.81	300	0.020	7.2				0.0	0.0	95%	2%	7.2	300	11.4	7.2
R-2	R-2	29,815	0.68	0.81	300	0.020	7.2				0.0	0.0	95%	2%	7.2	300	11.4	7.2
R-3	R-3	14,310	0.33	0.81	300	0.020	7.2				0.0	0.0	95%	2%	7.2	300	11.4	7.2
R-4	R-4	16,157	0.37	0.81	300	0.020	7.2				0.0	0.0	95%	2%	7.2	300	11.4	7.2
R-5	R-5	12,853	0.30	0.81	300	0.020	7.2				0.0	0.0	95%	2%	7.2	300	11.4	7.2
R-6	R-6	12,482	0.29	0.81	300	0.020	7.2				0.0	0.0	95%	2%	7.2	300	11.4	7.2
R-7	R-7	10,499	0.24	0.81	300	0.020	7.2				0.0	0.0	95%	2%	7.2	300	11.4	7.2
R-8	R-8	11,588	0.27	0.81	300	0.020	7.2				0.0	0.0	95%	2%	7.2	300	11.4	7.2
R-9	R-9	11,717	0.27	0.81	300	0.020	7.2				0.0	0.0	95%	2%	7.2	300	11.4	7.2
R-10	R-10	11,872	0.27	0.81	300	0.020	7.2				0.0	0.0	95%	2%	7.2	300	11.4	7.2
R-11	R-11	15,885	0.36	0.81	300	0.020	7.2				0.0	0.0	95%	2%	7.2	300	11.4	7.2
A-5	A-5	27,161	0.62	0.18	161	0.015	18.8				0.0	0.0	23%	2%	18.8	161	23.9	18.8
A-1 (future)	A-1 (future)	210,988	4.84	0.19	430	0.020	27.3				0.0	0.0	25%	2%	27.3	430	25.8	25.8
A-2 (future)	A-2 (future)	39,266	0.90	0.40	50	0.02	7.2				0.0	0.0	48%	2%	7.2	50	10.3	7.2
A-5 (future)	A-5 (future)	7,137	0.16	0.80	161	0.02	6.0				0.0	0.0	94%	2%	6.0	161	10.9	6.0
R-12 (future)	R-12 (future)	45,229	1.04	0.81	300	0.020	7.2				0.0	0.0	95%	2%	7.2	300	11.7	7.2
R-13 (future)	R-13 (future)	45,037	1.03	0.81	300	0.020	7.2				0.0	0.0	95%	2%	7.2	300	11.7	7.2
OS-1	OS-1	27,711	0.64	0.15	20	0.100	3.6	0	0.010	20	2.0	0.0	20%	10%	5.0	20	10.1	5.0
OS-2	OS-2	11,558	0.27	0.81	150	0.010	6.4	0	0.010	20	2.0	0.0	95%	1%	6.4	150	10.8	6.4
OS-3	OS-3	27,055	0.62	0.15	160	0.040	13.9	0	0.010	20	2.0	0.0	20%	4%	13.9	160	10.9	10.9

Associated Grocers of Colorado Filing No.2
Amendment No. 1 (Project Lowry) - West Expansion

RUNOFF CALCULATIONS

Design Storm 100 Year

BASIN INFORMATON				DIRECT RUNOFF				TOTAL RUNOFF				REMARKS
DESIGN POINT	DRAIN BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	SUM C x A	I in/hr	Q cfs	
A-1	A-1	6.24	0.54	29.7	3.35	3.88	13.0					
A-2	A-2	1.08	0.63	29.3	0.68	3.92	2.7	29.3	2.42	3.92	9.5	Basin A2 and R1-R4
A-3	A-3	1.72	0.61	24.1	1.06	4.39	4.6					
A-4	A-4	3.00	0.63	15.2	1.89	5.56	10.5					
R-1	R-1	0.61	0.87	7.2	0.53	7.60	4.1					
R-2	R-2	0.68	0.87	7.2	0.60	7.60	4.5					
R-3	R-3	0.33	0.87	7.2	0.29	7.60	2.2	7.2	0.61	7.60	4.6	Basin R3-R4
R-4	R-4	0.37	0.87	7.2	0.32	7.60	2.5	7.2	1.74	7.60	13.2	Basin R1-R4
R-5	R-5	0.30	0.87	7.2	0.26	7.60	2.0					
R-6	R-6	0.29	0.87	7.2	0.25	7.60	1.9	7.2	0.51	7.60	3.9	Basin R5-R6
R-7	R-7	0.24	0.87	7.2	0.21	7.60	1.6	7.2	0.72	7.60	5.5	Basin R5-R7
R-8	R-8	0.27	0.87	7.2	0.23	7.60	1.8	7.2	0.95	7.60	7.2	Basin R5-R8
R-9	R-9	0.27	0.87	7.2	0.23	7.60	1.8	7.2	1.18	7.60	9.0	Basin R5-R9
R-10	R-10	0.27	0.87	7.2	0.24	7.60	1.8					
R-11	R-11	0.36	0.87	7.2	0.32	7.60	2.4	7.2	1.74	7.60	13.2	Basin R5-11
A-5	A-5	0.62	0.44	18.8	0.27	5.02	1.4					
A-1 (future)	A-1 (future)	4.84	0.54	25.8	2.63	4.22	11.1					
A-2 (future)	A-2 (future)	0.90	0.65	7.2	0.59	7.60	4.5					
A-5 (future)	A-5 (future)	0.16	0.87	6.0	0.14	8.01	1.1					
R-12 (future)	R-12 (future)	1.04	0.87	7.2	0.91	7.60	6.9					
R-13 (future)	R-13 (future)	1.03	0.87	7.2	0.90	7.60	6.9					
OS-1	OS-1	0.64	0.52	5.0	0.33	8.34	8.5					
OS-2	OS-2	0.27	0.87	6.4	0.23	7.87	4.5					
OS-3	OS-3	0.62	0.52	10.9	0.32	6.46	4.9					

Associated Grocers of Colorado Filing No.2
Amendment No. 1 (Project Lowry) - West Expansion

RUNOFF CALCULATIONS

Design Storm 2 Year

BASIN INFORMATON				DIRECT RUNOFF				TOTAL RUNOFF				REMARKS
DESIGN POINT	DRAIN BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	SUM C x A	I in/hr	Q cfs	
A-1	A-1	6.24	0.16	29.7	1.00	1.36	1.4					
A-2	A-2	1.08	0.33	29.3	0.36	1.37	0.5	29.3	1.93	3.92	7.6	Basin A2 and R1-R4
A-3	A-3	1.72	0.33	24.1	0.56	1.53	0.9					
A-4	A-4	3.00	0.36	15.2	1.07	1.94	2.1					
R-1	R-1	0.61	0.79	7.2	0.48	2.66	1.3				0.0	
R-2	R-2	0.68	0.79	7.2	0.54	2.66	1.4				0.0	
R-3	R-3	0.33	0.79	7.2	0.26	2.66	0.7	7.2	0.55	7.60	4.2	Basin R3-R4
R-4	R-4	0.37	0.79	7.2	0.29	2.66	0.8	7.2	1.58	7.60	12.0	Basin R1-R4
R-5	R-5	0.30	0.79	7.2	0.23	2.66	0.6				0.0	
R-6	R-6	0.29	0.79	7.2	0.23	2.66	0.6	7.2	0.46	7.60	3.5	Basin R5-R6
R-7	R-7	0.24	0.79	7.2	0.19	2.66	0.5	7.2	0.65	7.60	4.9	Basin R5-R7
R-8	R-8	0.27	0.79	7.2	0.21	2.66	0.6	7.2	0.86	7.60	6.5	Basin R5-R8
R-9	R-9	0.27	0.79	7.2	0.21	2.66	0.6	7.2	1.07	7.60	8.2	Basin R5-R9
R-10	R-10	0.27	0.79	7.2	0.22	2.66	0.6				0.0	
R-11	R-11	0.36	0.79	7.2	0.29	2.66	0.8	7.2	1.58	7.60	12.0	Basin R5-11
A-5	A-5	0.62	0.15	18.8	0.10	1.75	0.2					
A-1 (future)	A-1 (future)	4.84	0.17	25.8	0.84	1.48	1.2					
A-2 (future)	A-2 (future)	0.90	0.38	7.2	0.34	2.66	0.9					
A-5 (future)	A-5 (future)	0.16	0.78	6.0	0.13	2.80	0.4					
R-12 (future)	R-12 (future)	1.04	0.79	7.2	0.82	2.66	2.2					
R-13 (future)	R-13 (future)	1.03	0.79	7.2	0.82	2.66	2.2					
OS-1	OS-1	0.64	0.13	5.0	0.08	2.92	0.2					
OS-2	OS-2	0.27	0.79	6.4	0.21	2.75	0.6					
OS-3	OS-3	0.62	0.13	10.9	0.08	2.26	0.2					

Rational Calculation Summary (West Expansion)

				Direct Flows		Cumulative Flows	
DESIGN POINT	DRAIN BASIN	AREA Ac	IMP %	Q_2 CFS	Q_{100} CFS	Q_2 CFS	Q_{100} CFS
A-1	A-1	6.24	24%	1.4	13.0		
A-2	A-2	1.08	43%	0.5	2.7	7.6	9.5
A-3	A-3	1.72	42%	0.9	4.6		
A-4	A-4	3.00	46%	2.1	10.5		
R-1	R-1	0.61	95%	1.3	4.1		
R-2	R-2	0.68	95%	1.4	4.5		
R-3	R-3	0.33	95%	0.7	2.2	4.2	4.6
R-4	R-4	0.37	95%	0.8	2.5	12.0	13.2
R-5	R-5	0.30	95%	0.6	2.0		
R-6	R-6	0.29	95%	0.6	1.9	3.5	3.9
R-7	R-7	0.24	95%	0.5	1.6	4.9	5.5
R-8	R-8	0.27	95%	0.6	1.8	6.5	7.2
R-9	R-9	0.27	95%	0.6	1.8	8.2	9.0
R-10	R-10	0.27	95%	0.6	1.8		
R-11	R-11	0.36	95%	0.8	2.4	12.0	13.2
A-5	A-5	0.62	23%	0.2	1.4		
A-1 (future)	A-1 (future)	4.84	25%	1.2	11.1		
A-2 (future)	A-2 (future)	0.90	48%	0.9	4.5		
A-5 (future)	A-5 (future)	0.16	94%	0.4	1.1		
R-12 (future)	R-12 (future)	1.04	95%	2.2	6.9		
R-13 (future)	R-13 (future)	1.03	95%	2.2	6.9		
OS-1	OS-1	0.64	20%	0.2	8.5		
OS-2	OS-2	0.27	95%	0.6	4.5		
OS-3	OS-3	0.62	20%	0.2	4.9		

Kimley»Horn

STANDARD FORM SF-1
RUNOFF COEFFICIENTS - IMPERVIOUS CALCULATION

PROJECT NAME: Project Lowry - North & South Expansion
PROJECT NUMBER: 196772002
CALCULATED BY: FSA
CHECKED BY: MTH
DATE: 4/29/2024

SOIL:

LAND USE:	LANDSCAPE AREA	CONCRETE AREA	PAVEMENT AREA	GRAVEL AREA	ROOF AREA
2-YEAR COEFF.	0.13	0.79	0.79	0.29	0.79
5-YEAR COEFF.	0.15	0.81	0.81	0.32	0.81
10-YEAR COEFF.	0.22	0.83	0.83	0.38	0.83
100-YEAR COEFF.	0.52	0.87	0.87	0.61	0.87
IMPERVIOUS %	20%	95%	95%	40%	95%

DESIGN BASIN	DESIGN POINT	LANDSCAPE AREA (AC)	CONCRETE AREA (AC)	PAVEMENT AREA (AC)	GRAVEL AREA (AC)	ROOF AREA (AC)	TOTAL AREA (AC)	C(2)	C(5)	C(10)	C(100)	Imp %
On-Site Basins												
N1	N1	0.11	0.07	0.66	0.01	0.00	**0.85**	0.70	0.72	0.74	0.82	85%
N2	N2	0.10	0.04	0.77	0.01	0.00	**0.91**	0.72	0.74	0.76	0.83	87%
N3	N3	0.16	0.00	1.22	0.01	0.00	**1.39**	0.71	0.73	0.75	0.83	86%
N4	N4	0.16	0.04	1.20	0.01	0.00	**1.41**	0.71	0.73	0.75	0.83	86%
N5	N5	0.16	0.10	0.97	0.01	0.00	**1.24**	0.70	0.72	0.74	0.83	85%
N6	N6	0.35	0.09	1.53	0.00	0.00	**1.97**	0.67	0.69	0.72	0.81	82%
N-R1	N-R1	0.00	0.00	0.00	0.00	2.41	**2.41**	0.79	0.81	0.83	0.87	95%
POND C	POND C	1.24	0.02	0.00	0.00	0.00	**1.25**	0.14	0.16	0.23	0.52	21%
SWALE-N	SWALE-N	1.23	0.00	0.00	0.00	0.00	**1.23**	0.13	0.15	0.22	0.52	20%
EX-1	EX-1	0.00	0.00	0.51	0.00	0.00	**0.51**	0.79	0.81	0.83	0.87	95%
NORTH BASIN		**3.50**	**0.34**	**6.86**	**0.05**	**2.41**	**13.16**	**0.61**	**0.63**	**0.66**	**0.78**	**75%**
SUBTOTAL		**27%**	**3%**	**52%**	**0%**	**18%**	**100%**					
S1	S1	0.00	0.00	0.20	0.00	0.00	**0.19**	0.79	0.81	0.83	0.87	95%
S2	S2	0.04	0.24	0.51	0.00	0.00	**0.79**	0.76	0.78	0.80	0.86	91%
S3	S3	0.00	0.00	0.54	0.00	0.00	**0.54**	0.79	0.81	0.83	0.87	95%
S4	S4	0.10	0.00	1.04	0.00	0.00	**1.14**	0.73	0.75	0.77	0.84	88%
S5	S5	0.14	0.01	0.49	0.00	0.00	**0.63**	0.65	0.67	0.70	0.80	79%
S6	S6	0.19	0.02	0.96	0.00	0.00	**1.18**	0.68	0.70	0.73	0.81	83%
S7	S7	0.05	0.00	0.25	0.00	0.00	**0.29**	0.69	0.71	0.73	0.82	83%
S8	S8	0.01	0.01	0.46	0.00	0.00	**0.49**	0.77	0.79	0.81	0.86	93%
S9	S9	0.23	0.14	2.46	0.00	0.00	**2.83**	0.74	0.76	0.78	0.84	89%
S10	S10	1.79	0.14	1.73	0.00	0.00	**3.66**	0.47	0.49	0.53	0.70	58%
S11	S11	0.22	0.01	1.19	0.01	0.00	**1.42**	0.69	0.71	0.73	0.82	83%
S12	S12	0.04	0.12	0.00	0.00	0.00	**0.17**	0.62	0.64	0.67	0.78	75%
S13	S13	0.00	0.05	2.35	0.00	0.00	**2.40**	0.79	0.81	0.83	0.87	95%
S14	S14	0.24	0.12	1.84	0.00	0.00	**2.20**	0.72	0.74	0.76	0.83	87%
S15	S15	0.21	0.13	1.00	0.00	0.00	**1.35**	0.69	0.71	0.73	0.82	83%
S16	S16	0.00	0.07	0.50	0.00	0.00	**0.57**	0.79	0.81	0.83	0.87	95%
S-R1	S-R1	0.00	0.00	0.00	0.00	0.69	**0.69**	0.79	0.81	0.83	0.87	95%
POND D	POND D	1.56	0.09	0.00	0.00	0.00	**1.65**	0.16	0.19	0.25	0.54	24%
EX-R1	EX-R1	0.00	0.00	0.00	0.00	2.41	**2.41**	0.79	0.81	0.83	0.87	95%
SOUTH BASIN		**4.82**	**1.16**	**15.50**	**0.01**	**3.10**	**24.59**	**0.66**	**0.68**	**0.71**	**0.80**	**80%**
SUBTOTAL		**20%**	**5%**	**63%**	**0%**	**13%**	**100.0%**					

Kimley»Horn

STANDARD FORM SF-2
Time of Concentration

PROJECT NAME: Project Lowry - North & South Expansion
PROJECT NUMBER: 196772002
CALCULATED BY: FSA
CHECKED BY: MTH

DATE: ########

SUB-BASIN DATA			INITIAL TIME (T_i)			TRAVEL TIME (T_t)					Tc CHECK (URBANIZED BASINS)					FINAL Tc
DESIGN BASIN (1)	AREA Ac (2)	C5 (3)	LENGTH Ft (4)	SLOPE % (5)	T_i Min. (6)	LENGTH Ft. (7)	SLOPE % (8)	C_v (9)	VEL fps (11)	T_t Min. (12)	COMP. tc (13)	TOTAL LENGTH (14)	TOTAL SLOPE (15)	TOTAL IMP. (16)	Tc Min. (17)	Min.
On-Site North Basins																
N1	0.847	0.722	205	1.5%	8.7			20.0			8.7	205	1.5%	85%	12.9	8.7
N2	0.907	0.739	203	1.5%	8.2			20.0			8.2	203	1.5%	87%	12.6	8.2
N3	1.387	0.734	207	1.5%	8.4			20.0			8.4	207	1.5%	86%	12.7	8.4
N4	1.413	0.733	279	1.5%	9.8			20.0			9.8	279	1.5%	86%	13.2	9.8
N5	1.237	0.724	201	1.5%	8.5			20.0			8.5	201	1.5%	85%	12.9	8.5
N6	1.973	0.694	300	1.5%	11.3	10	3.0%	20.0	3.5	0.0	11.3	310	1.5%	82%	14.2	11.3
N-R1	2.407	0.813	122	1.0%	5.8			20.0			5.8	122	1.0%	95%	10.8	5.8
POND C	1.251	0.158	130	20.0%	7.3	139	2.0%	7.0	1.0	2.3	9.6	269	10.7%	21%	23.6	9.6
SWALE-N	1.229	0.149	74	2.0%	11.9	730	1.0%	7.0	0.7	17.4	29.3	804	1.1%	20%	33.5	29.3
EX-1	0.510	0.813	350	3.5%	6.5	110	3.5%	20.0	3.7	0.5	7.0	460	3.5%	95%	11.7	7.0
On-Site South Basins																
S1	0.19	0.81	92	1.5%	4.4	210	1.0%	20.0	2.0	1.8	6.2	302	1.2%	95%	12.0	6.2
S2	0.79	0.78	134	3.0%	4.7			20.0			4.7	134	3.0%	91%	11.1	5.0
S3	0.54	0.81	143	2.5%	4.6			20.0			4.6	143	2.5%	95%	10.5	5.0
S4	1.14	0.75	169	1.0%	8.2	96	1.5%	20.0	2.4	0.7	8.9	265	1.2%	88%	12.9	8.9
S5	0.63	0.67	183	1.4%	9.5			20.0			9.5	183	1.4%	79%	13.9	9.5
S6	1.18	0.70	232	3.0%	7.7			20.0			7.7	232	3.0%	83%	13.0	7.7
S7	0.29	0.71	78	2.5%	4.7	78	1.0%	20.0	2.0	0.7	5.3	156	1.8%	83%	12.8	5.3
S8	0.49	0.79	175	3.0%	5.1			9220.0			5.1	175	3.0%	93%	11.0	5.1
S9	2.83	0.76	27	1.5%	2.8	261	1.8%	20.0	2.7	1.6	4.5	288	1.8%	89%	12.6	5.0
S10	3.66	0.49	347	3.5%	13.7	125	1.0%	20.0	2.0	1.0	14.8	472	2.8%	58%	18.8	14.8
S11	1.42	0.71	43	2.5%	3.5	338	0.7%	20.0	1.7	3.4	6.9	381	0.9%	83%	15.1	6.9
S12	0.17	0.64	8	33.0%	0.7			7.0			0.7	8	33.0%	75%	13.2	5.0
S13	2.40	0.81	350	1.3%	9.0	62	1.3%	20.0	2.3	0.5	9.5	412	1.3%	95%	12.6	9.5
S14	2.20	0.74	251	1.0%	10.4			20.0			10.4	251	1.0%	87%	13.2	10.4
S15	1.35	0.71	267	1.7%	9.8			20.0			9.8	267	1.7%	83%	13.5	9.8
S16	0.57	0.81	194	1.5%	6.4			20.0			6.4	194	1.5%	95%	11.0	6.4
S-R1	0.69	0.81	315	1.0%	9.3			20.0			9.3	315	1.0%	95%	12.2	9.3
POND D	1.65	0.19	195	20.0%	8.6	200	2.0%	7.0	1.0	3.4	12.0	395	10.9%	24%	23.5	12.0
EX-R1	2.41	0.81	212	1.0%	7.7			20.0			7.7	212	1.0%	95%	11.4	7.7

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_o^{0.33}} \qquad t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t} \qquad t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$$

Kimley»Horn

STANDARD FORM SF-3
STORM DRAINAGE DESIGN - RATIONAL METHOD X YEAR EVENT

PROJECT NAME: Project Lowry - North & South Expansion
PROJECT NUMBER: 1.97E+08
CALCULATED BY: FSA
CHECKED BY: MTH

DATE: 4/29/2024

P_1 (1-Hour Rainfall) = **0.86**

STORM LINE	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		DESIGN BASIN	AREA (AC)	RUNOFF COEFF	tc (min)	C*A(ac)	I (in/hr)	Q (cfs)	tc(max)	S(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCITY	tt (min)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
On-Site North Basins																					
		N1	N1	0.85	0.70	8.66	0.59	2.46	1.46	9.81	4.10	2.34	9.62									N5, N4, N3, N2, N1
		N2	N2	0.91	0.72	8.24	0.65	2.50	1.63	9.81	3.51	2.34	8.23									N5, N4, N3, N2
		N3	N3	1.39	0.71	8.44	0.99	2.48	2.45	9.81	2.86	2.34	6.71									N5, N4, N3
		N4	N4	1.41	0.71	9.81	1.00	2.34	2.36	9.81	1.87	2.34	4.39									N5, N4
		N5	N5	1.24	0.70	8.53	0.87	2.47	2.15													
		N6	N6	1.97	0.67	11.31	1.33	2.21	2.94													
		N-R1	N-R1	2.41	0.79	5.81	1.90	2.80	5.33													
		POND C	POND C	1.25	0.14	9.60	0.17	2.36	0.40	29.28	8.07	1.37	11.04									N1, N2, N3, N4, N5, N6, N-R1, EX-1, SWALE-N
		SWALE-N	SWALE-N	1.23	0.13	29.28	0.16	1.37	0.22													
		EX-1	EX-1	0.51	0.79	6.97	0.40	2.65	1.07													
On-Site South Basins																					
		S1	S1	0.19	0.79	6.15	0.15	2.75	0.42													
		S2	S2	0.79	0.76	5.00	0.60	2.92	1.75	14.78	3.56	1.97	7.01									S10, S4, S3, S2
		S3	S3	0.54	0.79	5.00	0.42	2.92	1.24	14.78	2.97	1.97	5.83									S10, S4, S3
		S4	S4	1.14	0.73	8.90	0.83	2.43	2.02	14.78	2.54	1.97	5.00									S10, S4
		S5	S5	0.63	0.65	9.53	0.41	2.37	0.97													
		S6	S6	1.18	0.68	7.68	0.80	2.56	2.05	9.53	1.21	2.37	2.87									S5, S6
		S7	S7	0.29	0.69	5.30	0.20	2.87	0.57													
		S8	S8	0.49	0.77	5.15	0.38	2.89	1.10	9.53	1.59	2.37	3.76									S5, S6, S8
		S9	S9	2.83	0.74	5.00	2.08	2.92	6.07													
		S10	S10	3.66	0.47	14.78	1.71	1.97	3.36													
		S11	S11	1.42	0.69	6.85	0.97	2.66	2.59													
		S12	S12	0.17	0.62	5.00	0.10	2.92	0.30													
		S13	S13	2.40	0.79	9.46	1.90	2.38	4.52	9.46	2.88	2.38	6.84									S11, S13
		S14	S14	2.20	0.72	10.43	1.58	2.29	3.63													
		S15	S15	1.35	0.69	9.85	0.93	2.34	2.17													
		S16	S16	0.57	0.79	6.40	0.45	2.72	1.23													
		S-R1	S-R1	0.69	0.79	9.33	0.55	2.39	1.31													
		POND D	POND D	1.65	0.16	11.99	0.27	2.16	0.59	14.78	8.23	1.97	16.18									All South Basins, Except S9, S11- S16
		EX-R1	EX-R1	2.41	0.79	7.65	1.90	2.57	4.89													

Kimley»Horn

STANDARD FORM SF-3
STORM DRAINAGE DESIGN - RATIONAL METHOD 100 YEAR EVENT

PROJECT NAME: Project Lowry - North & South Expansion
PROJECT NUMBER: 196772002
CALCULATED BY: FSA
CHECKED BY: MTH

DATE: 4/29/2024

P_1 (1-Hour Rainfall) = 2.46

STORM LINE	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		DESIGN BASIN	AREA (AC)	RUNOFF COEFF	tc (min)	C*A(ac)	I (in/hr)	Q (cfs)	tc(max)	S(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCITY	tt (min)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
On-Site North Basins																					
		N1	N1	0.85	0.82	8.66	0.70	7.03	4.90	9.81	4.80	6.71	32.18									N5, N4, N3, N2, N1
		N2	N2	0.91	0.83	8.24	0.76	7.16	5.41	1.41	3.32	10.34	34.33									N5, N4, N3, N2
		N3	N3	1.39	0.83	8.44	1.15	7.09	8.17	9.81	3.35	6.71	22.44									N5, N4, N3
		N4	N4	1.41	0.83	9.81	1.17	6.71	7.87	9.81	2.19	6.71	14.71									N5, N4
		N5	N5	1.24	0.83	8.53	1.02	7.07	7.21													
		N6	N6	1.97	0.81	11.31	1.60	6.33	10.11													
		N-R1	N-R1	2.41	0.87	5.81	2.10	8.01	16.82													
		POND C	POND C	1.25	0.52	9.60	0.66	6.76	4.44	29.28	10.24	3.92	40.07									N1, N2, N3, N4, N5, N6, N-R1, EX-1, SWALE-N
		SWALE-N	SWALE-N	1.23	0.52	29.28	0.64	3.92	2.50													
		EX-1	EX-1	0.51	0.87	6.97	0.45	7.57	3.37													
On-Site South Basins																					
		S1	S1	0.19	0.87	6.15	0.17	7.87	1.32													
		S2	S2	0.79	0.86	5.00	0.67	8.34	5.63	14.78	4.66	5.62	26.20									S10, S4, S3, S2
		S3	S3	0.54	0.87	5.00	0.47	8.34	3.90	14.78	3.99	5.62	22.41									S10, S4, S3
		S4	S4	1.14	0.84	8.90	0.96	6.96	6.65	14.78	3.52	5.62	19.78									S10, S4
		S5	S5	0.63	0.80	9.53	0.50	6.78	3.40													
		S6	S6	1.18	0.81	7.68	0.96	7.33	7.02	9.53	1.46	6.78	9.90									S5, S6
		S7	S7	0.29	0.82	5.30	0.24	8.22	1.95													
		S8	S8	0.49	0.86	5.15	0.42	8.28	3.50	9.53	1.88	6.78	12.76									S5, S6, S8
		S9	S9	2.83	0.84	5.00	2.38	8.34	19.88													
		S10	S10	3.66	0.70	14.78	2.56	5.62	14.41													
		S11	S11	1.42	0.82	6.85	1.16	7.61	8.83													
		S12	S12	0.17	0.78	5.00	0.13	8.34	1.10													
		S13	S13	2.40	0.87	9.46	2.10	6.80	14.27	9.46	3.26	6.80	22.15									S11, S13
		S14	S14	2.20	0.83	10.43	1.84	6.55	12.03													
		S15	S15	1.35	0.82	9.85	1.10	6.70	7.39													
		S16	S16	0.57	0.87	6.40	0.50	7.78	3.88													
		S-R1	S-R1	0.69	0.87	9.33	0.61	6.84	4.14													
		POND D	POND D	1.65	0.54	11.99	0.89	6.18	5.50	14.78	9.94	5.62	55.87									All South Basins, Except S9, S11- S16
		EX-R1	EX-R1	2.41	0.87	7.65	2.10	7.34	15.42													

Kimley»Horn

PROJECT NAME: Project Lowry - North & South Expansion DATE: 4/19/2024
PROJECT NUMBER: 196772002
CALCULATED BY: FSA
CHECKED BY: MTH

RATIONAL CALCULATIONS SUMMARY (N & S EXPANSION)

DESIGN POINT	TRIBUTARY BASINS	TRIBUTARY AREA (AC)	IMPERVIOUSNESS %	PEAK FLOWS (CFS)		CUMULATIVE FLOWS (CFS)	
				Q2	Q100	Q2	Q100
On-Site North Basins							
N1	N1	0.85	85%	1.46	4.90	9.62	32.18
N2	N2	0.91	87%	1.63	5.41	8.23	34.33
N3	N3	1.39	86%	2.45	8.17	6.71	22.44
N4	N4	1.41	86%	2.36	7.87	4.39	14.71
N5	N5	1.24	85%	2.15	7.21		
N6	N6	1.97	82%	2.94	10.11		
N-R1	N-R1	2.41	95%	5.33	16.82		
POND C	POND C	1.25	21%	0.40	4.44	11.04	40.07
SWALE-N	SWALE-N	1.23	20%	0.22	2.50		
EX-1	EX-1	0.51	95%	1.07	3.37		
TOTAL		**13.16**	**75%**	**19.99**	**70.80**		
On-Site South Basins							
S1	S1	0.19	95%	0.42	1.32		
S2	S2	0.79	91%	1.75	5.63	7.01	26.20
S3	S3	0.54	95%	1.24	3.90	5.83	22.41
S4	S4	1.14	88%	2.02	6.65	5.00	19.78
S5	S5	0.63	79%	0.97	3.40		
S6	S6	1.18	83%	2.05	7.02	2.87	9.90
S7	S7	0.29	83%	0.57	1.95		
S8	S8	0.49	93%	1.10	3.50	3.76	12.76
S9	S9	2.83	89%	6.07	19.88		
S10	S10	3.66	58%	3.36	14.41		
S11	S11	1.42	83%	2.59	8.83		
S12	S12	0.17	75%	0.30	1.10		
S13	S13	2.40	95%	4.52	14.27	6.84	22.15
S14	S14	2.20	87%	3.63	12.03		
S15	S15	1.35	83%	2.17	7.39		
S16	S16	0.57	95%	1.23	3.88		
S-R1	S-R1	0.69	95%	1.31	4.14		
POND D	POND D	1.65	24%	0.59	5.50	16.18	55.87
EX-R1	EX-R1	2.41	95%	4.89	15.42		
TOTAL		**24.59**	**80%**	**40.77**	**140.21**		

Kimley»Horn

PROJECT NAME: Project Lowry DATE 4/19/2024
PROJECT NUMBER: 196772002
CALCULATED BY: FSA
CHECKED BY: MTH

SOUTH EXPANSION DISTURBED AREA			
BASIN	AREA	DISTURBED AREA (AC)	UNDISTIRUBED AREA (AC)
S1	0.19	0.19	0.00
S2	0.79	0.79	0.00
S3	0.54	0.54	0.00
S4	1.14	1.14	0.00
S5	0.63	0.63	0.00
S6	1.18	1.18	0.00
S7	0.29	0.29	0.00
S8	0.49	0.49	0.00
S9	2.83	0.37	2.46
S10	3.66	1.87	1.79
S11	1.42	1.42	0.00
S12	0.17	0.17	0.00
S13	2.40	0.05	2.35
S14	2.20	0.36	1.84
S15	1.35	0.35	1.00
S16	0.57	0.07	0.50
S-R1	0.69	0.69	0.00
POND D	1.65	1.65	0.00
EX-R1	2.41	0.00	2.41
TOTAL	**24.59**	**12.24**	**12.35**

DISTURBED AREA BY LAND USE					
	LANDSCAPE (AC)	CONCRETE (AC)	PVMT (AC)	GRAVEL (AC)	ROOF (AC)
S1	0.00	0.00	0.20	0.00	0.00
S2	0.04	0.24	0.51	0.00	0.00
S3	0.00	0.00	0.54	0.00	0.00
S4	0.10	0.00	1.04	0.00	0.00
S5	0.14	0.01	0.49	0.00	0.00
S6	0.19	0.02	0.96	0.00	0.00
S7	0.05	0.00	0.25	0.00	0.00
S8	0.01	0.01	0.46	0.00	0.00
S9	0.23	0.14	0.00	0.00	0.00
S10	0.00	0.00	1.87	0.00	0.00
S11	0.22	0.01	1.19	0.01	0.00
S12	0.04	0.12	0.00	0.00	0.00
S13	0.00	0.05	0.00	0.00	0.00
S14	0.24	0.12	0.00	0.00	0.00
S15	0.21	0.13	0.00	0.00	0.00
S16	0.00	0.07	0.00	0.00	0.00
S-R1	0.00	0.00	0.00	0.00	0.69
POND D	1.56	0.09	0.00	0.00	0.00
EX-R1	0.00	0.00	0.00	0.00	0.00
Sub-Total	3.04	1.01	7.49	0.01	0.69
Total	**12.24**				

Kimley»Horn

STANDARD FORM SF-1
RUNOFF COEFFICIENTS - IMPERVIOUS CALCULATION

PROJECT NAME: Project Lowry - South Expansion (DISTURBED ONLY)
DATE: 4/18/2024
PROJECT NUMBER: 196772002
CALCULATED BY: FSA
CHECKED BY: MTH

SOIL:

LAND USE:	LANDSCAPE AREA	CONCRETE AREA	PAVEMENT AREA	GRAVEL AREA	ROOF AREA
2-YEAR COEFF.	0.13	0.79	0.79	0.29	0.79
5-YEAR COEFF.	0.15	0.81	0.81	0.32	0.81
10-YEAR COEFF.	0.22	0.83	0.83	0.38	0.83
100-YEAR COEFF.	0.52	0.87	0.87	0.61	0.87
IMPERVIOUS %	20%	95%	95%	40%	95%

DESIGN BASIN	DESIGN POINT	LANDSCAPE AREA (AC)	CONCRETE AREA (AC)	PAVEMENT AREA (AC)	GRAVEL AREA (AC)	ROOF AREA (AC)	TOTAL AREA (AC)	C(2)	C(5)	C(10)	C(100)	Imp %
On-Site Basins												
Total Disturbed		3.04	1.01	7.49	0.01	0.69	**12.24**	0.63	0.65	0.68	0.78	76%
		3.04	**1.01**	**7.49**	**0.01**	**0.69**	**12.24**	**0.63**	**0.65**	**0.68**	**0.78**	**76%**
BASIN SUBTOTAL		**25%**	**8%**	**61%**	**0%**	**6%**	**100%**					
Off-Site Basins												
							0.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
							0.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
							0.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
							0.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
							0.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
							0.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
							0.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		0.00	**0.00**	**0.00**		**0.00**	**0.00**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**
BASIN SUBTOTAL		**#DIV/0!**	**#DIV/0!**	**#DIV/0!**		**#DIV/0!**	**#DIV/0!**					

Appendix C

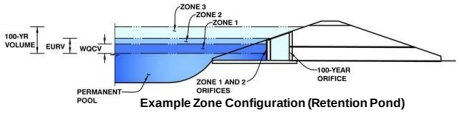
Detention Calculations
StormCAD Analysis (to be included with FDR)

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: Project Lowry

Basin ID: Existing North Pond (Pond A) As-Built using 2024 COA Drainage Criteria (Proposed Condition)



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB		Note: L / W Ratio < 1
Watershed Area =	8.78	acres	L / W Ratio = 0.94
Watershed Length =	600	ft	
Watershed Length to Centroid =	300	ft	
Watershed Slope =	0.020	ft/ft	
Watershed Imperviousness =	51.05%	percent	
Percentage Hydrologic Soil Group A =	77.0%	percent	
Percentage Hydrologic Soil Group B =	23.0%	percent	
Percentage Hydrologic Soil Groups C/D =	0.0%	percent	
Target WQCV Drain Time =	40.0	hours	
Location for 1-hr Rainfall Depths =	Aurora - Municipal Center		

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.153	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.511	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.86 in.) =	0.256	acre-feet	0.86	inches
5-yr Runoff Volume (P1 = 1.14 in.) =	0.358	acre-feet	1.14	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	0.459	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.79 in.) =	0.681	acre-feet	1.79	inches
50-yr Runoff Volume (P1 = 2.11 in.) =	0.875	acre-feet	2.11	inches
100-yr Runoff Volume (P1 = 2.46 in.) =	1.128	acre-feet	2.46	inches
500-yr Runoff Volume (P1 = 3.38 in.) =	1.763	acre-feet	3.38	inches
Approximate 2-yr Detention Volume =	0.246	acre-feet		
Approximate 5-yr Detention Volume =	0.344	acre-feet		
Approximate 10-yr Detention Volume =	0.451	acre-feet		
Approximate 25-yr Detention Volume =	0.599	acre-feet		
Approximate 50-yr Detention Volume =	0.689	acre-feet		
Approximate 100-yr Detention Volume =	0.805	acre-feet		

Define Zones and Basin Geometry

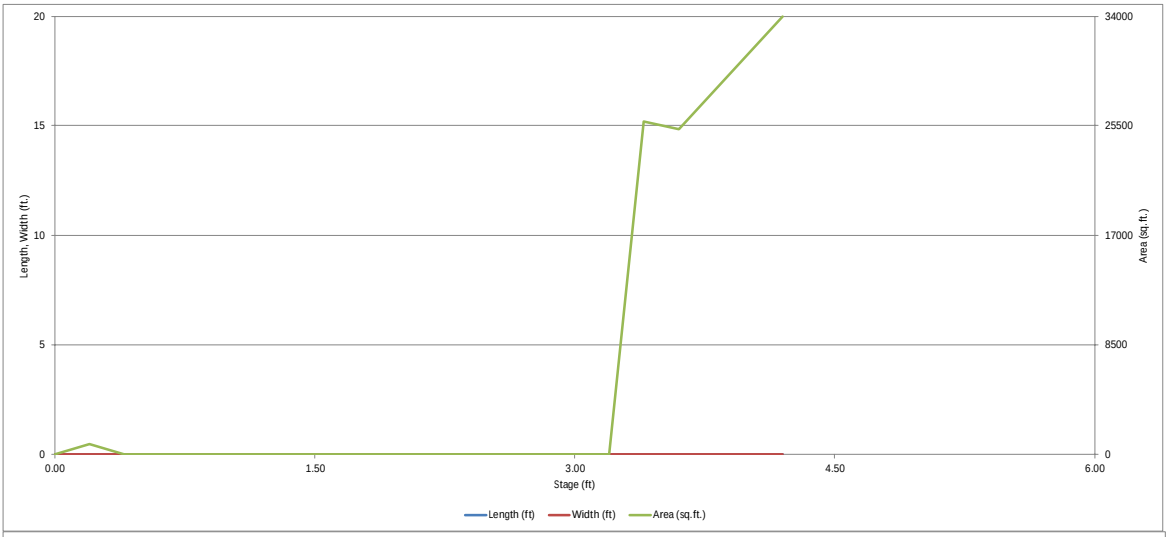
Zone 1 Volume (WQCV) =	0.153	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.358	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.294	acre-feet
Total Detention Basin Volume =	0.805	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

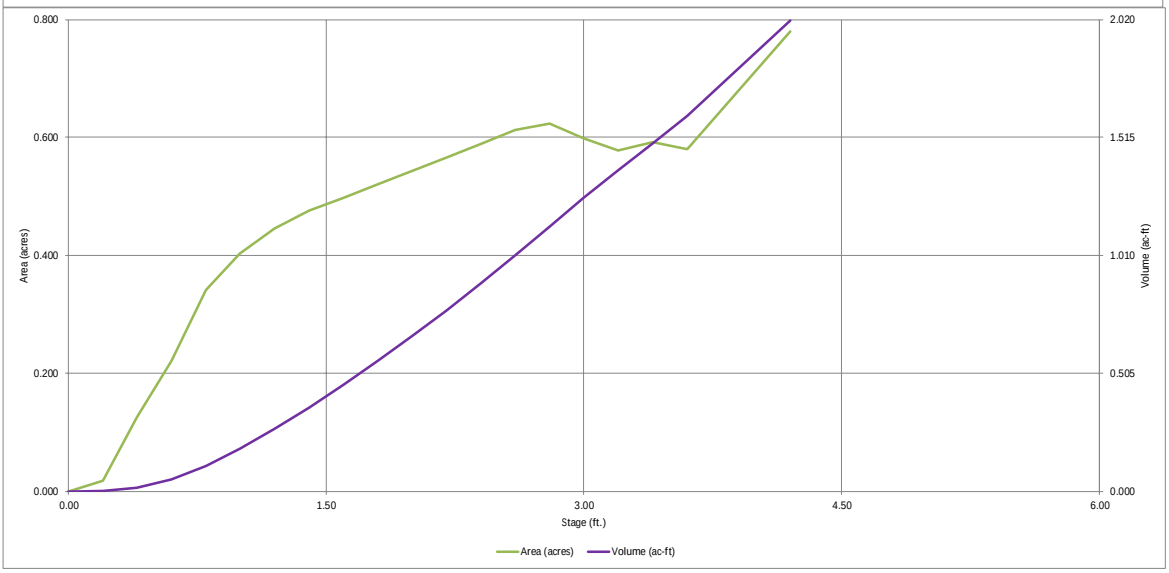
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	4.11	0.000		
5412.2	--	0.20	--	--	--	800	0.018	80	0.002
5412.4	--	0.40	--	--	--	5,461.14	0.125	706	0.016
5412.6	--	0.60	--	--	--	9,593.43	0.220	2,212	0.051
5412.8	--	0.80	--	--	--	14,851.80	0.341	4,656	0.107
5413	--	1.00	--	--	--	17,564.81	0.403	7,898	0.181
5413.2	--	1.20	--	--	--	19,383.88	0.445	11,593	0.266
5413.4	--	1.40	--	--	--	20,721.98	0.476	15,603	0.358
5413.6	--	1.60	--	--	--	21,679.07	0.498	19,843	0.456
5413.8	--	1.80	--	--	--	22,645.34	0.520	24,276	0.557
5414	--	2.00	--	--	--	23,632.57	0.543	28,904	0.664
5414.2	--	2.20	--	--	--	24,640.76	0.566	33,731	0.774
5414.4	--	2.40	--	--	--	25,657.36	0.589	38,761	0.890
5414.6	--	2.60	--	--	--	26,667.88	0.612	43,993	1.010
5414.8	--	2.80	--	--	--	27,152.79	0.623	49,375	1.134
5415	--	3.00	--	--	--	26,050.55	0.598	54,696	1.256
5415.2	--	3.20	--	--	--	25,160.04	0.578	59,817	1.373
5415.4	--	3.40	--	--	--	25,804	0.592	64,913	1.490
5415.6	--	3.60	--	--	--	25,246	0.580	70,018	1.607
5416.2	--	4.20	--	--	--	34,000	0.781	87,792	2.015

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)





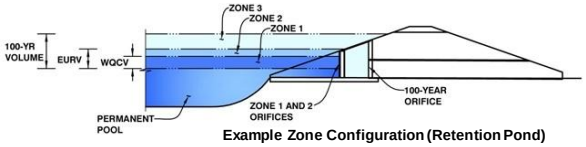
OUTLET STRUCTURE CALCULATIONS PROVIDED FOR REFERENCE ONLY, AND WILL NOT BE REVIEWED WITH THE PDR.

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Project Lowry

Basin ID: Existing North Pond (Pond A) As-Built using 2024 COA Drainage Criteria (Proposed Condition)



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.93	0.153	Orifice Plate
Zone 2 (EURV)	1.71	0.358	Orifice Plate
Zone 3 (100-year)	2.26	0.294	Weir&Pipe (Restrict)
Total (all zones)		0.805	

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	ft^2
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)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	1.007E-02	ft^2
Depth at top of Zone using Orifice Plate =	2.00	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	8.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.45	sq. inches (diameter = 1-3/8 inches)	Elliptical Slot Area =	N/A	ft^2

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	0.70	1.40					
Orifice Area (sq. inches)	1.45	1.45	1.45					

	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	ft^2
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 with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.46	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	1.46	N/A	feet
Overflow Weir Front Edge Length =	3.00	N/A	feet	Overflow Weir Slope Length =	2.75	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	8.63	N/A	
Horiz. Length of Weir Sides =	2.75	N/A	feet	Overflow Grate Open Area w/o Debris =	5.74	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	2.87	N/A	ft^2
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 =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.67	N/A	ft^2
Outlet Pipe Diameter =	15.00	N/A	inches	Outlet Orifice Centroid =	0.38	N/A	feet
Restrictor Plate Height Above Pipe Invert =	8.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.64	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.59	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.36	feet
Spillway Crest Length =	34.50	feet	Stage at Top of Freeboard =	3.95	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.69	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.82	acre-ft

Calculated Parameters for Spillway

Routed Hydrograph Results

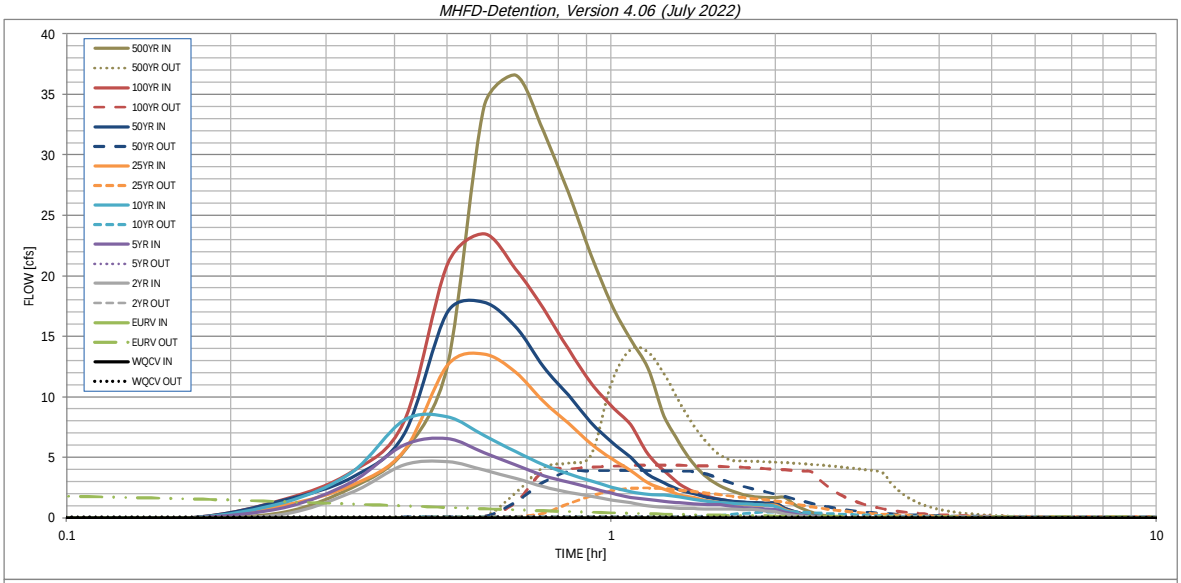
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

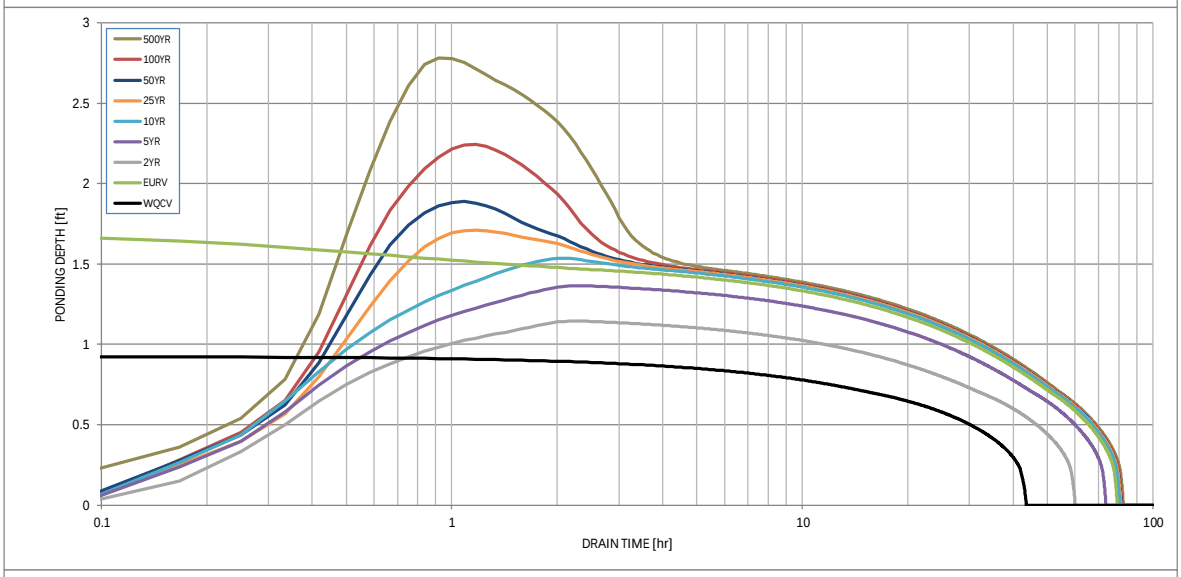
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.86	1.14	1.40	1.79	2.11	2.46	3.38
CUHP Runoff Volume (acre-ft) =	0.153	0.511	0.256	0.358	0.459	0.681	0.875	1.128	1.763
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.256	0.358	0.459	0.681	0.875	1.128	1.763
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.1	0.2	2.8	5.5	8.9	17.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.01	0.02	0.32	0.62	1.01	2.01
Peak Inflow Q (cfs) =	N/A	N/A	4.7	6.5	8.4	13.6	17.8	23.5	36.6
Peak Outflow Q (cfs) =	0.1	2.2	0.1	0.1	0.5	2.5	3.9	4.4	13.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.9	2.9	0.9	0.7	0.5	0.8
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.43	N/A	N/A	0.1	0.4	0.7	0.7	0.8
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) =	41	72	56	68	74	72	70	67	62
Time to Drain 99% of Inflow Volume (hours) =	42	76	58	71	78	77	76	76	74
Maximum Ponding Depth (ft) =	0.93	1.72	1.15	1.37	1.54	1.71	1.89	2.25	2.78
Area at Maximum Ponding Depth (acres) =	0.38	0.51	0.43	0.47	0.49	0.51	0.53	0.57	0.62
Maximum Volume Stored (acre-ft) =	0.154	0.516	0.240	0.339	0.421	0.511	0.605	0.797	1.121

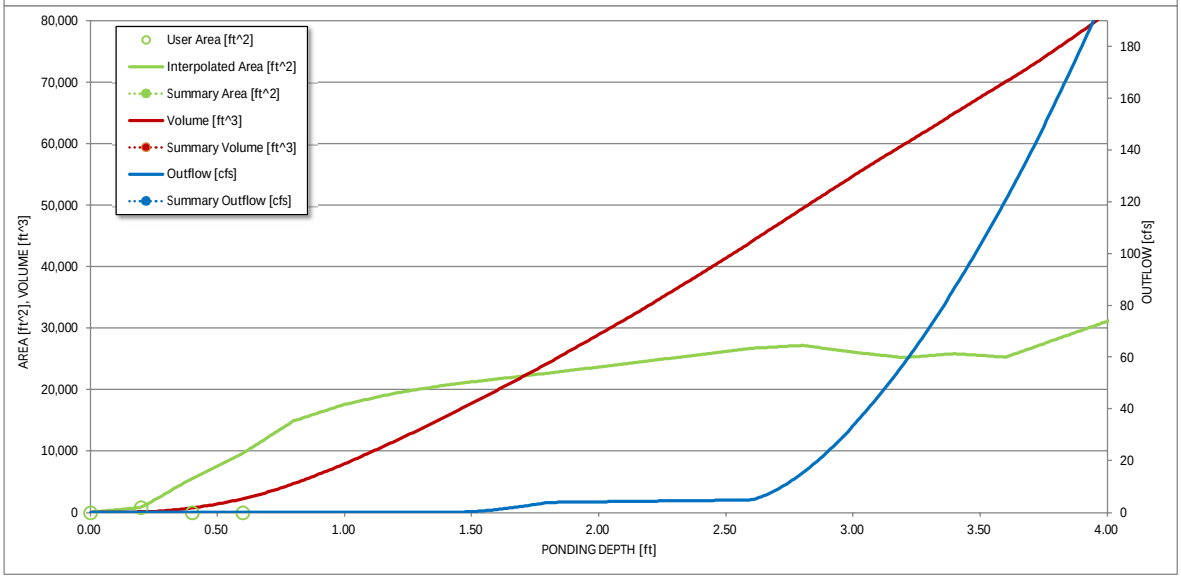
OUTLET STRUCTURE CALCULATIONS PROVIDED FOR REFERENCE ONLY, AND WILL NOT BE REVIEWED WITH THE PDR.

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

OUTLET STRUCTURE CALCULATIONS PROVIDED FOR REFERENCE ONLY, AND WILL NOT BE REVIEWED WITH THE PDR.

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.49
	0:15:00	0.00	0.00	0.32	0.87	1.29	1.04	1.48	1.55	2.51
	0:20:00	0.00	0.00	2.10	2.98	3.77	2.69	3.35	3.80	5.50
	0:25:00	0.00	0.00	4.38	6.03	8.09	5.56	6.94	7.99	12.63
	0:30:00	0.00	0.00	4.67	6.54	8.36	12.65	17.05	21.02	34.01
	0:35:00	0.00	0.00	3.96	5.41	6.81	13.56	17.81	23.51	36.62
	0:40:00	0.00	0.00	3.29	4.38	5.49	12.05	15.79	20.59	31.93
	0:45:00	0.00	0.00	2.57	3.52	4.41	9.63	12.51	17.31	26.85
	0:50:00	0.00	0.00	2.13	2.98	3.65	7.85	10.15	13.95	21.77
	0:55:00	0.00	0.00	1.80	2.49	3.07	6.13	7.91	11.16	17.68
	1:00:00	0.00	0.00	1.50	2.06	2.57	4.90	6.28	9.24	14.78
	1:05:00	0.00	0.00	1.27	1.72	2.16	3.94	5.01	7.71	12.38
	1:10:00	0.00	0.00	1.02	1.53	1.96	2.93	3.62	5.30	8.42
	1:15:00	0.00	0.00	0.89	1.39	1.89	2.37	2.89	3.89	6.19
	1:20:00	0.00	0.00	0.82	1.26	1.73	1.93	2.33	2.83	4.43
	1:25:00	0.00	0.00	0.78	1.18	1.52	1.68	2.02	2.17	3.32
	1:30:00	0.00	0.00	0.75	1.12	1.37	1.44	1.71	1.79	2.66
	1:35:00	0.00	0.00	0.74	1.09	1.28	1.28	1.52	1.54	2.22
	1:40:00	0.00	0.00	0.72	0.96	1.21	1.19	1.40	1.38	1.93
	1:45:00	0.00	0.00	0.72	0.87	1.17	1.12	1.32	1.27	1.76
	1:50:00	0.00	0.00	0.71	0.81	1.13	1.08	1.27	1.24	1.71
	1:55:00	0.00	0.00	0.60	0.77	1.08	1.06	1.25	1.23	1.68
	2:00:00	0.00	0.00	0.52	0.72	0.96	1.05	1.23	1.22	1.68
	2:05:00	0.00	0.00	0.34	0.48	0.64	0.69	0.82	0.81	1.11
	2:10:00	0.00	0.00	0.22	0.31	0.42	0.46	0.53	0.53	0.73
	2:15:00	0.00	0.00	0.14	0.20	0.27	0.29	0.34	0.34	0.46
	2:20:00	0.00	0.00	0.09	0.12	0.17	0.18	0.21	0.21	0.28
	2:25:00	0.00	0.00	0.05	0.07	0.10	0.11	0.13	0.13	0.17
	2:30:00	0.00	0.00	0.02	0.04	0.05	0.06	0.07	0.07	0.09
	2:35:00	0.00	0.00	0.01	0.02	0.02	0.02	0.03	0.02	0.03
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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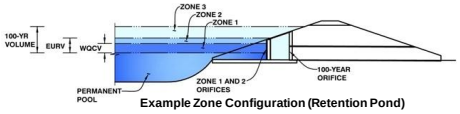
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: Project Lowry

Basin ID: Existing South Pond (Pond B) As-Builts using 2024 COA Drainage Criteria (Proposed Condition)



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	7.90	acres
Watershed Length =	800	ft
Watershed Length to Centroid =	400	ft
Watershed Slope =	0.015	ft/ft
Watershed Imperviousness =	63.28%	percent
Percentage Hydrologic Soil Group A =	77.0%	percent
Percentage Hydrologic Soil Group B =	23.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Aurora - Municipal Center	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.163	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.599	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.86 in.) =	0.308	acre-feet	0.86	inches
5-yr Runoff Volume (P1 = 1.14 in.) =	0.425	acre-feet	1.14	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	0.541	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.79 in.) =	0.761	acre-feet	1.79	inches
50-yr Runoff Volume (P1 = 2.11 in.) =	0.949	acre-feet	2.11	inches
100-yr Runoff Volume (P1 = 2.46 in.) =	1.185	acre-feet	2.46	inches
500-yr Runoff Volume (P1 = 3.38 in.) =	1.779	acre-feet	3.38	inches
Approximate 2-yr Detention Volume =	0.293	acre-feet		
Approximate 5-yr Detention Volume =	0.405	acre-feet		
Approximate 10-yr Detention Volume =	0.522	acre-feet		
Approximate 25-yr Detention Volume =	0.685	acre-feet		
Approximate 50-yr Detention Volume =	0.782	acre-feet		
Approximate 100-yr Detention Volume =	0.892	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.163	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.436	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.293	acre-feet
Total Detention Basin Volume =	0.892	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

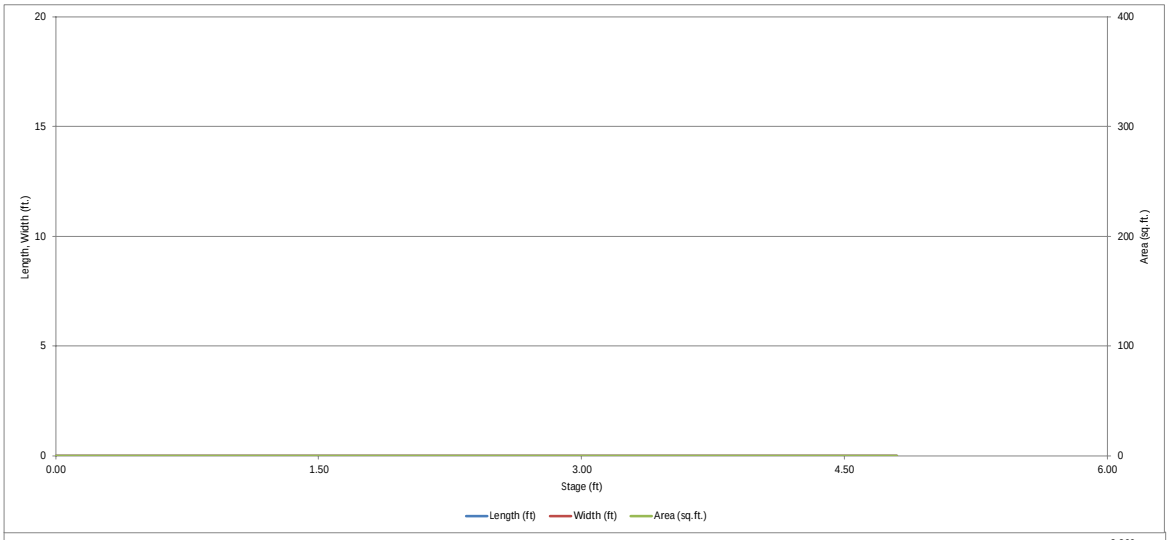
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

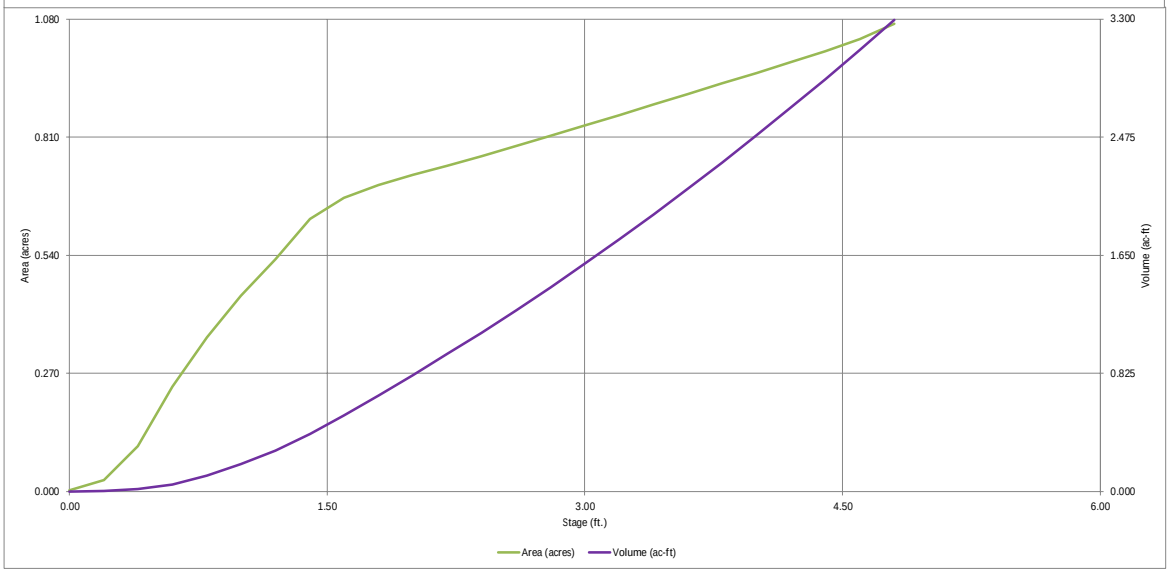
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	149.12	0.003		
5415.60	--	0.20	--	--	--	1,163.43	0.027	131	0.003
5415.80	--	0.40	--	--	--	4,522.67	0.104	700	0.016
5416.00	--	0.60	--	--	--	10,422.34	0.239	2,194	0.050
5416.20	--	0.80	--	--	--	15,330.12	0.352	4,769	0.109
5416.40	--	1.00	--	--	--	19,519.98	0.448	8,254	0.189
5416.60	--	1.20	--	--	--	23,118.82	0.531	12,518	0.287
5416.80	--	1.40	--	--	--	27,123.18	0.623	17,542	0.403
5417.00	--	1.60	--	--	--	29,249.28	0.671	23,180	0.532
5417.20	--	1.80	--	--	--	30,530.66	0.701	29,158	0.669
5417.40	--	2.00	--	--	--	31,512.45	0.723	35,362	0.812
5417.60	--	2.20	--	--	--	32,462.15	0.745	41,759	0.959
5417.80	--	2.40	--	--	--	33,420.32	0.767	48,348	1.110
5418.00	--	2.60	--	--	--	34,391.49	0.790	55,129	1.266
5418.20	--	2.80	--	--	--	35,442.76	0.814	62,112	1.426
5418.40	--	3.00	--	--	--	36,461.20	0.837	69,303	1.591
5418.60	--	3.20	--	--	--	37,495.06	0.861	76,698	1.761
5418.80	--	3.40	--	--	--	38,533.82	0.885	84,301	1.935
5419.00	--	3.60	--	--	--	39,579.07	0.909	92,112	2.115
5419.20	--	3.80	--	--	--	40,632.24	0.933	100,134	2.299
5419.40	--	4.00	--	--	--	41,693.55	0.957	108,366	2.488
5419.60	--	4.20	--	--	--	42,747.46	0.981	116,810	2.682
5419.80	--	4.40	--	--	--	43,852.58	1.007	125,470	2.880
5420.00	--	4.60	--	--	--	45,046.45	1.034	134,360	3.084
5420.20	--	4.80	--	--	--	46,587.93	1.070	143,524	3.295

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)





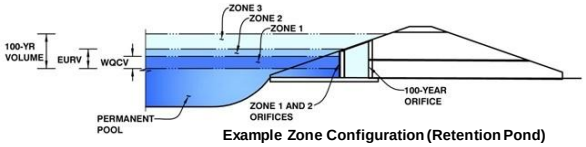
OUTLET STRUCTURE CALCULATIONS PROVIDED FOR REFERENCE ONLY, AND WILL NOT BE REVIEWED WITH THE PDR.

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Project Lowry

Basin ID: Existing South Pond (Pond B) As-Builts using 2024 COA Drainage Criteria (Proposed Condition)



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.94	0.163	Orifice Plate
Zone 2 (EURV)	1.70	0.436	Orifice Plate
Zone 3 (100-year)	2.11	0.293	Weir&Pipe (Restrict)
Total (all zones)		0.892	

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)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	1.118E-02	ft²
Depth at top of Zone using Orifice Plate =	1.59	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	8.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.61	sq. inches (diameter = 1-7/16 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	0.70	1.40					
Orifice Area (sq. inches)	1.61	1.61	1.61					

	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 with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.80	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	1.80	N/A	feet
Overflow Weir Front Edge Length =	3.33	N/A	feet	Overflow Weir Slope Length =	2.75	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	9.58	N/A	
Horiz. Length of Weir Sides =	2.75	N/A	feet	Overflow Grate Open Area w/o Debris =	6.37	N/A	ft²
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	3.19	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 =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.67	N/A	ft²
Outlet Pipe Diameter =	15.00	N/A	inches	Outlet Orifice Centroid =	0.38	N/A	feet
Restrictor Plate Height Above Pipe Invert =	8.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.64	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.59	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.55	feet
Spillway Crest Length =	15.00	feet	Stage at Top of Freeboard =	4.14	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.97	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	2.62	acre-ft

Calculated Parameters for Spillway

Routed Hydrograph Results

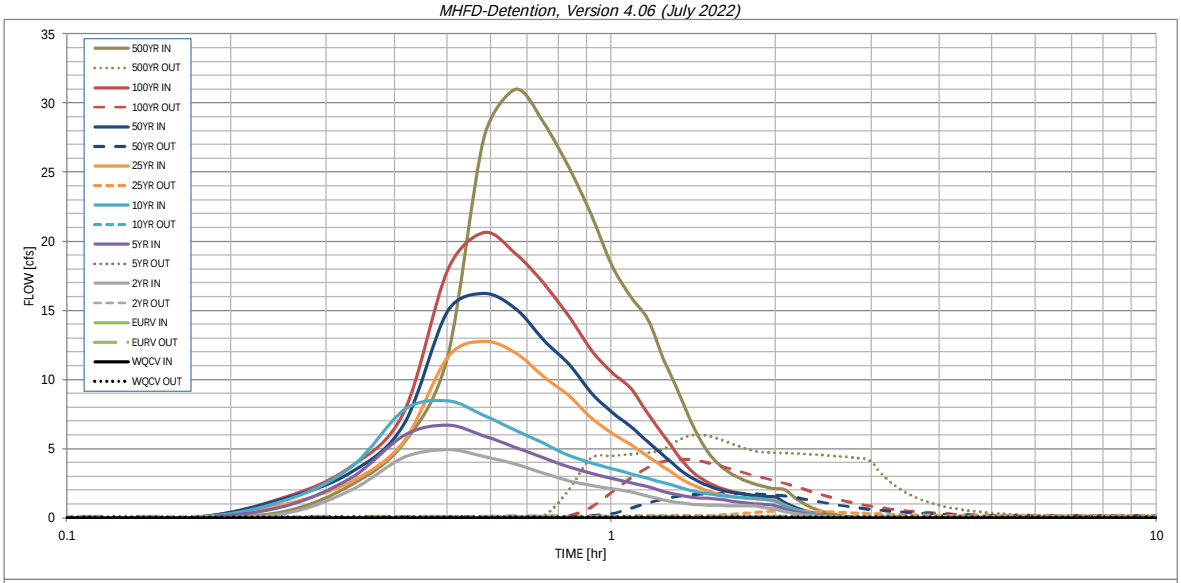
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

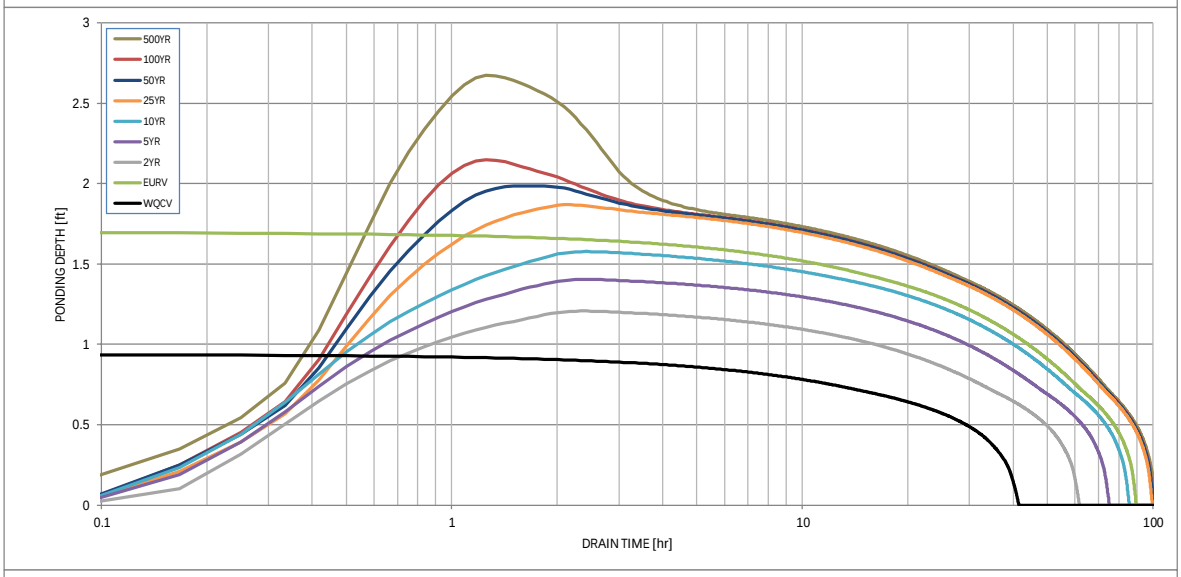
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.86	1.14	1.40	1.79	2.11	2.46	3.38
CUHP Runoff Volume (acre-ft) =	0.163	0.599	0.308	0.425	0.541	0.761	0.949	1.185	1.779
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.308	0.425	0.541	0.761	0.949	1.185	1.779
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.1	0.1	1.8	3.7	5.9	12.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.01	0.01	0.23	0.46	0.75	1.52
Peak Inflow Q (cfs) =	N/A	N/A	4.9	6.7	8.5	12.8	16.2	20.6	31.0
Peak Outflow Q (cfs) =	0.1	0.2	0.1	0.1	0.1	0.5	1.8	4.2	6.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.7	1.3	0.3	0.5	0.7	0.5
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.1	0.3	0.6	0.7
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) =	38	82	57	69	78	90	89	87	82
Time to Drain 99% of Inflow Volume (hours) =	40	86	60	72	82	95	95	95	94
Maximum Ponding Depth (ft) =	0.94	1.70	1.21	1.41	1.58	1.87	1.99	2.15	2.68
Area at Maximum Ponding Depth (acres) =	0.42	0.69	0.53	0.62	0.66	0.71	0.72	0.74	0.80
Maximum Volume Stored (acre-ft) =	0.163	0.600	0.287	0.403	0.512	0.719	0.797	0.922	1.321

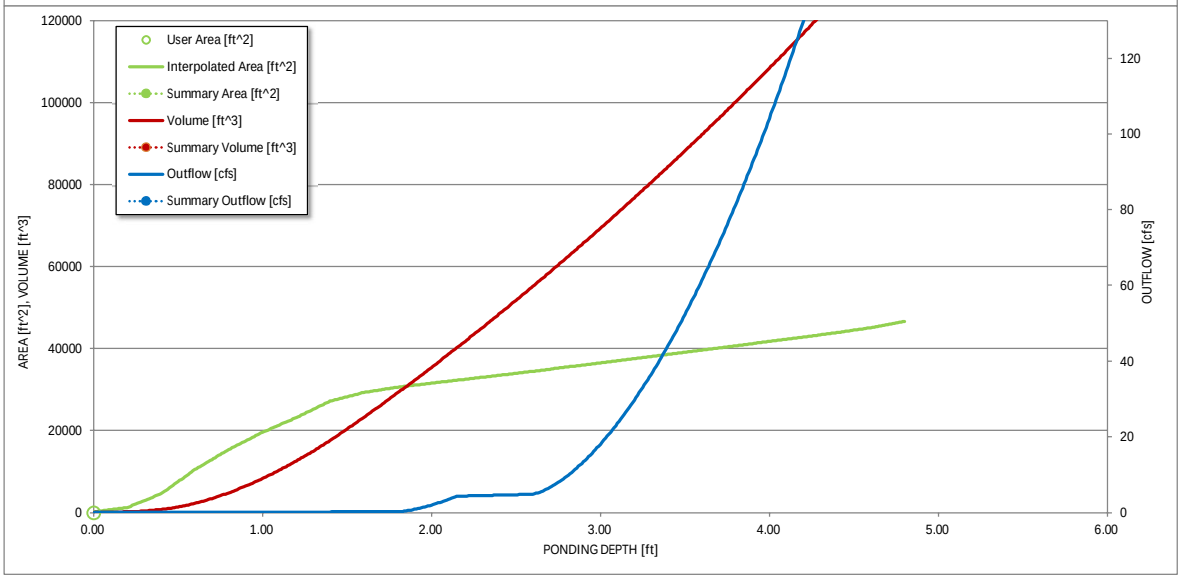
OUTLET STRUCTURE CALCULATIONS PROVIDED FOR REFERENCE ONLY, AND WILL NOT BE REVIEWED WITH THE PDR.

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

OUTLET STRUCTURE CALCULATIONS PROVIDED FOR REFERENCE ONLY, AND WILL NOT BE REVIEWED WITH THE PDR.

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

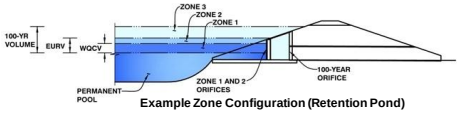
	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.47
	0:15:00	0.00	0.00	0.31	0.84	1.24	0.99	1.40	1.47	2.42
	0:20:00	0.00	0.00	2.04	2.93	3.71	2.65	3.32	3.74	5.45
	0:25:00	0.00	0.00	4.39	5.98	7.80	5.57	6.79	7.71	11.68
	0:30:00	0.00	0.00	4.94	6.72	8.47	11.64	14.97	17.92	27.52
	0:35:00	0.00	0.00	4.45	5.95	7.42	12.80	16.25	20.65	30.99
	0:40:00	0.00	0.00	3.91	5.12	6.35	11.95	15.13	19.12	28.60
	0:45:00	0.00	0.00	3.24	4.34	5.41	10.22	12.88	16.97	25.42
	0:50:00	0.00	0.00	2.71	3.72	4.55	8.88	11.17	14.65	21.98
	0:55:00	0.00	0.00	2.37	3.23	3.99	7.26	9.07	12.18	18.35
	1:00:00	0.00	0.00	2.12	2.88	3.59	6.15	7.68	10.57	16.03
	1:05:00	0.00	0.00	1.90	2.56	3.21	5.33	6.64	9.42	14.35
	1:10:00	0.00	0.00	1.57	2.26	2.85	4.45	5.50	7.53	11.41
	1:15:00	0.00	0.00	1.29	1.92	2.55	3.68	4.50	5.94	8.94
	1:20:00	0.00	0.00	1.10	1.65	2.22	2.91	3.52	4.38	6.53
	1:25:00	0.00	0.00	1.00	1.50	1.94	2.36	2.83	3.26	4.82
	1:30:00	0.00	0.00	0.95	1.42	1.75	1.96	2.34	2.59	3.79
	1:35:00	0.00	0.00	0.92	1.36	1.63	1.72	2.04	2.19	3.17
	1:40:00	0.00	0.00	0.90	1.22	1.53	1.56	1.84	1.92	2.74
	1:45:00	0.00	0.00	0.88	1.11	1.47	1.45	1.71	1.74	2.45
	1:50:00	0.00	0.00	0.87	1.04	1.42	1.38	1.62	1.62	2.25
	1:55:00	0.00	0.00	0.75	0.98	1.35	1.33	1.56	1.54	2.12
	2:00:00	0.00	0.00	0.66	0.91	1.22	1.29	1.52	1.49	2.05
	2:05:00	0.00	0.00	0.48	0.66	0.89	0.94	1.11	1.09	1.49
	2:10:00	0.00	0.00	0.35	0.47	0.63	0.67	0.79	0.78	1.07
	2:15:00	0.00	0.00	0.24	0.33	0.45	0.48	0.56	0.56	0.76
	2:20:00	0.00	0.00	0.17	0.23	0.31	0.33	0.39	0.39	0.53
	2:25:00	0.00	0.00	0.12	0.15	0.21	0.23	0.27	0.26	0.36
	2:30:00	0.00	0.00	0.08	0.10	0.14	0.16	0.18	0.18	0.25
	2:35:00	0.00	0.00	0.05	0.07	0.09	0.10	0.12	0.12	0.16
	2:40:00	0.00	0.00	0.02	0.04	0.05	0.06	0.07	0.07	0.09
	2:45:00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.04
	2:50:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: Project Lowry

Basin ID: Pond C - North Expansion



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	13.16	acres
Watershed Length =	1,490	ft
Watershed Length to Centroid =	745	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	75.00%	percent
Percentage Hydrologic Soil Group A =	47.8%	percent
Percentage Hydrologic Soil Group B =	52.2%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Aurora - Municipal Center	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.328	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	1.178	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.86 in.) =	0.644	acre-feet	0.86	inches
5-yr Runoff Volume (P1 = 1.14 in.) =	0.896	acre-feet	1.14	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	1.133	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.79 in.) =	1.582	acre-feet	1.79	inches
50-yr Runoff Volume (P1 = 2.11 in.) =	1.932	acre-feet	2.11	inches
100-yr Runoff Volume (P1 = 2.46 in.) =	2.356	acre-feet	2.46	inches
500-yr Runoff Volume (P1 = 3.38 in.) =	3.403	acre-feet	3.38	inches
Approximate 2-yr Detention Volume =	0.612	acre-feet		
Approximate 5-yr Detention Volume =	0.846	acre-feet		
Approximate 10-yr Detention Volume =	1.092	acre-feet		
Approximate 25-yr Detention Volume =	1.377	acre-feet		
Approximate 50-yr Detention Volume =	1.538	acre-feet		
Approximate 100-yr Detention Volume =	1.718	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.328	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.850	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.539	acre-feet
Total Detention Basin Volume =	1.718	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

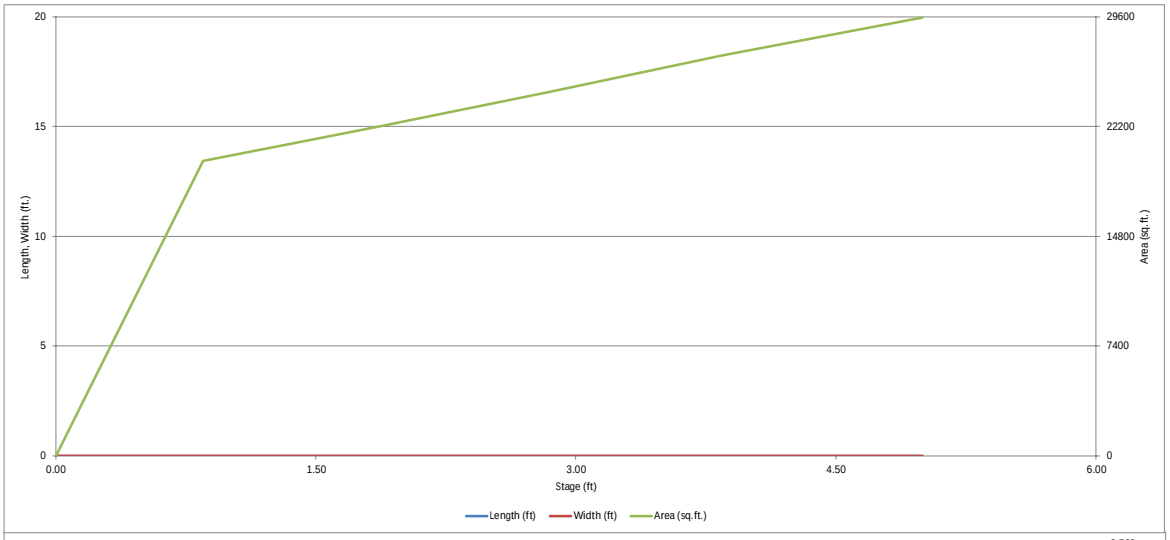
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

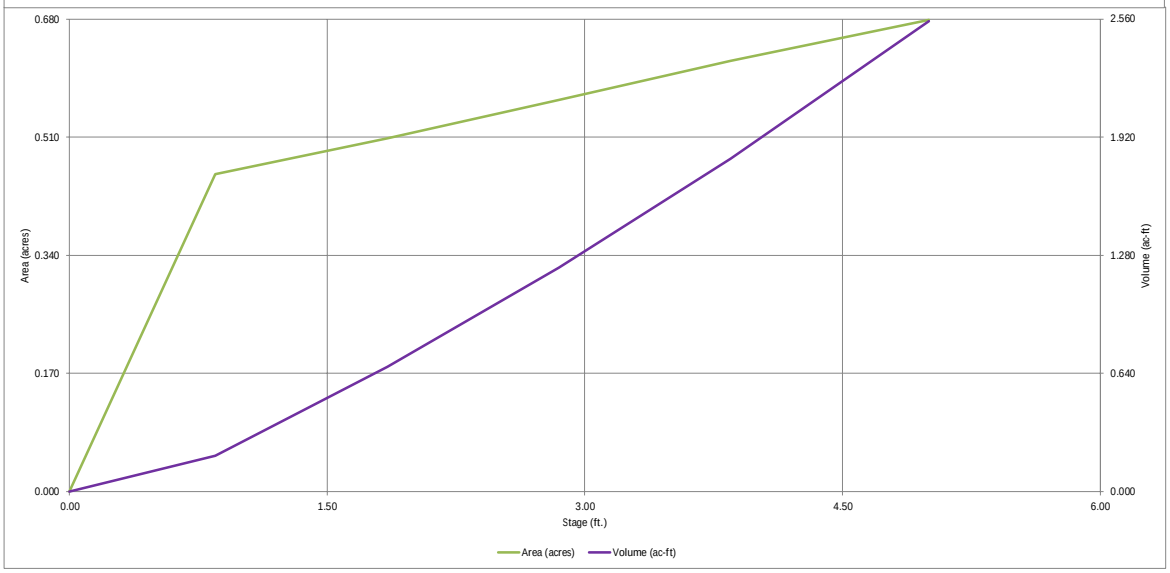
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	0	0.000		
5419	--	0.85	--	--	--	19,895	0.457	8,455	0.194
5420	--	1.85	--	--	--	22,165	0.509	29,485	0.677
5421	--	2.85	--	--	--	24,535	0.563	52,835	1.213
5422	--	3.85	--	--	--	27,005	0.620	78,605	1.805
5423.15	--	5.00	--	--	--	29,575	0.679	111,138	2.551

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)





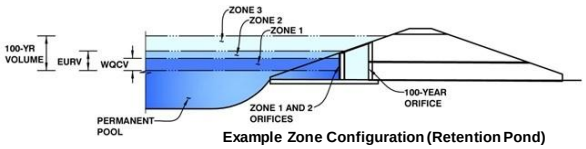
OUTLET STRUCTURE CALCULATIONS PROVIDED FOR REFERENCE ONLY, AND WILL NOT BE REVIEWED WITH THE PDR.

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Project Lowry

Basin ID: Pond C - North Expansion



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.14	0.328	Orifice Plate
Zone 2 (EURV)	2.79	0.850	Orifice Plate
Zone 3 (100-year)	3.71	0.539	Weir&Pipe (Restrict)
Total (all zones)		1.718	

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)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	2.396E-02	ft²
Depth at top of Zone using Orifice Plate =	3.00	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	11.20	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	3.45	sq. inches (use rectangular openings)	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	1.00	2.00					
Orifice Area (sq. inches)	3.45	3.45	3.45					

	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 with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.00	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.66	N/A	feet
Overflow Weir Front Edge Length =	3.43	N/A	feet	Overflow Weir Slope Length =	2.70	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	3.65	N/A	
Horiz. Length of Weir Sides =	2.62	N/A	feet	Overflow Grate Open Area w/o Debris =	6.45	N/A	ft²
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	3.22	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 =	1.00	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.77	N/A	ft²
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.75	N/A	feet
Restrictor Plate Height Above Pipe Invert =	18.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.02	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.27	feet
Spillway Crest Length =	80.00	feet	Stage at Top of Freeboard =	5.29	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.68	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	2.55	acre-ft

Calculated Parameters for Spillway

Routed Hydrograph Results

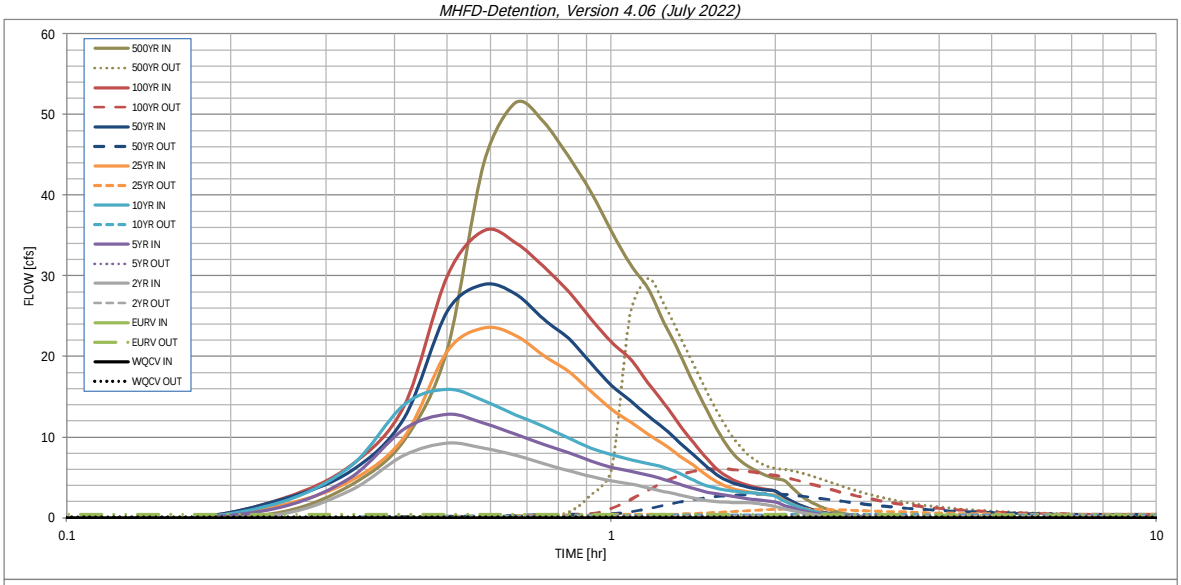
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

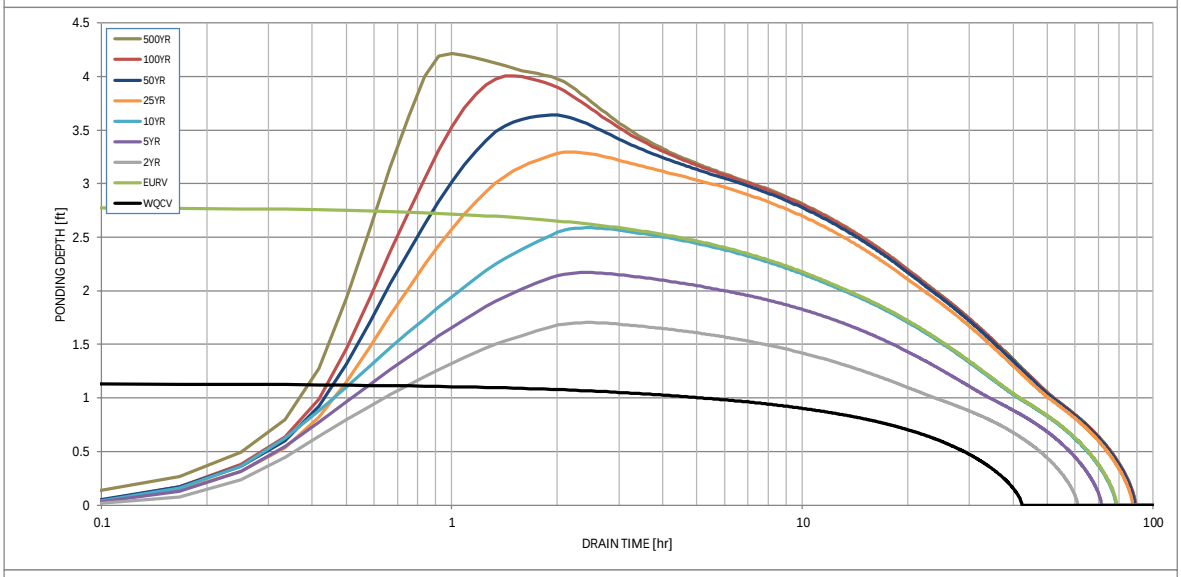
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.86	1.14	1.40	1.79	2.11	2.46	3.38
CUHP Runoff Volume (acre-ft) =	0.328	1.178	0.644	0.896	1.133	1.582	1.932	2.356	3.403
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.644	0.896	1.133	1.582	1.932	2.356	3.403
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.1	0.2	4.1	6.7	10.4	18.5
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.01	0.01	0.31	0.51	0.79	1.40
Peak Inflow Q (cfs) =	N/A	N/A	9.3	12.8	15.9	23.5	28.9	35.6	51.5
Peak Outflow Q (cfs) =	0.2	0.4	0.2	0.3	0.4	1.1	3.0	6.1	29.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.9	2.3	0.3	0.4	0.6	1.6
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.1	0.4	0.9	1.2
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	71	56	65	71	77	77	75	71
Time to Drain 99% of Inflow Volume (hours) =	41	75	59	68	75	83	84	83	81
Maximum Ponding Depth (ft) =	1.14	2.79	1.71	2.17	2.59	3.30	3.64	4.01	4.22
Area at Maximum Ponding Depth (acres) =	0.47	0.56	0.50	0.53	0.55	0.59	0.61	0.63	0.64
Maximum Volume Stored (acre-ft) =	0.329	1.179	0.601	0.842	1.068	1.466	1.676	1.904	2.031

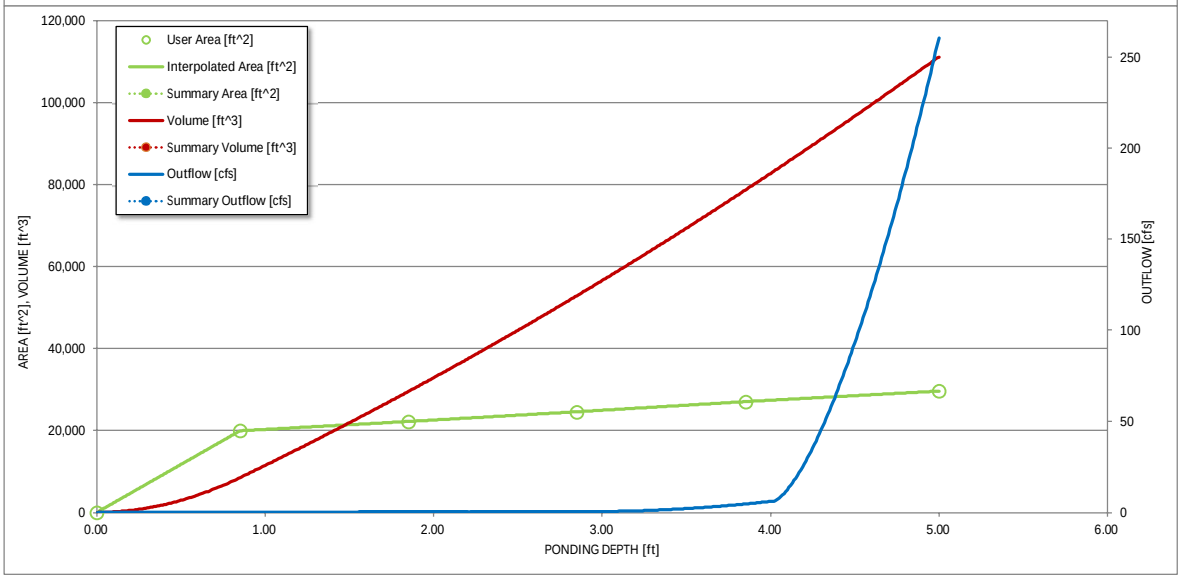
OUTLET STRUCTURE CALCULATIONS PROVIDED FOR REFERENCE ONLY, AND WILL NOT BE REVIEWED WITH THE PDR.

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







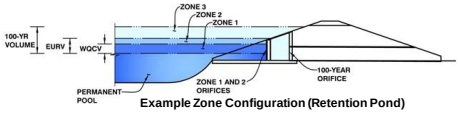
S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: Project Lowry

Basin ID: Pond D - South Expansion (Disturbed Areas Only)



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	12.24	acres
Watershed Length =	850	ft
Watershed Length to Centroid =	425	ft
Watershed Slope =	0.030	ft/ft
Watershed Imperviousness =	76.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Aurora - Municipal Center	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.311	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	1.028	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.86 in.) =	0.595	acre-feet	0.86	inches
5-yr Runoff Volume (P1 = 1.14 in.) =	0.829	acre-feet	1.14	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	1.073	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.79 in.) =	1.486	acre-feet	1.79	inches
50-yr Runoff Volume (P1 = 2.11 in.) =	1.808	acre-feet	2.11	inches
100-yr Runoff Volume (P1 = 2.46 in.) =	2.184	acre-feet	2.46	inches
500-yr Runoff Volume (P1 = 3.38 in.) =	3.134	acre-feet	3.38	inches
Approximate 2-yr Detention Volume =	0.586	acre-feet		
Approximate 5-yr Detention Volume =	0.815	acre-feet		
Approximate 10-yr Detention Volume =	1.072	acre-feet		
Approximate 25-yr Detention Volume =	1.286	acre-feet		
Approximate 50-yr Detention Volume =	1.400	acre-feet		
Approximate 100-yr Detention Volume =	1.546	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.311	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.717	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.517	acre-feet
Total Detention Basin Volume =	1.546	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

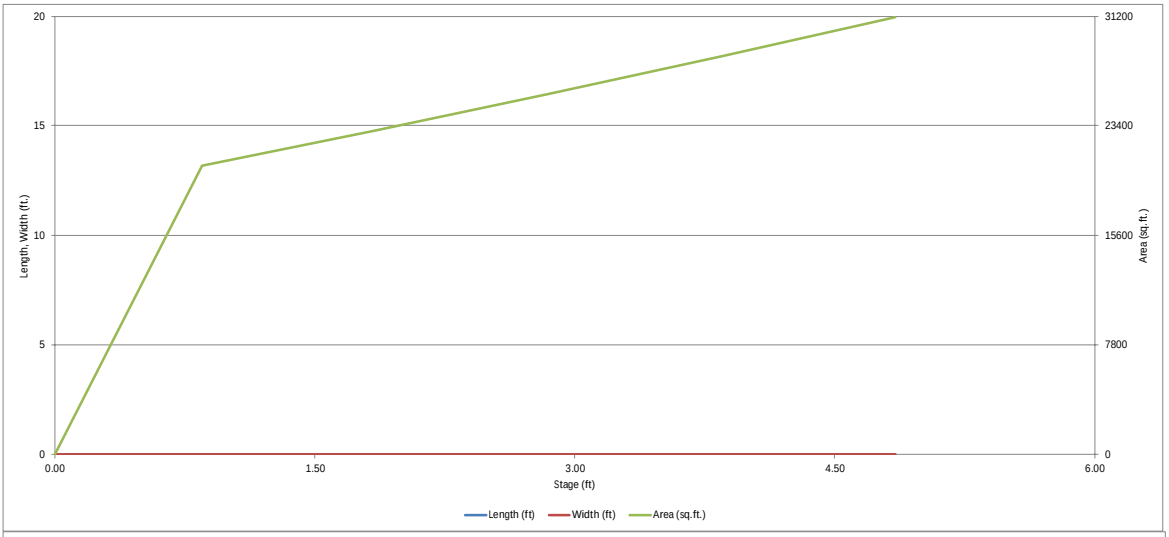
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

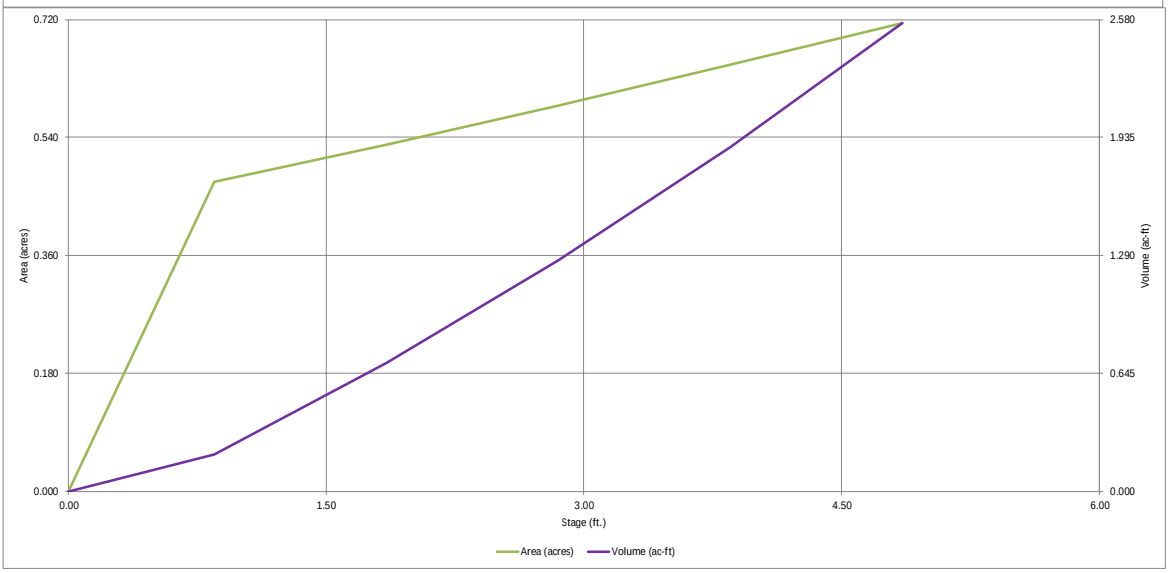
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	0	0.000		
5417	--	0.85	--	--	--	20,547	0.472	8,732	0.200
5418	--	1.85	--	--	--	23,045	0.529	30,528	0.701
5419	--	2.85	--	--	--	25,647	0.589	54,874	1.260
5420	--	3.85	--	--	--	28,350	0.651	81,872	1.880
5421	--	4.85	--	--	--	31,154	0.715	111,624	2.563

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)





Kimley»Horn

Project: Project Lowry
Date: 4/19/2024

Emergency Overflow Weir Calculation - Pond C

Q (cfs) =	35.6	(100-yr Peak Inflow from Rational Calculation)
C_{BCW} =	3	
Z =	4	
H =	0.282	
L (ft) =	78.34	(80-ft is proposed)

*orange cells require input

$$Q = C_{BCW} L H^{1.5} + 2\left[\left(2/5\right) C_{BCW} Z H^{2.5}\right]$$

rearrange to solve for length:

$$L = \frac{Q - \left(4/5\right) C_{BCW} Z H^{2.5}}{C_{BCW} H^{1.5}}$$

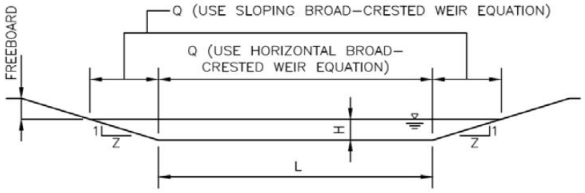


Figure 12-20. Sloping broad-crest weir

Horizontal Broad Crested Weir Equation (from USDCM Eqn. 12-8)

$$Q = C_{BCW} L H^{1.5}$$ Equation 12-8

Where:

Q = discharge (cfs)

C_{BCW} = broad-crested weir coefficient (This ranges from 2.6 to 3.0. A value of 3.0 is often used in practice.) See Hydraulic Engineering Circular No. 22 for additional information.

L = broad-crested weir length (ft)

H = head above weir crest (ft)

Sloping Broad Crested Weir Equation (from USDCM Eqn. 12-9)

$$Q = \left(\frac{2}{5}\right) C_{BCW} Z H^{2.5}$$ Equation 12-9

Where:

Q = discharge (cfs)

C_{BCW} = broad-crested weir coefficient (This ranges from 2.6 to 3.0. A value of 3.0 is often used in practice.) See Hydraulic Engineering Circular No. 22 for additional information.

Z = side slope (horizontal: vertical)

H = head above weir crest (ft)

Note that in order to calculate the total flow over the weir depicted in Figure 12-20, the results from Equation 12-8 must be added to two times the results from Equation 12-9.

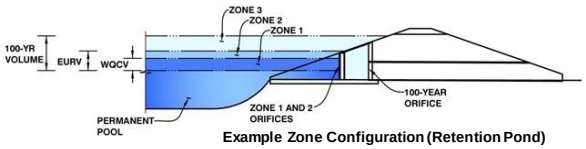
OUTLET STRUCTURE CALCULATIONS PROVIDED FOR REFERENCE ONLY, AND WILL NOT BE REVIEWED WITH THE PDR.

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Project Lowry

Basin ID: Pond D - South Expansion (Disturbed Areas Only)



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.09	0.311	Orifice Plate
Zone 2 (EURV)	2.45	0.717	Orifice Plate
Zone 3 (100-year)	3.33	0.517	Weir&Pipe (Restrict)
Total (all zones)		1.546	

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)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	2.354E-02	ft²
Depth at top of Zone using Orifice Plate =	2.75	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	9.80	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	3.39	sq. inches (use rectangular openings)	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	0.92	1.83					
Orifice Area (sq. inches)	3.39	3.39	3.39					

	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 with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.75	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.41	N/A	feet
Overflow Weir Front Edge Length =	3.44	N/A	feet	Overflow Weir Slope Length =	2.71	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	12.59	N/A	
Horiz. Length of Weir Sides =	2.63	N/A	feet	Overflow Grate Open Area w/o Debris =	6.49	N/A	ft²
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	3.25	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 =	1.00	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.52	N/A	ft²
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.29	N/A	feet
Restrictor Plate Height Above Pipe Invert =	6.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.23	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=		ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=		feet
Spillway Crest Length =		feet	Stage at Top of Freeboard =		feet
Spillway End Slopes =		H:V	Basin Area at Top of Freeboard =		acres
Freeboard above Max Water Surface =		feet	Basin Volume at Top of Freeboard =		acre-ft

Calculated Parameters for Spillway

Routed Hydrograph Results

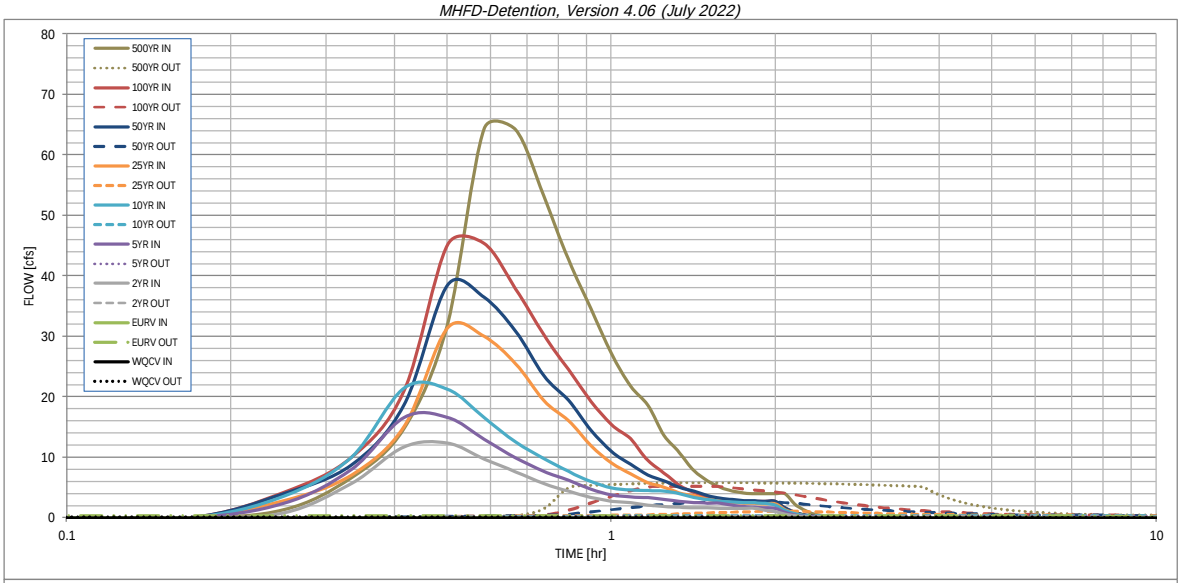
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

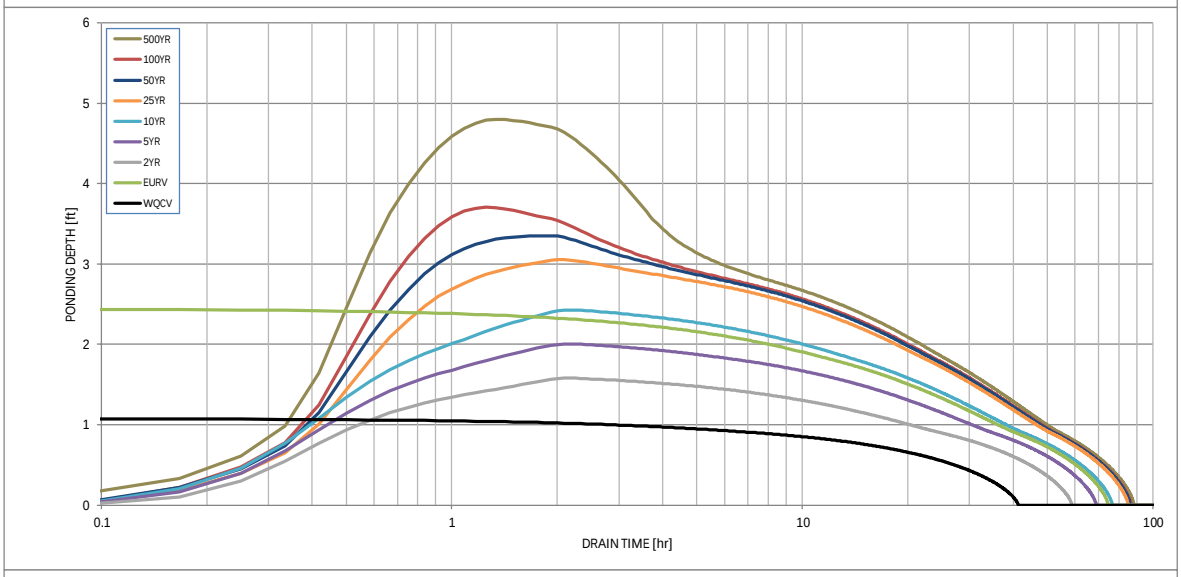
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.86	1.14	1.40	1.79	2.11	2.46	3.38
CUHP Runoff Volume (acre-ft) =	0.311	1.028	0.595	0.829	1.073	1.486	1.808	2.184	3.134
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.595	0.829	1.073	1.486	1.808	2.184	3.134
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.6	3.2	9.9	13.9	18.9	30.4
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.05	0.26	0.81	1.14	1.55	2.49
Peak Inflow Q (cfs) =	N/A	N/A	12.3	16.6	21.5	31.4	38.5	45.4	64.4
Peak Outflow Q (cfs) =	0.2	0.4	0.2	0.3	0.4	1.1	2.7	5.2	5.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.1	0.1	0.2	0.3	0.2
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.1	0.3	0.7	0.8
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) =	38	67	54	62	69	75	75	73	71
Time to Drain 99% of Inflow Volume (hours) =	40	71	57	66	73	81	81	81	81
Maximum Ponding Depth (ft) =	1.09	2.45	1.58	2.01	2.43	3.06	3.35	3.71	4.80
Area at Maximum Ponding Depth (acres) =	0.49	0.56	0.51	0.54	0.56	0.60	0.62	0.64	0.71
Maximum Volume Stored (acre-ft) =	0.315	1.029	0.560	0.781	1.018	1.379	1.562	1.783	2.527

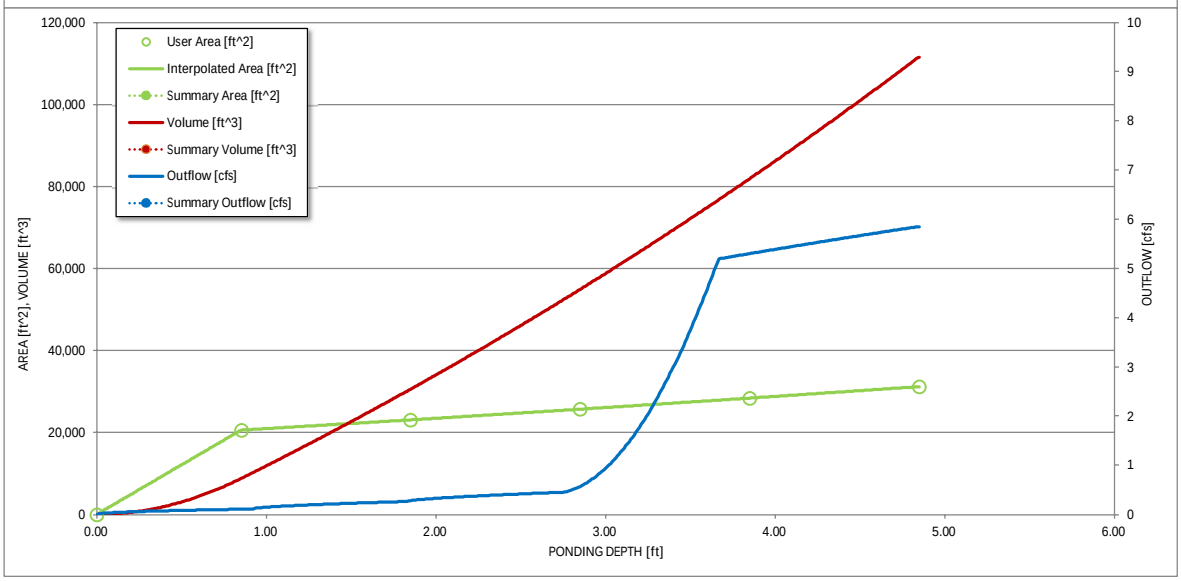
OUTLET STRUCTURE CALCULATIONS PROVIDED FOR REFERENCE ONLY, AND WILL NOT BE REVIEWED WITH THE PDR.

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

OUTLET STRUCTURE CALCULATIONS PROVIDED FOR REFERENCE ONLY, AND WILL NOT BE REVIEWED WITH THE PDR.

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	1.33
	0:15:00	0.00	0.00	0.89	2.41	3.56	2.85	4.01	4.22	6.69
	0:20:00	0.00	0.00	5.70	8.03	10.08	7.13	8.81	10.00	14.80
	0:25:00	0.00	0.00	11.77	16.63	21.49	15.15	18.69	21.01	32.10
	0:30:00	0.00	0.00	12.35	16.63	21.31	31.40	38.55	45.13	64.38
	0:35:00	0.00	0.00	9.77	13.02	16.59	30.02	36.48	45.41	64.17
	0:40:00	0.00	0.00	7.66	9.93	12.56	25.53	30.90	37.92	53.36
	0:45:00	0.00	0.00	5.71	7.73	9.89	19.48	23.54	30.35	42.72
	0:50:00	0.00	0.00	4.41	6.23	7.68	16.11	19.48	24.53	34.58
	0:55:00	0.00	0.00	3.39	4.75	6.00	11.97	14.51	19.30	27.22
	1:00:00	0.00	0.00	2.78	3.85	4.98	9.09	11.04	15.45	21.84
	1:05:00	0.00	0.00	2.53	3.49	4.62	7.29	8.89	13.08	18.60
	1:10:00	0.00	0.00	2.12	3.36	4.50	5.84	7.11	9.47	13.61
	1:15:00	0.00	0.00	1.90	3.07	4.46	5.07	6.15	7.45	10.84
	1:20:00	0.00	0.00	1.77	2.77	4.01	4.16	5.04	5.38	7.82
	1:25:00	0.00	0.00	1.70	2.58	3.40	3.66	4.44	4.25	6.15
	1:30:00	0.00	0.00	1.66	2.48	3.01	3.09	3.71	3.51	5.08
	1:35:00	0.00	0.00	1.63	2.42	2.78	2.75	3.28	3.09	4.46
	1:40:00	0.00	0.00	1.61	2.08	2.64	2.55	3.02	2.87	4.14
	1:45:00	0.00	0.00	1.61	1.87	2.55	2.44	2.89	2.79	4.02
	1:50:00	0.00	0.00	1.61	1.75	2.51	2.38	2.81	2.77	3.98
	1:55:00	0.00	0.00	1.29	1.69	2.39	2.36	2.78	2.77	3.98
	2:00:00	0.00	0.00	1.09	1.56	2.11	2.35	2.77	2.77	3.98
	2:05:00	0.00	0.00	0.65	0.92	1.26	1.40	1.65	1.65	2.37
	2:10:00	0.00	0.00	0.38	0.54	0.74	0.83	0.98	0.97	1.40
	2:15:00	0.00	0.00	0.20	0.30	0.41	0.46	0.54	0.54	0.77
	2:20:00	0.00	0.00	0.10	0.16	0.22	0.26	0.30	0.30	0.43
	2:25:00	0.00	0.00	0.04	0.07	0.09	0.12	0.14	0.14	0.19
	2:30:00	0.00	0.00	0.01	0.02	0.02	0.03	0.04	0.03	0.05
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Kimley»Horn

Project: Project Lowry
Date: 4/18/2024

Emergency Overflow Weir Calculation - Pond D

Q (cfs) =	45.4	(100-yr Peak Inflow from Rational Calculation)
C_{BCW} =	3	
Z =	4	
H =	0.282	
L (ft) =	100.15	

*orange cells require input

$$Q = C_{BCW} L H^{1.5} + 2\left[\left(2/5\right) C_{BCW} Z H^{2.5}\right]$$

rearrange to solve for length:

$$L = \frac{Q - \left(4/5\right) C_{BCW} Z H^{2.5}}{C_{BCW} H^{1.5}}$$

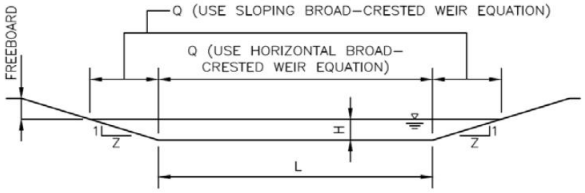


Figure 12-20. Sloping broad-crest weir

Horizontal Broad Crested Weir Equation (from USDCM Eqn. 12-8)

$$Q = C_{BCW} L H^{1.5}$$ Equation 12-8

Where:

Q = discharge (cfs)

C_{BCW} = broad-crested weir coefficient (This ranges from 2.6 to 3.0. A value of 3.0 is often used in practice.) See Hydraulic Engineering Circular No. 22 for additional information.

L = broad-crested weir length (ft)

H = head above weir crest (ft)

Sloping Broad Crested Weir Equation (from USDCM Eqn. 12-9)

$$Q = \left(\frac{2}{5}\right) C_{BCW} Z H^{2.5}$$ Equation 12-9

Where:

Q = discharge (cfs)

C_{BCW} = broad-crested weir coefficient (This ranges from 2.6 to 3.0. A value of 3.0 is often used in practice.) See Hydraulic Engineering Circular No. 22 for additional information.

Z = side slope (horizontal: vertical)

H = head above weir crest (ft)

Note that in order to calculate the total flow over the weir depicted in Figure 12-20, the results from Equation 12-8 must be added to two times the results from Equation 12-9.

Worksheet for Swale N - 100 YR

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data		
Roughness Coefficient	0.020	
Channel Slope	0.010	ft/ft
Left Side Slope	4.000	H:V
Right Side Slope	4.000	H:V
Discharge	2.50	cfs

Results		
Normal Depth	5.7	in
Flow Area	0.9	ft²
Wetted Perimeter	3.9	ft
Hydraulic Radius	2.8	in
Top Width	3.79	ft
Critical Depth	5.7	in
Critical Slope	0.010	ft/ft
Velocity	2.79	ft/s
Velocity Head	0.12	ft
Specific Energy	0.59	ft
Froude Number	1.010	
Flow Type	Supercritical	

GVF Input Data		
Downstream Depth	0.0	in
Length	0.0	ft
Number Of Steps	0	

GVF Output Data		
Upstream Depth	0.0	in
Profile Description	N/A	
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	5.7	in
Critical Depth	5.7	in
Channel Slope	0.010	ft/ft
Critical Slope	0.010	ft/ft

Appendix D

Inlet Calculations (to be included with FDR)

Appendix E

Grocer's of Colorado Filing No. 2 FDR Excerpts

218104FD1
1982-3078
04L, 04M

Lot 1, Block 1 Associated Grocers of Colorado Subdivision Filing No. 2

FINAL DRAINAGE REPORT

Project:
Kroger Aurora Expansion
Aurora, Colorado

Client:
The Kroger Company
1983 Tower Road
Aurora, Colorado 80011
Mark Smekrud
(720) 244-5976

Prepared By:
Kimley-Horn and Associates, Inc.
4582 South Ulster Street, Suite 1500
Denver, CO 80237
Randall Phelps, P.E.
(303) 228-2300

Prepared: April 19, 2018
Revised: May 21, 2018
Revised: June 28, 2018

APPROVED FOR ONE YEAR FROM THIS DATE 7/12/2018	
CDP [signature]	07/10/2018
City Engineer	Date
[signature]	07/12/2018
Water Department	Date

Kimley»Horn

ENGINEER'S CERTIFICATION

This report and plan for the drainage design of Kroger Aurora Expansion was prepared by me (or under my direct supervision) in accordance with the provisions of City of Aurora Storm Drainage Design and Technical Criteria, and was designed to comply with the provisions thereof.

Randall J. Phelps, P.E.
Registered Professional Engineer
State of Colorado No. 35204

TABLE OF CONTENTS

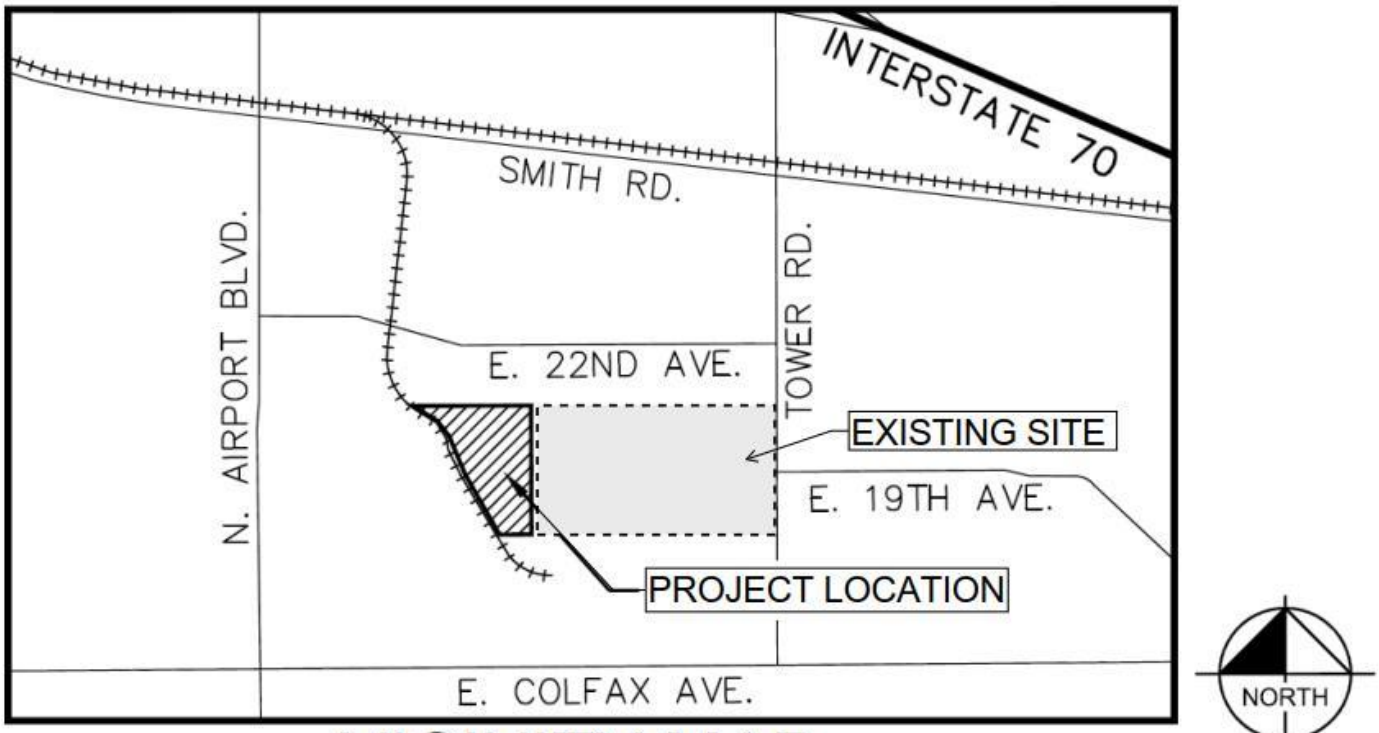
INTRODUCTION

Location

The site is located on Tower Road just north of East Colfax Avenue, situated in the South 1/2 of Section 33, Township 3 South, Range 66 West of the 6th Principal Meridian, City of Aurora, County of Adams, State of Colorado. More specifically, the site is located on Lot 1, Block 1 Associated Grocers of Colorado subdivision Filing No.2. The proposed expansion is located on the west side of the existing Kroger Distribution Center, bounded by businesses to the north, an industrial distribution center to the south, and the Woodshire East residential community to the west. The 16.6 +/- acre project site is currently undeveloped and consists of primarily sparse native grass, weeds, and brush cover.

Vicinity Map

A vicinity map is provided below for reference:



VICINITY MAP
NTS

Proposed Development

The proposed development (the project) is located west of the current Kroger Distribution Center on currently undeveloped land. The project is proposed to add 174,152 SF to the west end of the existing building. The development of this project results in an overall imperviousness of 38% for the site.

The project site is currently undeveloped and generally sheet flows with slopes between 0% and 3% west towards Sand Creek. Generally, runoff from the existing site splits and flows either north or south toward the existing concrete channels along the north and south property lines.

A NRCS soil study for the project area was obtained to determine the soil characteristics of the site. The results of this study show that 77% of the site is soil type A and 23% of the site is soil type B. The NRCS study is found in the appendix of this report. This site does not contain any types C or D soils.

No drainage variances are being requested at this time.

HISTORIC DRAINAGE

Overall Sub-Basin Description

The Site is not part of any Master Drainage Report.

The site is located within FEMA Flood Insurance Rate Map (FIRM) Number 08005C0181K, dated December 17, 2010. The northwest corner of the project site is located in Zone 'X' which is the 500-year floodplain. These maps are located in Appendix A. The project site is not located within the 100-year mapped floodplain.

Off-site Basins

The expansion project site does not accept flows from off-site basins. The existing development to the east drains north and south to the existing concrete channels. The area east of the project site drains directly to Sand Creek.

Outfalls Downstream from Property

Site drainage currently sheet flows to the west side of the property and ultimately to Sand Creek. Existing runoff on the north half of the site sheet flows to the north and is captured by the existing concrete channel along the north property line. Existing runoff on the south half of the site sheet flows south to the existing concrete channel along the southern property line. Both the existing concrete channels discharge to Sand Creek.

DESIGN CRITERIA

The "City of Aurora Storm Drainage Design and Technical Criteria," revised October 2010 (The "Criteria") and the "Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual" Volumes 1, 2, and 3 (The "Manual"), with latest revisions, were used when preparing the storm calculations.

Hydrologic Criteria

Per the Criteria, an industrial site requires design for the 2-year and 100-year design storm frequency events. In addition, Chapter 5.00 of the Criteria was used to determine the time of concentrations, rainfall intensities, and runoff coefficients to calculate the peak runoff for each storm event. The Manual, adopted by the City of Aurora, was used to calculate runoff using the Rational Method for sub-basins less than 160 acres in size. Figures RA-1 through RA-6, of the Manual, were used to determine the P1 values for the intensity values used. One-hour rainfall depths used for the calculations at the site are 0.97 inches and 2.63 inches for the 2-year and 100-year events, respectively. All water quality and detention will be sized using the full-spectrum detention method as described in Chapter 12 of the Manual, Volume 2.

Hydraulic Criteria

The project will construct a private internal storm sewer network, including inlets, to capture runoff. All inlets will be sized using UD Inlet to intercept the 100-year event, and all pipes will be sized to convey the 100-year event using StormCAD for design. These calculations have been included in Appendix B.

The project will convey stormwater to the existing concrete channels along the north and south property lines. Per the *Tower Center for Industry Filing No. 1, 2 & 3 Construction Plans* prepared by Stearns-Roger Architects LTD on June 17, 1981 the normal depth in the northern channel is approximately 3.57ft. The channel geometry has a 10ft bottom with 3:1 side-slopes and 28ft top width. Given the approximate normal depth and channel geometry, it is assumed that the channel is sized to convey approximately 565cfs. Per the *Final Drainage Report and Grading Plan for the Associated Grocers of Colorado Warehouse* prepared by Engineering Service Company dated November 3, 1982, the southern channel has been designed to convey 463cfs with a normal depth of 3.60ft and 1.40ft of freeboard. The channel geometry has a 10ft bottom with 2:1 side-slopes and 30ft top width.

Excerpts from reference reports have been included in Appendix E.

DRAINAGE PLAN

Proposed Drainage Concept

Stormwater generated by the project will sheet flow to the proposed drainage swales and will be captured and conveyed to two proposed detention ponds by an underground storm sewer system. The proposed north detention pond will release flows to the existing concrete drainage channel directly north of the site and the proposed south detention pond will release flows to the existing concrete drainage channel along the south property line. These discharges will release at flow rates in accordance with the Criteria. Ultimately, these two concrete drainage channels will discharge into Sand Creek running along the west property line. The property owner will be responsible for maintenance of the on-site detention system. No off-site flows currently enter the site, nor will any on-site drainage impact adjacent development.

The two existing concrete drainage channels to the north and south of the property will be used to convey the off-site flow to the ultimate discharge point of Sand Creek. Design calculations have been completed to ensure the existing channels are sized to convey the additional flows from the proposed development.

The existing distribution center's stormwater runoff will not be included in these water quality and discharge calculations.

Sub-basin Descriptions

A Drainage Map is provided in Appendix D, illustrating the sub-basins proposed with this project. Individual sub-basin details such as runoff coefficient calculations and imperviousness percentages are provided in Appendix B. The 2-year and 100-year peak flows for each sub-basin are also provided in Appendix B. A summary of the basin parameters is included in Table 1 below.

ON-SITE BASINS

Sub-basin A-1

Sub-basin A-1 is located west of the proposed building expansion and consists of asphalt paving, gravel access and landscaping, along with the proposed north detention pond. The 100-year event flow will be conveyed via sheet flow across the fire access drive and landscaping west to the proposed North Detention Facility at Design Point A1.

In the future, the eastern portion of this basin will consist of an additional building expansion. Approximately 43,581sf of the future roof area (Future Basin R-12) is anticipated to contribute to the North Detention Facility. The North Detention Facility has been sized to accommodate the anticipated future building expansion.

Sub-basin A-2

Sub-basin A-2 is located north of the proposed building and consists of a fire access road, landscaping, and the proposed northern swale. The 100-year event flow will be conveyed from south to north and flow to the swale along the north property line to Design Point A2.

Sub-Basins R1-R4 are routed by storm sewer to the proposed northern swale in Sub-Basin A-2. The cumulative 100-year event flow is 14.1 cfs for the northern swale. Ultimately, runoff from Sub-Basin A-2 and R1-R4 are conveyed to the proposed North Detention Facility to Design Point A1.

In the future, a portion of this basin will be made of up an additional building expansion (Basin R-12).

Sub-basin A-3

Sub-basin A-3 is located south and southwest of the proposed expansion building. The basin consists of pavement, some landscaping, and proposed Swale A3. The 100-year event flow will be conveyed via sheet flow from the landscape and pavement to the South Detention Facility to Design Point A4.

Sub-basin A-4

Sub-basin A-4 is located south and southwest of the proposed expansion building. The basin consists of pavement, some landscaping, and the proposed South Detention Facility. The 100-year event flow will be conveyed via sheet flow from the landscape and pavement to Swale A3 and ultimately to the South Detention Facility to Design Point A4. Design Point A4 also consists of flows routed from Sub-basins R5-R11.

Sub-basin A-5

Sub-basin A-5 is located at the southwest corner of the proposed building. In the current condition, the basin consists of pavement and some landscaping. The 100-year event flow will be conveyed via sheet flow from the landscape and pavement to an area drain and ultimately conveyed to the South Detention Facility to Design Point A4. The proposed area drain has been sized for the current contributing acres.

In the future, this basin will consist of an additional building expansion. Approximately 43,581sf of the future roof area (Basin R-13) is anticipated to contribute to the south storm sewer system and South Detention Facility. The storm sewer and South Detention Facility have been sized to accommodate the anticipated future building expansion.

Sub-basin R-1

Sub-basin R-1 is located on the northern portion of the proposed expansion building and consists of 100% impervious roof area. The 100-year event flow drains through roof drains directly to the proposed swale running along the north property line and conveyed to Design Point A2. Design Point A2 also consists of flows routed from Sub-basins A2 and R2-R4.

Sub-basin R-2

Sub-basin R-2 is located on the northern portion of the proposed expansion building and consists of 100% impervious roof area. The 100-year event flow drains through roof drains directly to the proposed swale running along the north property line and conveyed to Design Point A2. Design Point A2 also consists of flows routed from Sub-basins A2, R1, and R3-R4.

Sub-basin R-3

Sub-basin R-3 is located on the northern portion of the proposed expansion building and consists of 100% impervious roof area. The 100-year event flow drains through roof drains directly to the proposed swale running along the north property line and conveyed to Design Point A2. Design Point A2 also consists of flows routed from Sub-basins A2, R1-R2, and R4.

Sub-basin R-4

Sub-basin R-3 is located on the northern portion of the proposed expansion building and consists of 100% impervious roof area. The 100-year event flow drains through roof drains directly to the proposed swale running along the north property line and conveyed to Design Point A2. Design Point A2 also consists of flows routed from Sub-basins A2 and R1-R3.

Sub-basin R-5

Sub-basin R-5 is located on the southern portion of the proposed expansion building and consists of 100% impervious roof area. The 100-year event drains through roof drains directly to the proposed south detention pond to Design Point A3.

Sub-basin R-6

Sub-basin R-6 is located on the southern portion of the proposed expansion building and consists of 100% impervious roof area. The 100-year event flow drains through roof drains directly to the proposed south detention pond to Design Point A3.

Sub-basin R-7

Sub-basin R-7 is located on the southern portion of the proposed expansion building and consists of 100% impervious roof area. The 100-year event flow drains through roof drains directly to the proposed south detention pond to Design Point A3.

Sub-basin R-8

Sub-basin R-8 is located on the southern portion of the proposed expansion building and consists of 100% impervious roof area. The 100-year event flow drains through roof drains directly to the proposed south detention pond to Design Point A3.

Sub-basin R-9

Sub-basin R-9 is located on the southern portion of the proposed expansion building and consists of 100% impervious roof area. The 100-year event flow drains through roof drains directly to the proposed south detention pond to Design Point A3.

Sub-basin R-10

Sub-basin R-10 is located on the southern portion of the proposed expansion building and consists of 100% impervious roof area. The 100-year event flow drains through roof drains directly to the proposed south detention pond to Design Point A3.

Sub-basin R-11

Sub-basin R-11 is located on the southern portion of the proposed expansion building and consists of 100% impervious roof area. The 100-year event flow drains through roof drains directly to the proposed south detention pond to Design Point A3.

Sub-basins R-12 & R-13

Sub-basins R-12 & R-13 are future basins that are anticipated to consist of approximately 87,702sf of a future building expansion. The 100-year event flow will be split and drain through roof drains to the detention facilities on-site.

OFFSITE BASINS

Sub-basin OS-1

Sub-basin OS-1 consists of the landscape berm north of the site. The 100-year event flow will be conveyed via overland flow west to the existing Sand Creek to the west of the site.

Sub-basin OS-2

Sub-basin OS-2 consists of pavement and landscaping. The 100-year event flow will be conveyed via overland flow east to the existing stormwater system located east of the proposed expansion site.

Sub-basin OS-3

Sub-basin OS-3 consists of the landscape berm south of the site. The 100-year event flow will be conveyed via overland flow south to the existing 31.4' drainage channel running east to west along the south end of the site.

Table 1: Basin Summary							
		Basin Coefficients		Direct Flows		Cumulative Flows	
DRAIN BASIN	AREA Ac	Q_2	Q_{100}	Q_2 CFS	Q_{100} CFS	Q_2 CFS	Q_{100} CFS
A-1	6.24	0.21	0.26	3.0	9.7		
A-2	1.08	0.38	0.45	0.9	3.0	12.4	14.1
A-3	1.72	0.37	0.41	1.4	4.3		
A-4	3.00	0.42	0.46	3.0	9.0		
R-1	0.61	0.80	0.90	1.5	4.6		
R-2	0.68	0.80	0.90	1.7	5.2		
R-3	0.33	0.80	0.90	0.8	2.5		
R-4	0.37	0.80	0.90	0.9	2.8	13.5	15.2
R-5	0.30	0.80	0.90	0.7	2.2		
R-6	0.29	0.80	0.90	0.7	2.2		
R-7	0.24	0.80	0.90	0.6	1.8		
R-8	0.27	0.80	0.90	0.7	2.0		
R-9	0.27	0.80	0.90	0.7	2.0		
R-10	0.27	0.80	0.90	0.7	2.1		
R-11	0.36	0.80	0.90	0.9	2.8	13.5	15.2
A-5	0.62	0.18	0.19	0.3	0.8		
A-1 (future)	4.84	0.22	0.27	2.6	8.5		
A-2 (future)	0.90	0.42	0.49	1.2	3.7		
A-5 (future)	0.18	0.18	0.22	0.1	0.3		
R-12 (future)	1.01	0.80	0.90	2.5	7.7		
R-13 (future)	1.01	0.80	0.90	2.5	7.7		
OS-1	0.64	0.18	0.22	0.4	8.5		
OS-2	0.27	0.87	0.92	0.8	4.5		
OS-3	0.62	0.18	0.22	0.3	4.9		

Water Quality and Detention Summary

All onsite flows will be conveyed directly to the proposed detention ponds north and south of the site. Detention and water quality will be provided for all onsite and offsite detained flows via the detention ponds designed for the 100-year event plus half of the EURV event per the City of Aurora Criteria. Calculations for the detention ponds are provided in Appendix C. Both the north and south detention facilities have been sized to receive half of the anticipated future 87,702sf building expansion. The release rates for the proposed detention systems are based on 0.58 cfs/acre. A summary of the pond designs are included in Table 2 below.

Table 2 - Pond Summary Table			
Pond	*Volume Required*	*100-year +1/2 EURV WSEL*	*Max Release Rate*
North	0.834 ac-ft	5414.70	5.06 cfs
South	0.994 ac-ft	5418.20	4.58 cfs

The additional runoff conveyed to the existing concrete channels is not anticipated to have negative impacts to the channels. Flow in the southern channel is increased from 463cfs to approximately 468cfs, increasing the normal depth in the channel by 0.02ft. Flow in the northern channel will be increased by approximately 5.0cfs and the normal depth will increase by approximately 0.02ft. Calculations for the existing and proposed channel capacities have been included in Appendix B. Each of the channels have in excess of 1-ft of freeboard in their existing conditions.

The two detention ponds will be owned and maintained by Kroger Co.

CONCLUSIONS

Compliance with Standards

The project complies with the City of Aurora criteria for storm drainage design. City of Aurora Storm Drainage Design and Technical Criteria and the Urban Drainage Flood Control District Urban Storm Drainage Criteria Manual Volumes 1, 2, and 3 have been utilized in the design of the storm sewer system as well as Best Management Practices. The ultimate storm sewer system for this site will provide for the 100-year storm event and will not surcharge the storm sewer in the minor event. This project will comply with the state law regarding the requisite release rates and times and will be uploaded to the state.

Summary of Drainage Concept

The project's runoff generated within the site is collected using private roof drains, swales, and storm inlets, which flow to the north and south detention ponds, where the stormwater will be detained and treated by the forebay, trickle channel, and micropool per UDFCD requirements. The proposed detention pond releases flows at City of Aurora Criteria Manual rates to the existing Sand Creek located west of the site.

REFERENCES

Final Drainage Report and Grading Plan for Associated Grocers of Colorado Warehouse, Engineering Service Company; November 3, 1982

Flood Insurance Rate Map – Map Number 08005C0181K, Federal Emergency Management Agency; December 17, 2010.

Storm Drainage Design and Technical Criteria, City of Aurora; October 2010.

Tower Center for Industry Filing No. 1, 2 & 3 Construction Plans, Stearns-Roger Architects LTD; June 17, 1981

Urban Storm Drainage Criteria Manual, Volumes 1-3, Urban Drainage and Flood Control District, June 2001 with latest revisions.

Lot 1, Block 1 Associated Grocers of Colorado Subdivision Filing No. 2 Preliminary Drainage Report COA EDN _____, Kimley-Horn & Associates; May 16, 2018

APPENDIX B – HYDROLOGIC/HYDRAULIC CALCULATIONS

RAINFALL INTENSITY

$$I = \frac{28.5\ P_1}{(10+T_C)^{0.786}}$$

Where:

I = rainfall intensity (inches per hour)

P_1 = one-hour rainfall depth (inches) from figures RA1-RA-6 in USDCM, Volume 1

T_C = time of concentration (minutes)

	2-yr	5-yr	10-yr	100-yr
P_1 =	0.97	1.39	1.63	2.63

Time Intensity Frequency Tabulation

TIME	2 YR	5 YR	10 YR	100 YR
5	3.29	4.71	5.53	8.92
10	2.62	3.76	4.41	7.12
15	2.20	3.16	3.70	5.97
20	1.91	2.73	3.21	5.17
25	1.69	2.42	2.84	4.58
30	1.52	2.18	2.56	4.13
40	1.28	1.83	2.15	3.46
50	1.11	1.59	1.86	3.00
60	0.98	1.40	1.65	2.66
120	0.60	0.86	1.01	1.63

BASIN IMPERVIOUSNESS AND RUNOFF COEFFICIENT

	Imp.	C2	C5	C10	C100
Landscape	5%	0.18	0.19	0.20	0.22
Light Industrial	80%	0.71	0.72	0.76	0.82
Roof	90%	0.80	0.85	0.90	0.90
Concrete	96%	0.87	0.87	0.88	0.89
Street - Paved	100%	0.87	0.88	0.90	0.93
Gravel (packed)	40%	0.15	0.25	0.35	0.65

ON SITE BASINS

Basin ID	Roof (SF)	Landscape (SF)	Concrete (SF)	Street - Paved (SF)	Gravel (packed) (SF)	Total Basin Area (SF)	Total Basin Area (Acres)	Basin Imperviousness*	C2*	C5*	C100*
A-1	0	257749		13130	906	271785	6.24	10%	0.21	0.22	0.26
A-2	0	31062	400	13489	1905	46856	1.08	35%	0.38	0.40	0.45
A-3	0	53271	0	20568	1201	75040	1.72	32%	0.37	0.38	0.41
A-4	0	83061	9136	35533	2927	130657	3.00	38%	0.42	0.43	0.46
R-1	26614	0	0	0	0	26614	0.61	90%	0.80	0.85	0.90
R-2	29815	0	0	0	0	29815	0.68	90%	0.80	0.85	0.90
R-3	14310	0	0	0	0	14310	0.33	90%	0.80	0.85	0.90
R-4	16157	0	0	0	0	16157	0.37	90%	0.80	0.85	0.90
R-5	12853	0	0	0	0	12853	0.30	90%	0.80	0.85	0.90
R-6	12482	0	0	0	0	12482	0.29	90%	0.80	0.85	0.90
R-7	10499	0	0	0	0	10499	0.24	90%	0.80	0.85	0.90
R-8	11588	0	0	0	0	11588	0.27	90%	0.80	0.85	0.90
R-9	11717	0	0	0	0	11717	0.27	90%	0.80	0.85	0.90
R-10	11872	0	0	0	0	11872	0.27	90%	0.80	0.85	0.90
R-11	15885	0	0	0	0	15885	0.36	90%	0.80	0.85	0.90
A-5	0	22890	0	0	4271	27161	0.62	11%	0.18	0.20	0.19
A-1 (future)	0	196952	0	13130	906	210988	4.84	11%	0.22	0.23	0.27
A-2 (future)	0	23472	400	13489	1905	39266	0.90	40%	0.42	0.44	0.49
A-5 (future)	0	7782	0	0	0	7782	0.18	5%	0.18	0.19	0.22
R-12 (future)	43851	0	0	0	0	43851	1.01	90%	0.80	0.85	0.90
R-13 (future)	43851	0	0	0	0	43851	1.01	90%	0.80	0.85	0.90
Total	173792	448033	9536	82720	11210	725291	16.65	38%	0.42	0.44	0.48

OFFSITE BASINS

OS-1	0	27711	0	0	0	27711	0.64	5%	0.18	0.19	0.22
OS-2	0	0	3926	7632	0	11558	0.27	99%	0.87	0.88	0.92
OS-3	0	27055	0	0	0	27055	0.62	5%	0.18	0.19	0.22

POND SIZING (for future conditions)

North	130747	220424	400	26619	2811	381001	8.747	40.87%	0.44	0.47	0.50
South	117894	144114	9136	56101	4128	331373	7.902	53.77%	0.53	0.56	0.60

Associated Grocers of Colorado Filing No.2
Kroger Aurora Expansion

TIME OF CONCENTRATION

					Watercourse Coefficient											
					Forest & Meadow	2.50	Short Grass Pasture & Lawns	7.00			Grassed Waterway	15.00				
					Fallow or Cultivation	5.00	Nearly Bare Ground	10.00			Paved Area & Shallow Gutter	20.00				
SUB-BASIN DATA					INITIAL / OVERLAND 0.00			TRAVEL TIME T(t)					T(c) CHECK (URBANIZED BASINS)			FINAL T(c)*
DESIGN POINT	DRAIN BASIN	AREA sq. ft.	AREA ac.	COEFF C5	Length ft.	Slope ft/ft	T(i) min	Length ft.	Slope ft/ft	Coeff.	Velocity fps	T(t) min.	COMP. T(c)	TOTAL LENGTH	L/180+10	min.
A-1	A-1	271,785	6.24	0.22	430	0.020	26.4	380	0.020	20	2.8	2.2	28.6	810	14.5	14.5
A-2	A-2	46,856	1.08	0.40	50	0.020	7.2	690	0.005	20	1.4	8.1	15.3	740	14.1	14.1
A-3	A-3	75,040	1.72	0.38	180	0.015	15.4	670	0.005	20	1.4	7.9	23.3	850	14.7	14.7
A-4	A-4	130,657	3.00	0.43	75	0.010	10.7	320	0.005	20	1.4	3.8	14.5	395	12.2	12.2
R-1	R-1	26,614	0.61	0.85	300	0.020	6.3				0.0	0.0	6.3	300	11.7	6.3
R-2	R-2	29,815	0.68	0.85	300	0.020	6.3				0.0	0.0	6.3	300	11.7	6.3
R-3	R-3	14,310	0.33	0.85	300	0.020	6.3				0.0	0.0	6.3	300	11.7	6.3
R-4	R-4	16,157	0.37	0.85	300	0.020	6.3				0.0	0.0	6.3	300	11.7	6.3
R-5	R-5	12,853	0.30	0.85	300	0.020	6.3				0.0	0.0	6.3	300	11.7	6.3
R-6	R-6	12,482	0.29	0.85	300	0.020	6.3				0.0	0.0	6.3	300	11.7	6.3
R-7	R-7	10,499	0.24	0.85	300	0.020	6.3				0.0	0.0	6.3	300	11.7	6.3
R-8	R-8	11,588	0.27	0.85	300	0.020	6.3				0.0	0.0	6.3	300	11.7	6.3
R-9	R-9	11,717	0.27	0.85	300	0.020	6.3				0.0	0.0	6.3	300	11.7	6.3
R-10	R-10	11,872	0.27	0.85	300	0.020	6.3				0.0	0.0	6.3	300	11.7	6.3
R-11	R-11	15,885	0.36	0.85	300	0.020	6.3				0.0	0.0	6.3	300	11.7	6.3
A-5	A-5	27,161	0.62	0.20	161	0.015	18.3				0.0	0.0	18.3	161	10.9	10.9
A-1 (future)	A-1 (future)	210,988	4.84	0.23	430	0.020	26.1				0.0	0.0	26.1	430	12.4	12.4
A-2 (future)	A-2 (future)	39,266	0.90	0.44	50	0.02	6.8				0.0	0.0	6.8	50	10.3	6.8
A-5 (future)	A-5 (future)	7,782	0.18	0.19	161	0.02	18.5				0.0	0.0	18.5	161	10.9	10.9
R-12 (future)	R-12 (future)	43,851	1.01	0.85	300	0.020	6.3				0.0	0.0	6.3	300	11.7	6.3
R-13 (future)	R-13 (future)	43,851	1.01	0.85	300	0.020	6.3				0.0	0.0	6.3	300	11.7	6.3
OS-1	OS-1	27,711	0.64	0.19	20	0.100	3.5	0	0.010	20	2.0	0.0	5.0	20	10.1	5.0
OS-2	OS-2	11,558	0.27	0.88	150	0.010	5.0	0	0.010	20	2.0	0.0	5.0	150	10.8	5.0
OS-3	OS-3	27,055	0.62	0.19	160	0.040	13.3	0	0.010	20	2.0	0.0	13.3	160	10.9	10.9

Associated Grocers of Colorado Filing No.2
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RUNOFF CALCULATIONS

Design Storm 100 Year

BASIN INFORMATON				DIRECT RUNOFF				TOTAL RUNOFF				REMARKS
DESIGN POINT	DRAIN BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	SUM C x A	I in/hr	Q cfs	
A-1	A-1	6.24	0.26	14.5	1.60	6.09	9.7					
A-2	A-2	1.08	0.45	14.1	0.48	6.18	3.0	14.1	2.28	6.18	14.1	Basin A2 and R1-R4
A-3	A-3	1.72	0.41	14.7	0.71	6.04	4.3					
A-4	A-4	3.00	0.46	12.2	1.36	6.61	9.0					
R-1	R-1	0.61	0.90	6.3	0.55	8.45	4.6					
R-2	R-2	0.68	0.90	6.3	0.62	8.45	5.2					
R-3	R-3	0.33	0.90	6.3	0.30	8.45	2.5	6.3	0.63	8.45	5.3	Basin R3-R4
R-4	R-4	0.37	0.90	6.3	0.33	8.45	2.8	6.3	1.80	8.45	15.2	Basin R1-R4
R-5	R-5	0.30	0.90	6.3	0.27	8.45	2.2					
R-6	R-6	0.29	0.90	6.3	0.26	8.45	2.2	6.3	0.52	8.45	4.4	Basin R5-R6
R-7	R-7	0.24	0.90	6.3	0.22	8.45	1.8	6.3	0.74	8.45	6.3	Basin R5-R7
R-8	R-8	0.27	0.90	6.3	0.24	8.45	2.0	6.3	0.98	8.45	8.3	Basin R5-R8
R-9	R-9	0.27	0.90	6.3	0.24	8.45	2.0	6.3	1.22	8.45	10.3	Basin R5-R9
R-10	R-10	0.27	0.90	6.3	0.25	8.45	2.1					
R-11	R-11	0.36	0.90	6.3	0.33	8.45	2.8	6.3	1.80	8.45	15.2	Basin R5-11
A-5	A-5	0.62	0.19	10.9	0.12	6.91	0.8					
A-1 (future)	A-1 (future)	4.84	0.27	12.4	1.29	6.57	8.5					
A-2 (future)	A-2 (future)	0.90	0.49	6.8	0.44	8.27	3.7					
A-5 (future)	A-5 (future)	0.18	0.22	10.9	0.04	6.91	0.3					
R-12 (future)	R-12 (future)	1.01	0.90	6.3	0.91	8.45	7.7					
R-13 (future)	R-13 (future)	1.01	0.90	6.3	0.91	8.45	7.7					
OS-1	OS-1	0.64	0.22	5.0	0.14	8.92	8.5					
OS-2	OS-2	0.27	0.92	5.0	0.24	8.92	4.5					
OS-3	OS-3	0.62	0.22	10.9	0.14	6.91	4.9					

Associated Grocers of Colorado Filing No.2
Kroger Aurora Expansion

RUNOFF CALCULATIONS

Design Storm 2 Year

BASIN INFORMATON				DIRECT RUNOFF				TOTAL RUNOFF				REMARKS
DESIGN POINT	DRAIN BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	SUM C x A	I in/hr	Q cfs	
A-1	A-1	6.24	0.21	14.5	1.33	2.24	3.0					
A-2	A-2	1.08	0.38	14.1	0.41	2.28	0.9	14.1	2.01	6.18	12.4	Basin A2 and R1-R4
A-3	A-3	1.72	0.37	14.7	0.64	2.23	1.4					
A-4	A-4	3.00	0.42	12.2	1.25	2.44	3.0					
R-1	R-1	0.61	0.80	6.3	0.49	3.12	1.5				0.0	
R-2	R-2	0.68	0.80	6.3	0.55	3.12	1.7				0.0	
R-3	R-3	0.33	0.80	6.3	0.26	3.12	0.8	6.3	0.56	8.45	4.7	Basin R3-R4
R-4	R-4	0.37	0.80	6.3	0.30	3.12	0.9	6.3	1.60	8.45	13.5	Basin R1-R4
R-5	R-5	0.30	0.80	6.3	0.24	3.12	0.7				0.0	
R-6	R-6	0.29	0.80	6.3	0.23	3.12	0.7	6.3	0.47	8.45	3.9	Basin R5-R6
R-7	R-7	0.24	0.80	6.3	0.19	3.12	0.6	6.3	0.66	8.45	5.6	Basin R5-R7
R-8	R-8	0.27	0.80	6.3	0.21	3.12	0.7	6.3	0.87	8.45	7.4	Basin R5-R8
R-9	R-9	0.27	0.80	6.3	0.22	3.12	0.7	6.3	1.09	8.45	9.2	Basin R5-R9
R-10	R-10	0.27	0.80	6.3	0.22	3.12	0.7				0.0	
R-11	R-11	0.36	0.80	6.3	0.29	3.12	0.9	6.3	1.60	8.45	13.5	Basin R5-11
A-5	A-5	0.62	0.18	10.9	0.11	2.55	0.3					
A-1 (future)	A-1 (future)	4.84	0.22	12.4	1.08	2.42	2.6					
A-2 (future)	A-2 (future)	0.90	0.42	6.8	0.38	3.05	1.2					
A-5 (future)	A-5 (future)	0.18	0.18	10.9	0.03	2.55	0.1					
R-12 (future)	R-12 (future)	1.01	0.80	6.3	0.81	3.12	2.5					
R-13 (future)	R-13 (future)	1.01	0.80	6.3	0.81	3.12	2.5					
OS-1	OS-1	0.64	0.18	5.0	0.11	3.29	0.4					
OS-2	OS-2	0.27	0.87	5.0	0.23	3.29	0.8					
OS-3	OS-3	0.62	0.18	10.9	0.11	2.55	0.3					

Site Runoff Summary

			Direct Flows		Cumulative Flows	
DESIGN POINT	DRAIN BASIN	AREA Ac	Q_2 CFS	Q_{100} CFS	Q_2 CFS	Q_{100} CFS
A-1	A-1	6.24	3.0	9.7		
A-2	A-2	1.08	0.9	3.0	12.4	14.1
A-3	A-3	1.72	1.4	4.3		
A-4	A-4	3.00	3.0	9.0		
R-1	R-1	0.61	1.5	4.6		
R-2	R-2	0.68	1.7	5.2		
R-3	R-3	0.33	0.8	2.5		
R-4	R-4	0.37	0.9	2.8	13.5	15.2
R-5	R-5	0.30	0.7	2.2		
R-6	R-6	0.29	0.7	2.2		
R-7	R-7	0.24	0.6	1.8		
R-8	R-8	0.27	0.7	2.0		
R-9	R-9	0.27	0.7	2.0		
R-10	R-10	0.27	0.7	2.1		
R-11	R-11	0.36	0.9	2.8	13.5	15.2
A-5	A-5	0.62	0.3	0.8		
A-1 (future)	A-1 (future)	4.84	2.6	8.5		
A-2 (future)	A-2 (future)	0.90	1.2	3.7		
A-5 (future)	A-5 (future)	0.18	0.1	0.3		
R-12 (future)	R-12 (future)	1.01	2.5	7.7		
R-13 (future)	R-13 (future)	1.01	2.5	7.7		
OS-1	OS-1	0.64	0.4	8.5		
OS-2	OS-2	0.27	0.8	4.5		
OS-3	OS-3	0.62	0.3	4.9		

Worksheet for Swale A1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	(cobble bottom)
Channel Slope	0.01200	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	3.00	ft
Discharge	9.70	ft^3/s

Results

Normal Depth	0.69	ft
Flow Area	4.00	ft^2
Wetted Perimeter	8.72	ft
Hydraulic Radius	0.46	ft
Top Width	8.55	ft
Critical Depth	0.54	ft
Critical Slope	0.03298	ft/ft
Velocity	2.42	ft/s
Velocity Head	0.09	ft
Specific Energy	0.78	ft
Froude Number	0.62	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.69	ft
Critical Depth	0.54	ft
Channel Slope	0.01200	ft/ft

Worksheet for Swale A2

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	(cobble)
Channel Slope	0.00890	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	3.00	ft
Discharge	14.10	ft^3/s

Results

Normal Depth	0.89	ft
Flow Area	5.87	ft^2
Wetted Perimeter	10.37	ft
Hydraulic Radius	0.57	ft
Top Width	10.15	ft
Critical Depth	0.66	ft
Critical Slope	0.03125	ft/ft
Velocity	2.40	ft/s
Velocity Head	0.09	ft
Specific Energy	0.98	ft
Froude Number	0.56	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.89	ft
Critical Depth	0.66	ft
Channel Slope	0.00890	ft/ft

Worksheet for Swale A3

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	(cobble bottom)
Channel Slope	0.00940	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	3.00	ft
Discharge	4.30	ft^3/s

Results

Normal Depth	0.49	ft
Flow Area	2.43	ft^2
Wetted Perimeter	7.04	ft
Hydraulic Radius	0.34	ft
Top Width	6.92	ft
Critical Depth	0.34	ft
Critical Slope	0.03726	ft/ft
Velocity	1.77	ft/s
Velocity Head	0.05	ft
Specific Energy	0.54	ft
Froude Number	0.53	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.49	ft
Critical Depth	0.34	ft
Channel Slope	0.00940	ft/ft

Existing North Channel

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.015	
Channel Slope	0.00200	ft/ft
Normal Depth	3.57	ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	10.00	ft

Results

Discharge	565.64	ft³/s
Flow Area	73.93	ft²
Wetted Perimeter	32.58	ft
Hydraulic Radius	2.27	ft
Top Width	31.42	ft
Critical Depth	3.34	ft
Critical Slope	0.00263	ft/ft
Velocity	7.65	ft/s
Velocity Head	0.91	ft
Specific Energy	4.48	ft
Froude Number	0.88	
Flow Type	Subcritical	

estimated existing flow based on design criteria found in Tower Center construction documents.

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.57	ft
Critical Depth	3.34	ft
Channel Slope	0.00200	ft/ft

Existing North Channel with Additional Flow

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.015	
Channel Slope	0.00200	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	571.02	ft³/s

Results

Normal Depth	3.59	ft
Flow Area	74.45	ft²
Wetted Perimeter	32.68	ft
Hydraulic Radius	2.28	ft
Top Width	31.52	ft
Critical Depth	3.36	ft
Critical Slope	0.00263	ft/ft
Velocity	7.67	ft/s
Velocity Head	0.91	ft
Specific Energy	4.50	ft
Froude Number	0.88	
Flow Type	Subcritical	

increase in normal depth is 0.02ft, still providing 2.41ft freeboard in the channel

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.59	ft
Critical Depth	3.36	ft
Channel Slope	0.00200	ft/ft

Existing South Channel

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.015	
Channel Slope	0.00180	ft/ft
Normal Depth	3.60	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft

Results

Discharge	462.92	ft³/s
Flow Area	61.92	ft²
Wetted Perimeter	26.10	ft
Hydraulic Radius	2.37	ft
Top Width	24.40	ft
Critical Depth	3.24	ft
Critical Slope	0.00270	ft/ft
Velocity	7.48	ft/s
Velocity Head	0.87	ft
Specific Energy	4.47	ft
Froude Number	0.83	
Flow Type	Subcritical	

estimated existing flow based on design criteria found in Report.

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.60	ft
Critical Depth	3.24	ft
Channel Slope	0.00180	ft/ft

Channel with Additional Flow

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.015	
Channel Slope	0.00180	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	467.17	ft³/s

Results

Normal Depth	3.62	ft
Flow Area	62.33	ft²
Wetted Perimeter	26.18	ft
Hydraulic Radius	2.38	ft
Top Width	24.47	ft
Critical Depth	3.26	ft
Critical Slope	0.00269	ft/ft
Velocity	7.49	ft/s
Velocity Head	0.87	ft
Specific Energy	4.49	ft
Froude Number	0.83	
Flow Type	Subcritical	

increase in normal depth is 0.02ft, still providing 1.38ft freeboard in the channel

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.62	ft
Critical Depth	3.26	ft
Channel Slope	0.00180	ft/ft

APPENDIX C – DETENTION CALCULATIONS

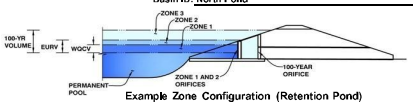
Pond Summary										
Pond	*Contributing Area (ac)*	*WQCV Volume (ac-ft)*	*10-year Volume (ac-ft)*	*100-year Volume (ac-ft)*	*100-year + 1/2 EURV Volume (ac-ft)*	*Allowable Release Rate (cfs)*	*Bottom of Pond Elev.*	*Top of Pond Elev.*	*Pond Depth (ft)*	*100yr + 1/2 EURV WSE*
North	8.75	0.133	0.344	0.641	0.834	5.07	5411.85	5416.40	4.55	5414.70
South	7.90	0.143	0.428	0.749	0.994	4.58	5415.60	5420.50	4.90	5418.20

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Associated Grocers of Colorado Filing No.2

Basin ID: North Pond



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB		
Watershed Area =	8.74	acres	Note: L / W Ratio < 1
Watershed Length =	600	ft	L / W Ratio = 0.9
Watershed Slope =	0.020	ft/ft	
Watershed Imperviousness =	40.87%	percent	
Percentage Hydrologic Soil Group A =	77.0%	percent	
Percentage Hydrologic Soil Group B =	23.0%	percent	
Percentage Hydrologic Soil Groups C/D =	0.0%	percent	
Desired WQCV Drain Time =	40.0	hours	
Location for 1-hr Rainfall Depths =	Aurora - Municipal Center		
Water Quality Capture Volume (WQCV) =	0.133	acre-feet	Optional User Override 1-hr Precipitation
Excess Urban Runoff Volume (EURV) =	0.388	acre-feet	
2-yr Runoff Volume (P1 = 0.87 in.) =	0.197	acre-feet	inches
5-yr Runoff Volume (P1 = 1.14 in.) =	0.276	acre-feet	inches
10-yr Runoff Volume (P1 = 1.39 in.) =	0.371	acre-feet	inches
25-yr Runoff Volume (P1 = 1.76 in.) =	0.550	acre-feet	inches
50-yr Runoff Volume (P1 = 2.08 in.) =	0.735	acre-feet	inches
100-yr Runoff Volume (P1 = 2.42 in.) =	0.966	acre-feet	inches
500-yr Runoff Volume (P1 = 3.3 in.) =	1.556	acre-feet	inches
Approximate 2-yr Detention Volume =	0.185	acre-feet	
Approximate 5-yr Detention Volume =	0.260	acre-feet	
Approximate 10-yr Detention Volume =	0.344	acre-feet	
Approximate 25-yr Detention Volume =	0.459	acre-feet	
Approximate 50-yr Detention Volume =	0.535	acre-feet	
Approximate 100-yr Detention Volume =	0.641	acre-feet	

Total Pond Volume Required
100yr + 1/2 EURV= 0.834 ac-ft

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.133	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.253	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.255	acre-feet
Total Detention Basin Volume =	0.641	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{100A}) =	user	ft
Length of Basin Floor (L_{100A}) =	user	ft
Width of Basin Floor (W_{100A}) =	user	ft
Area of Basin Floor (A_{100A}) =	user	ft^2
Volume of Basin Floor (V_{100A}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Depth Increment = ft

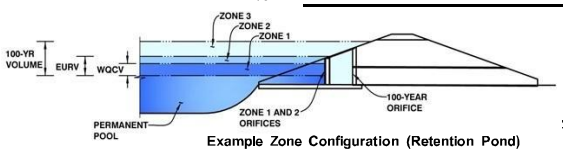
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	384	0.009		
5412.2	--	0.20	--	--	--	1,739	0.040	265	0.006
	--	0.40	--	--	--	4,263	0.098	857	0.020
	--	0.60	--	--	--	7,707	0.177	1,953	0.045
	--	0.80	--	--	--	10,952	0.251	3,910	0.090
5413	--	1.00	--	--	--	14,263	0.327	6,706	0.154
	--	1.20	--	--	--	15,363	0.353	9,819	0.225
	--	1.40	--	--	--	15,824	0.363	13,024	0.299
	--	1.60	--	--	--	16,289	0.374	16,324	0.375
	--	1.80	--	--	--	16,760	0.385	19,719	0.453
5414	--	2.00	--	--	--	17,238	0.396	23,211	0.533
	--	2.20	--	--	--	17,724	0.407	26,982	0.619
	--	2.40	--	--	--	18,214	0.418	30,674	0.704
	--	2.60	--	--	--	18,709	0.429	34,466	0.791
	--	2.80	--	--	--	19,208	0.441	38,358	0.881
5415	--	3.00	--	--	--	19,712	0.453	42,351	0.972
	--	3.20	--	--	--	20,221	0.464	46,446	1.066
	--	3.40	--	--	--	20,735	0.476	50,645	1.163
	--	3.60	--	--	--	21,259	0.488	54,950	1.261
	--	3.80	--	--	--	21,790	0.500	59,362	1.363
5416.4	--	4.40	--	--	--	23,750	0.545	73,255	1.682

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)	0.93	0.133	Orifice Plate
Zone 2 (EURV)	1.62	0.253	Orifice Plate
Zone 3 (100-year)	2.26	0.255	Weir&Pipe (Restrict)
		0.641	Total

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	ft^2
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 =	9.097E-03	ft^2
Depth at top of Zone using Orifice Plate =	1.70	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	8.10	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.31	sq. inches (diameter = 1-1/4 inches)	Elliptical Slot Area =	N/A	ft^2

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	0.57	1.13					
Orifice Area (sq. inches)	1.31	1.31	1.31					

	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	ft^2
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 =	1.70	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	1.70	N/A	feet
Overflow Weir Front Edge Length =	3.00	N/A	feet	Over Flow Weir Slope Length =	2.75	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)	Grate Open Area / 100-yr Orifice Area =	8.68	N/A	should be ≥ 4
Horiz. Length of Weir Sides =	2.75	N/A	feet	Overflow Grate Open Area w/o Debris =	5.78	N/A	ft^2
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area	Overflow Grate Open Area w/ Debris =	2.89	N/A	ft^2
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 =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.67	N/A	ft^2
Outlet Pipe Diameter =	15.00	N/A	inches	Outlet Orifice Centroid =	0.38	N/A	feet
Restrictor Plate Height Above Pipe Invert =	8.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.64	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.30	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.81	feet
Spillway Crest Length =	7.00	feet	Stage at Top of Freeboard =	4.11	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.53	acres
Freeboard above Max Water Surface =	1.00	feet			

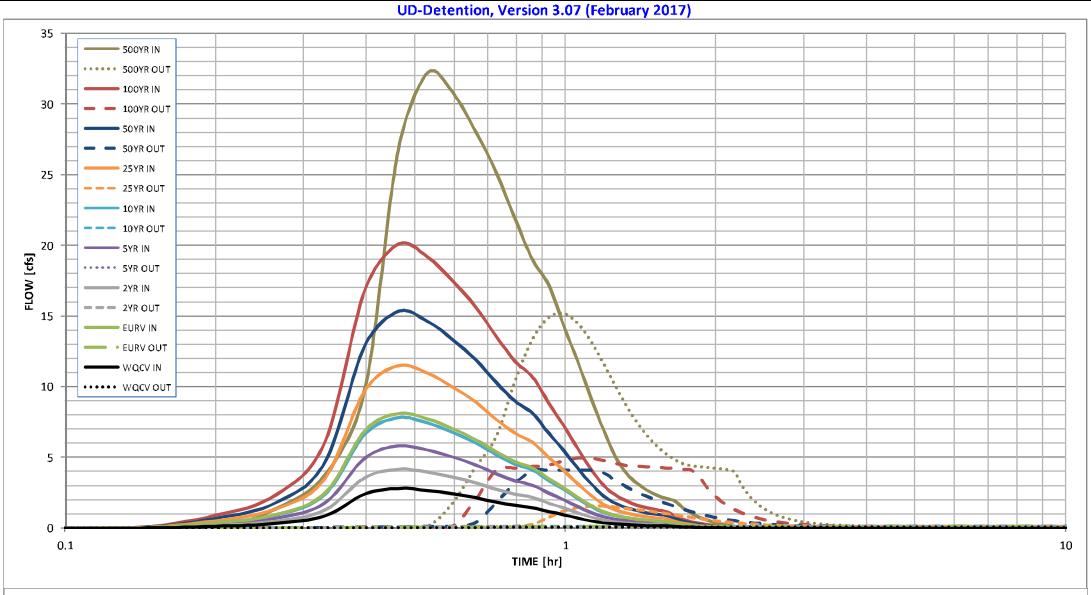
Calculated Parameters for Spillway

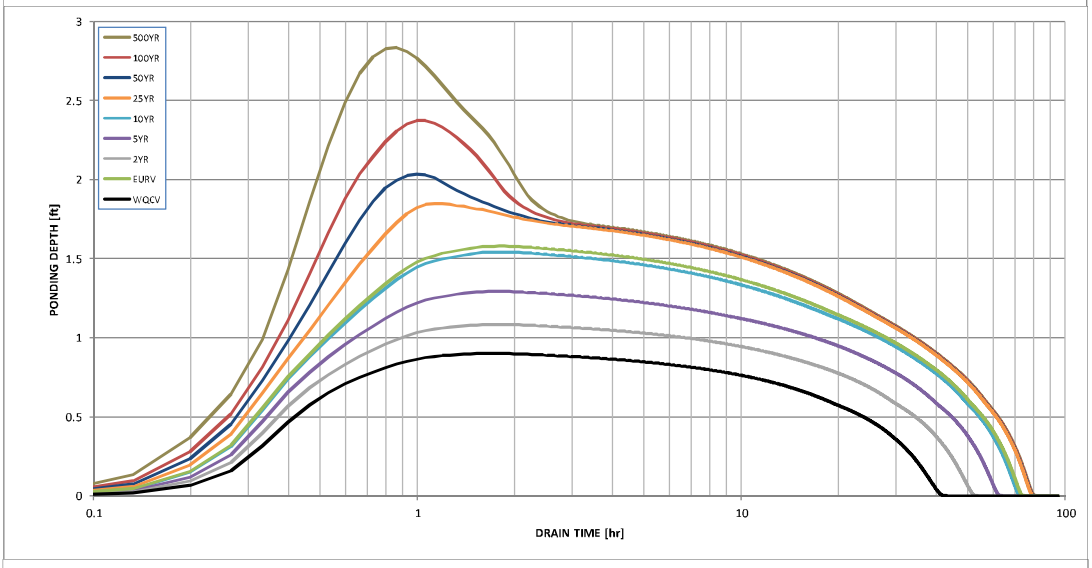
Routed Hydrograph Results

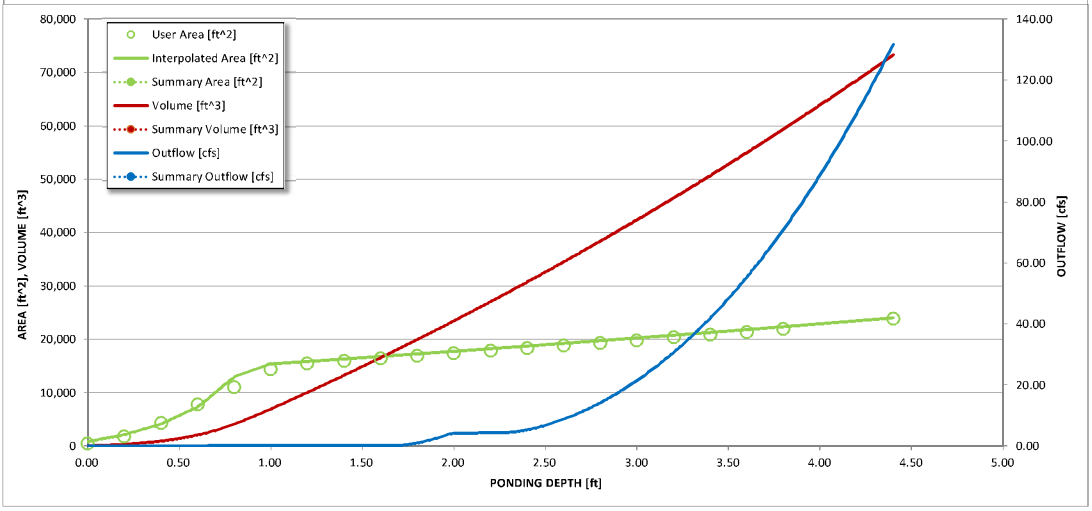
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	0.87	1.14	1.39	1.76	2.08	2.42	3.30
Calculated Runoff Volume (acre-ft) =	0.133	0.386	0.197	0.276	0.371	0.550	0.735	0.966	1.556
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.132	0.386	0.197	0.275	0.371	0.549	0.735	0.966	1.556
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.01	0.06	0.20	0.44	0.82	1.71
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.1	0.5	1.7	3.9	7.2	14.9
Peak Inflow Q (cfs) =	2.8	8.1	4.2	5.8	7.8	11.5	15.3	20.1	32.2
Peak Outflow Q (cfs) =	0.1	0.1	0.1	0.1	0.1	1.6	4.1	5.0	15.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.4	0.2	0.9	1.1	0.7	1.0
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.2	0.7	0.8	0.8
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) =	37	65	47	55	64	68	65	63	57
Time to Drain 99% of Inflow Volume (hours) =	**40**	69	50	59	68	74	73	72	69
Maximum Ponding Depth (ft) =	0.90	1.58	1.08	1.29	1.54	1.85	2.04	2.37	2.83
Area at Maximum Ponding Depth (acres) =	0.32	0.38	0.36	0.37	0.38	0.40	0.41	0.43	0.45
Maximum Volume Stored (acre-ft) =	0.124	0.367	0.186	0.262	0.356	0.473	0.549	0.691	0.894

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

North Pond Spillway Design

utilize a sharp-crest weir to determine spillway dimensions

Sharp-Crested Weir Equations

$Q_{spillway\ Allowed} = C_{SCW} * L * H^{1.5}$

$Q_{spillway\ Design}$ = Discharge (cfs) = 2 X $Q_{100\ for\ Total}$

$C_{SCW} = 3.27+0.4(H/H_C)$ = Coefficient

L = Horizontal weir length

H = Head above weir crest

H_C = Inv of pond - Inv of Spillway = Height of weir crest above channel bottom

Input Information

Inv of pond =	*5411.85*
Inv of spillway =	*5414.70*

Weir Design Information

Q_{100}	20.10	cfs
$Q_{spillway\ design}$	40.20	cfs
$Q_{spillway\ Allowed}$	41.33	cfs
C_{SCW}	3.34	
L	*35*	*ft*
H	*0.50*	*ft*
H_C	2.85	ft

Results: Utilize a 35' long sharp crested weir as spillway

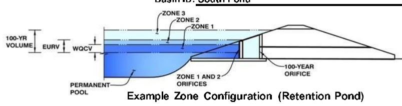
Top of Bank	5416.40	
Elev @ Crest of Flow	5415.20	
H of flow over spillway	0.50	ft
Freeboard	1.20	ft

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Associated Grocers of Colorado Filing No.2

Basin ID: South Pond



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB			
Watershed Area =	7.90	acres		
Watershed Length =	800	ft		
Watershed Slope =	0.015	ft/ft		
Watershed Imperviousness =	53.77%	percent		
Percentage Hydrologic Soil Group A =	77.0%	percent		
Percentage Hydrologic Soil Group B =	23.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	Aurora - Municipal Center			
Water Quality Capture Volume (WQCV) =	0.143	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	0.490	acre-feet		
2-yr Runoff Volume (P1 = 0.87 in.) =	0.253	acre-feet		inches
5-yr Runoff Volume (P1 = 1.14 in.) =	0.351	acre-feet		inches
10-yr Runoff Volume (P1 = 1.39 in.) =	0.459	acre-feet		inches
25-yr Runoff Volume (P1 = 1.76 in.) =	0.646	acre-feet		inches
50-yr Runoff Volume (P1 = 2.08 in.) =	0.828	acre-feet		inches
100-yr Runoff Volume (P1 = 2.42 in.) =	1.046	acre-feet		inches
500-yr Runoff Volume (P1 = 3.3 in.) =	1.601	acre-feet		inches
Approximate 2-yr Detention Volume =	0.239	acre-feet		
Approximate 5-yr Detention Volume =	0.331	acre-feet		
Approximate 10-yr Detention Volume =	0.428	acre-feet		
Approximate 25-yr Detention Volume =	0.562	acre-feet		
Approximate 50-yr Detention Volume =	0.647	acre-feet		
Approximate 100-yr Detention Volume =	0.749	acre-feet		

Total Pond Volume Required
100yr + 1/2 EURV= 0.994 ac-ft

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.143	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.347	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.259	acre-feet
Total Detention Basin Volume =	0.749	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	–	0.00	–	–	–	1,055	0.024		
	–	0.20	–	–	–	3,330	0.076	406	0.009
5416	–	0.40	–	–	–	6,508	0.149	1,358	0.031
	–	0.60	–	–	–	10,539	0.242	3,022	0.069
	–	0.80	–	–	–	15,169	0.348	5,547	0.127
	–	1.00	–	–	–	20,128	0.462	9,027	0.207
	–	1.20	–	–	–	22,239	0.511	13,242	0.304
5417	–	1.40	–	–	–	22,782	0.523	17,738	0.407
	–	1.60	–	–	–	23,329	0.536	22,344	0.513
	–	1.80	–	–	–	23,881	0.548	27,060	0.621
	–	2.00	–	–	–	24,437	0.561	31,886	0.732
	–	2.20	–	–	–	24,996	0.574	37,073	0.851
5418	–	2.40	–	–	–	25,562	0.587	42,129	0.967
	–	2.60	–	–	–	26,132	0.600	47,298	1.086
	–	2.80	–	–	–	26,709	0.613	52,583	1.207
	–	3.00	–	–	–	27,291	0.627	57,983	1.331
	–	3.20	–	–	–	27,882	0.640	63,500	1.458
5419	–	3.40	–	–	–	28,482	0.654	69,136	1.587
	–	3.60	–	–	–	29,090	0.668	74,893	1.719
	–	3.80	–	–	–	29,705	0.682	80,773	1.854
	–	4.00	–	–	–	30,327	0.696	86,776	1.992
	–	4.20	–	–	–	30,955	0.711	92,904	2.133
5420	–	4.40	–	–	–	31,590	0.725	99,159	2.276
	–	4.60	–	–	–	32,233	0.740	105,541	2.423
	–	4.80	–	–	–	32,885	0.755	112,053	2.572
5420.5	–	4.90	–	–	–	33,248	0.763	115,360	2.648
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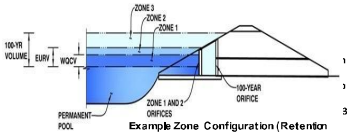
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project:

Basin ID:



Example Zone Configuration (Retention

	Stage (ft)	ne Volume (ac-	Outlet Type
ıe 1 (WQCV)	0.84	0.143	Orifice Plate
ɔne 2 (EURV)	1.55	0.347	Orifice Plate
3 (100-year)	2.02	0.259	Weir&Pipe (Restrict)
		0.749	Total

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 Diameter =	N/A	inches	

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft²
Underdrain Orifice Centroid =	N/A	feet

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	1.60	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	8.00	inches
Orifice Plate: Orifice Area per Row =	1.61	sq. inches (diameter = 1-7/16 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	1.118E-02	ft²
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft²

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	0.53	1.07					
Orifice Area (sq. inches)	1.61	1.61	1.61					

	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	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
epth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft²
Vertical Orifice Centroid =	N/A	N/A	feet

ut: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.60	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.33	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	2.75	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	1.60	N/A	feet
Over Flow Weir Slope Length =	2.75	N/A	feet
Grate Open Area / 100-yr Orifice Area =	9.07	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	6.41	N/A	ft²
Overflow Grate Open Area w/ Debris =	3.21	N/A	ft²

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	15.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	8.40		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.71	N/A	ft²
Outlet Orifice Centroid =	0.40	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.69	N/A	radians

r Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.60	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	15.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

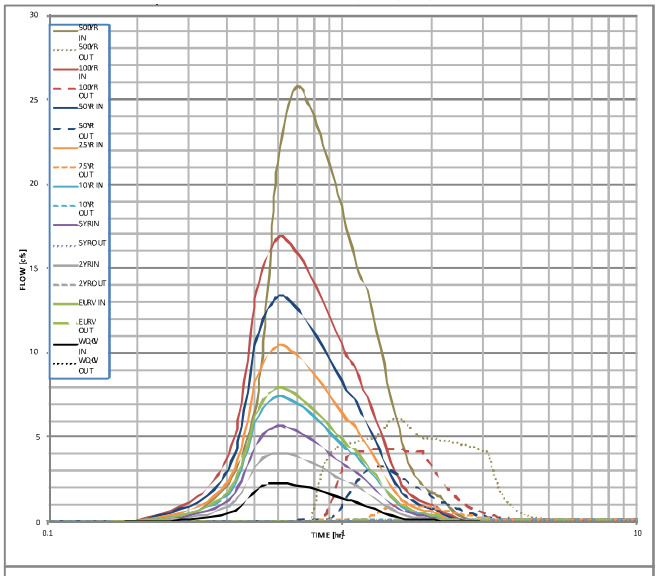
Spillway Design Flow Depth =	0.49	feet
Stage at Top of Freeboard =	4.09	feet
Basin Area at Top of Freeboard =	0.70	acres

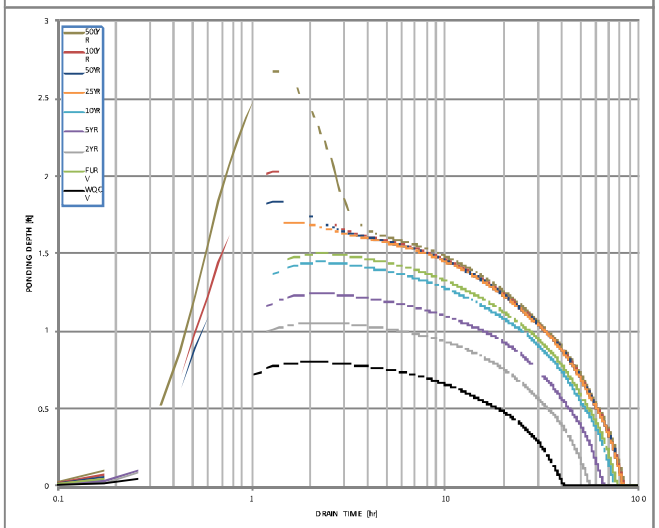
Routed Hydrograph Results

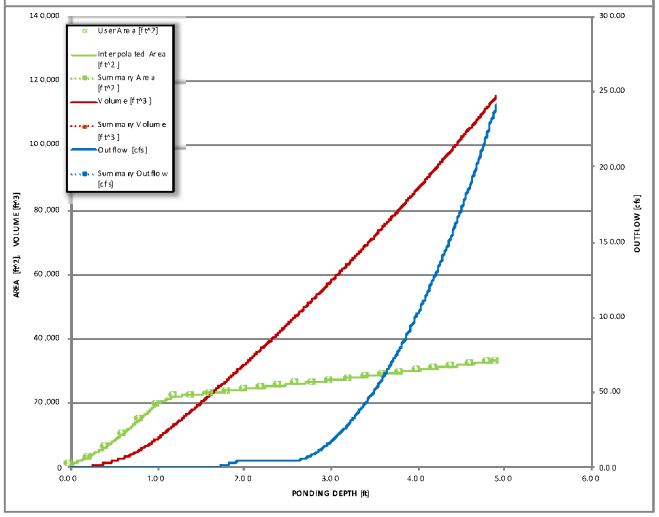
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	0.87	1.14	1.39	1.76	2.08	2.42	3.30
Calculated Runoff Volume (acre-ft) =	0.143	0.490	0.253	0.351	0.459	0.646	0.828	1.046	1.601
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.142	0.489	0.253	0.350	0.459	0.646	0.827	1.045	1.600
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.01	0.04	0.15	0.33	0.61	1.28
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.1	0.3	1.2	2.6	4.8	10.1
Peak Inflow Q (cfs) =	2.4	8.0	4.2	5.7	7.5	10.5	13.4	16.9	25.7
Peak Outflow Q (cfs) =	0.1	0.2	0.1	0.1	0.1	1.0	3.3	4.4	6.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.5	0.4	0.9	1.3	0.9	0.6
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.1	0.5	0.6	0.8
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) =	37	68	50	59	66	72	70	68	63
Time to Drain 99% of Inflow Volume (hours) =	40	73	54	63	71	78	77	76	75
Maximum Ponding Depth (ft) =	0.80	1.50	1.06	1.24	1.45	1.70	1.84	2.03	2.68
Area at Maximum Ponding Depth (acres) =	0.35	0.53	0.47	0.51	0.53	0.54	0.55	0.56	0.60
Maximum Volume Stored (acre-ft) =	0.131	0.465	0.235	0.330	0.433	0.572	0.649	0.754	1.128

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

South Pond Spillway Design

utilize a sharp-crest weir to determine spillway dimensions

Sharp-Crested Weir Equations

$Q_{spillway\ Allowed} = C_{SCW} * L * H^{1.5}$

$Q_{spillway\ Design}$ = Discharge (cfs) = 2 X $Q_{100\ for\ Total}$

$C_{SCW} = 3.27+0.4(H/H_C)$ = Coefficient

L = Horizontal weir length

H = Head above weir crest

H_C = Inv of pond - Inv of Spillway = Height of weir crest above channel bottom

Input Information

Inv of pond =	*5415.60*
Inv of spillway =	*5418.20*

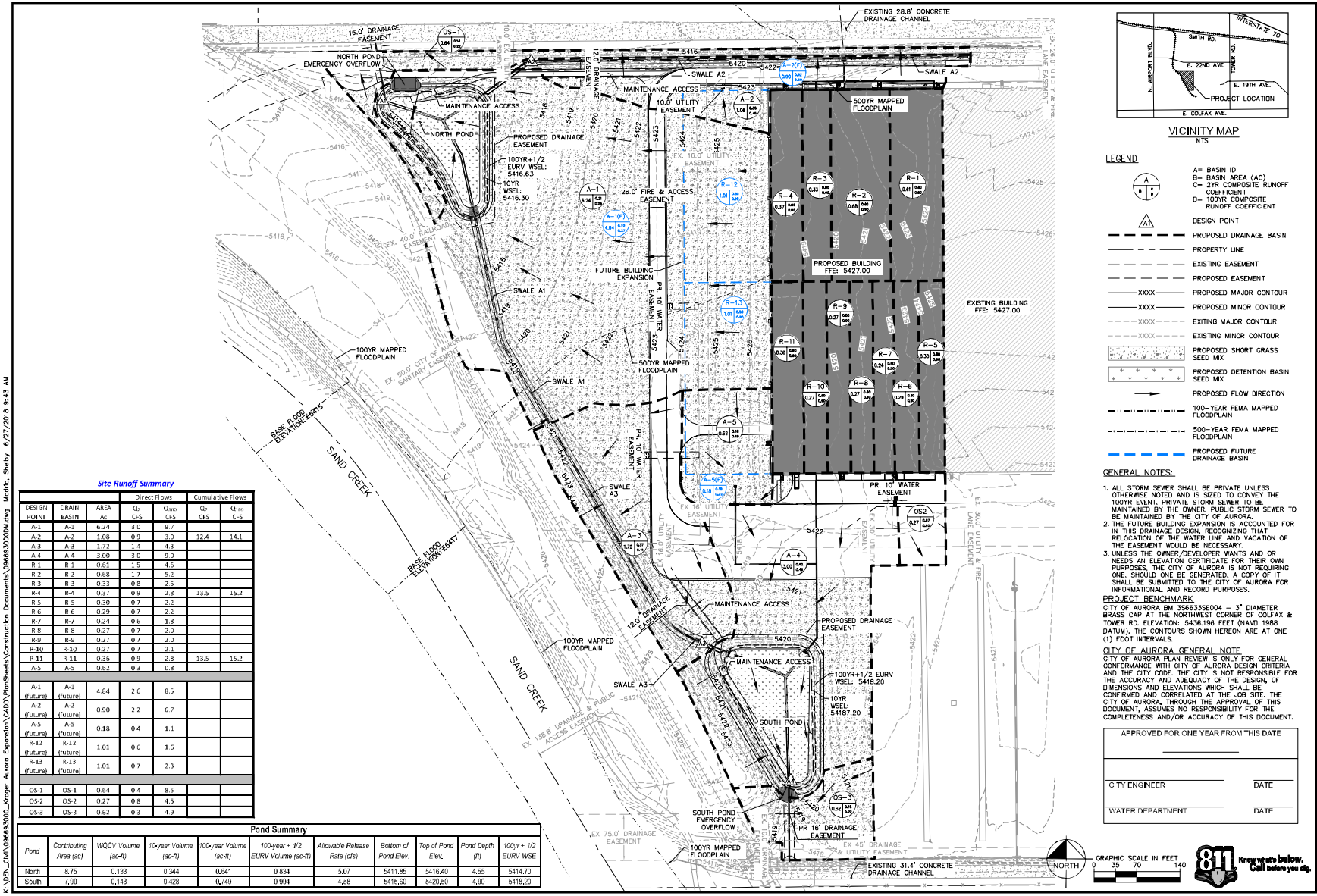
Weir Design Information

Q_{100}	16.90	cfs
$Q_{spillway\ design}$	33.80	cfs
$Q_{spillway\ Allowed}$	34.24	cfs
C_{SCW}	3.42	
L	*10.00*	*ft*
H	*1.00*	*ft*
H_C	2.60	ft

Results: Utilize a 10' long sharp crested weir as spillway

Top of Bank	5420.50	
Elev @ Crest of Flow	5419.20	
H of flow over spillway	1.00	ft
Freeboard	1.30	ft

APPENDIX D – DRAINAGE MAP



VICINITY MAP
NTS

LEGEND

- A= BASIN ID; B= BASIN AREA (AC); C= 2YR COMPOSITE RUNOFF COEFFICIENT; D= 100YR COMPOSITE RUNOFF COEFFICIENT
- DESIGN POINT
- PROPOSED DRAINAGE BASIN
- PROPERTY LINE
- EXISTING EASEMENT
- PROPOSED EASEMENT
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- EXITING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED SHORT GRASS SEED MIX
- PROPOSED DETENTION BASIN SEED MIX
- PROPOSED FLOW DIRECTION
- 100-YEAR FEMA MAPPED FLOODPLAIN
- 500-YEAR FEMA MAPPED FLOODPLAIN
- PROPOSED FUTURE DRAINAGE BASIN

GENERAL NOTES:

1. ALL STORM SEWER SHALL BE PRIVATE UNLESS OTHERWISE NOTED AND IS SIZED TO CONVEY THE 100YR EVENT. PRIVATE STORM SEWER TO BE MAINTAINED BY THE OWNER. PUBLIC STORM SEWER TO BE MAINTAINED BY THE CITY OF AURORA.
2. THE FUTURE BUILDING EXPANSION IS ACCOUNTED FOR IN THIS DRAINAGE DESIGN, RECOGNIZING THAT RELOCATION OF THE WATER LINE AND VACATION OF THE EASEMENT WOULD BE NECESSARY.
3. UNLESS THE OWNER/DEVELOPER WANTS AND OR NEEDS AN ELEVATION CERTIFICATE FOR THEIR OWN PURPOSES, THE CITY OF AURORA IS NOT REQUIRING ONE. SHOULD ONE BE GENERATED, A COPY OF IT SHALL BE SUBMITTED TO THE CITY OF AURORA FOR INFORMATIONAL AND RECORD PURPOSES.

PROJECT BENCHMARK

CITY OF AURORA BM 356633SE004 – 3" DIAMETER BRASS CAP AT THE NORTHWEST CORNER OF COLFAX & TOWER RD. ELEVATION: 5436.196 FEET (NAVD 1988 DATUM). THE CONTOURS SHOWN HEREON ARE AT ONE (1) FOOT INTERVALS.

CITY OF AURORA GENERAL NOTE

CITY OF AURORA PLAN REVIEW IS ONLY FOR GENERAL CONFORMANCE WITH CITY OF AURORA DESIGN CRITERIA AND THE CITY CODE. THE CITY IS NOT RESPONSIBLE FOR THE ACCURACY AND ADEQUACY OF THE DESIGN, OF DIMENSIONS AND ELEVATIONS WHICH SHALL BE CONFIRMED AND CORRELATED AT THE JOB SITE. THE CITY OF AURORA, THROUGH THE APPROVAL OF THIS DOCUMENT, ASSUMES NO RESPONSIBILITY FOR THE COMPLETENESS AND/OR ACCURACY OF THIS DOCUMENT.

APPROVED FOR ONE YEAR FROM THIS DATE

CITY ENGINEER — DATE

WATER DEPARTMENT — DATE

NORTH

GRAPHIC SCALE IN FEET
0 35 70 140

811 Know what's below. Call before you dig.

Site Runoff Summary

DESIGN POINT	DRAIN BASIN	AREA Ac	Direct Flows Qb CFS	Direct Flows Q100 CFS	Cumulative Flows Qb CFS	Cumulative Flows Q100 CFS
A-1	A-1	6.24	3.0	9.7		
A-2	A-2	1.08	0.9	3.0	12.4	14.1
A-3	A-3	1.72	1.4	4.3		
A-4	A-4	3.00	3.0	9.0		
R-1	R-1	0.61	1.5	4.6		
R-2	R-2	0.68	1.7	5.2		
R-3	R-3	0.33	0.8	2.5		
R-4	R-4	0.37	0.9	2.8	13.5	15.2
R-5	R-5	0.30	0.7	2.2		
R-6	R-6	0.29	0.7	2.2		
R-7	R-7	0.24	0.6	1.8		
R-8	R-8	0.27	0.7	2.0		
R-9	R-9	0.27	0.7	2.0		
R-10	R-10	0.27	0.7	2.1		
R-11	R-11	0.36	0.9	2.8	13.5	15.2
A-5	A-5	0.62	0.3	0.8		
A-1 (future)	A-1 (future)	4.84	2.6	8.5		
A-2 (future)	A-2 (future)	0.90	2.2	6.7		
A-5 (future)	A-5 (future)	0.18	0.4	1.1		
R-12 (future)	R-12 (future)	1.01	0.6	1.6		
R-13 (future)	R-13 (future)	1.01	0.7	2.3		
OS-1	OS-1	0.64	0.4	8.5		
OS-2	OS-2	0.27	0.8	4.5		
OS-3	OS-3	0.62	0.3	4.9		

Pond Summary

Pond	Contributing Area (ac)	WQCV Volume (ac-ft)	10-year Volume (ac-ft)	100-year Volume (ac-ft)	100-year + 1/2 EURV Volume (ac-ft)	Allowable Release Rate (cfs)	Bottom of Pond Elev.	Top of Pond Elev.	Pond Depth (ft)	100yr + 1/2 EURV WSE
North	8.75	0.133	0.344	0.641	0.834	5.07	5411.85	5416.40	4.55	5414.70
South	7.90	0.143	0.428	0.749	0.994	4.36	5415.60	5420.50	4.90	5418.20

Kimley»Horn

NO.	REVISION	BY	DATE	APPR.

DESIGNED BY: SAM
DRAWN BY: SAM
CHECKED BY: RJP
DATE: 06/06/18

ASSOCIATED GROCERS OF COLORADO FILING NO.2
CONSTRUCTION DOCUMENTS
DRAINAGE MAP
CITY OF AURORA, COUNTY OF ADAMS

FACSIMILE
This electronic plan is a facsimile of the signed and sealed pdf set
Randall J. Phelps
06/28/2018

PROJECT NO. 096693000
FILE NO. 096693000DMAP.DWG
14

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APPENDIX E –MISCELLANEOUS REPORT EXCERPTS

FINAL
DRAINAGE REPORT
& GRADING PLAN

ASSOCIATED GROCERS
OF COLORADO
WAREHOUSE

AUGUST 25, 1982

REVISED OCTOBER 5, 1982

REVISED OCTOBER 26, 1982

REVISED NOVEMBER 3, 1982

PREPARED FOR: OPUS CORPORATION
800 OPUS CENTER
9900 BREN ROAD EAST
MINNEAPOLIS, MINNESOTA 55440
PHONE (612) 936-4487

PREPARED BY: ENGINEERING SERVICE COMPANY
9755 MONTVIEW BOULEVARD
AURORA, COLORADO 80010
PHONE (303) 364-7468

JAMES J. WATSON
REGISTERED
8104
P.E. & L.S.
STATE OF COLORADO

C8-2-1432

APPROVED FOR ONE YEAR FROM THIS DATE
11-17-82

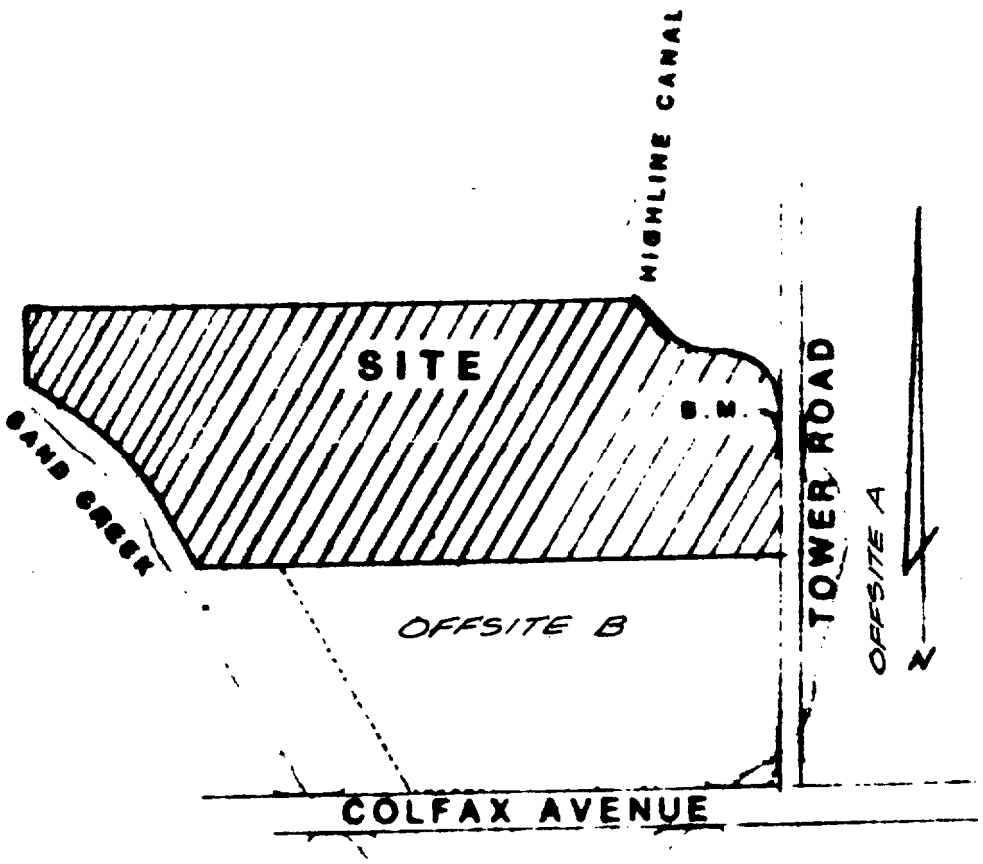
DPH 11-5-82
Director of Public Works — Date 11/5/82

Director of Utilities — Date 11/8/82

FINAL DRAINAGE REPORT &
GRADING PLAN FOR
ASSOCIATED GROCERS OF COLORADO
WAREHOUSE

1. LOCATION:

The site is bounded on the North by the extension of East Montview Blvd., on the East by Tower Road, on the South by the extension of E. 17th Avenue and on the West by Sand Creek.



VICINITY MAP
1":1000'

2. EXISTING DRAINAGE:

The site generally drains from southeast to northwest, eventually discharging into Sand Creek.

The swale along the south property line in Area M is sized for the 100-year storm. No off-site flow is considered to be tributary to this swale as the topography along this property line falls off to the south up to a point west of Design Point (6). Thus, this off-site area is tributary to the channel but not to the swale in Area M. The typical section for the swale appears on the Final Drainage Plan, and its capacity is as follows:

$$Q = A \frac{1.486}{n} R^{2/3} S^{\frac{1}{2}}$$

$$Q = 11.75 \times \frac{1.486}{0.06} \times 0.74^{2/3} \times 0.015^{\frac{1}{2}}$$

$Q = 29.1$ CFS $>$ 21.9 CFS $= Q_{100}$ @ d = 1.5'

$Q = 13.2$ CFS $\simeq$ 13.9 CFS $= Q_{10}$ @ d = 1.0'

The final area not discussed in off-site Area B. The historic runoff from this area is directly contributory to the channel. The Time of Concentration was calculated as follows:

Total D = 1250 feet

Overlot D = 200 feet, C = 0.2, S = 0.5%

$$t_c = \frac{1.8\ (1.1 - 0.2)\ \sqrt{250}}{0.25}$$

$t_c = 32.3$ min.

Swale D = 1000 feet, v = 1 FPS

$t_c = 16.7$ min.

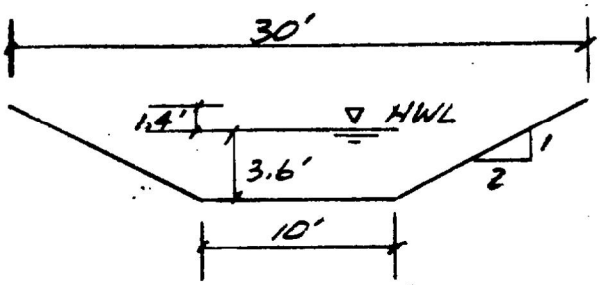
Total $t_c = 49.0$ min., say 50 min.

Finally, the concrete channel typical section is shown on the Final Drainage Plan. It is anticipated that the 100-year storm will remain in the concrete channel with at least 1½ feet of freeboard. Erosion control at Sand

CHANNEL FLOW CALCULATIONS

$Q_{MAX} = 460$ CFS $n = 0.015$ $S = 0.18\%$

AT $H = 3.6'$; $A = 61.92$ SF
$P = 26.10$
$R = 2.37$



$Q = A \frac{1.486}{n} R^{2/3} S^{1/2}$

$= 61.92 \frac{1.486}{0.015} \times 2.37^{2/3} \times 0.0018^{1/2}$

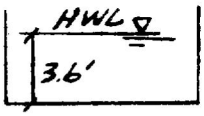
$= 463$ CFS

∴ MAXIMUM HIGH WATER IN NORMAL CHANNEL = 3.6'

CHANNEL TRANSITION

NEED WIDTH OF RECTANGULAR CHANNEL TO MAINTAIN EQUIVALENT HWL.

BY TRIAL & ERROR, WIDTH = 16.25'



$A = 58.50$ SF, $P = 23.45'$, $R = 2.49$

$Q = 58.50 \times \frac{1.486}{0.015} \times 2.49^{2/3} \times 0.0018^{1/2}$

$Q = 452.4$ CFS ≈ 460

DROP STRUCTURE CALCS.

CRITICAL DEPTH AT OUTFALL

$\frac{Q^2}{g} = \frac{A^3}{W}$

$\frac{460^2}{32.2} = \frac{A^3}{16.25}$

$A = 47.26'$

$y_c = \frac{47.26}{16.25}$

$y_c = 2.91'$

STRUCTURE SIZING

$h_o = 10.4'$

$h_o/y_c = 3.57$

$h_2 = h_o - 2.15 y_c$

$h_2 = 4.14$

$h_2/y_c = 1.42$

FROM FIG. IX-A-2

$L_1/y_c = 4.3$

$L_1 = 12.50'$

$L_2 = 0.8 y_c = 2.33'$

$L_3 > 1.75 y_c = 5.09'$ SAY $5.17'$

$L_B = 20.0'$

FLOOR BLOCKS:
$H_T = 0.8 y_c = 2.33'$
$W_o = 0.4 y_c = 1.17'$

END SILL:
$H_T = 0.4 y_c = 1.17'$

TOWER CENTER FOR INDUSTRY

FILING NO. 1,2,&3

CONSTRUCTION PLANS

OWNER / DEVELOPER

STEARNS - ROGER CORPORATION

ENGINEERS

STEARNS - ROGER ARCHITECTS LTD.

DRAWING INDEX

SHEET NO.		DESCRIPTION
I	-	COVER SHEET
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3 - 4	-	HIGHLINE CANAL RELOCATION AND DETAILS
5 - 9	-	DRAINAGE CHANNEL PLAN AND PROFILE
10	-	DRAINAGE CHANNEL DETAILS
11	-	TYPICAL STREET SECTIONS
12 - 15	-	TOWER ROAD PLAN AND PROFILES
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21 - 24	-	EAST 22nd AVENUE PLAN AND PROFILES
25 - 27	-	EAST 23rd AVENUE PLAN AND PROFILES
28 - 30	-	EAST 24th DRIVE PLAN AND PROFILES
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39 - 43	-	CURB RETURN PROFILES
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47 - 49	-	OVERALL UTILITY PLANS
50 - 52	-	SMITH ROAD WATER AND SANITARY SEWER PLAN AND PROFILES
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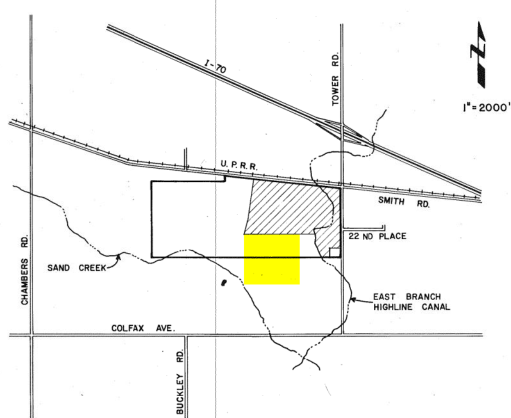
56 - 57	-	EAST 23rd AVENUE WATER AND SANITARY SEWER PLAN AND PROFILES
58 - 59	-	EAST 24th DRIVE WATER AND SANITARY SEWER PLAN AND PROFILES
60 - 63	-	EAST 25th DRIVE WATER AND SANITARY SEWER PLAN AND PROFILES
64 - 65	-	URAVAN STREET WATER AND SANITARY SEWER PLAN AND PROFILES
66 - 68	-	RIFLE STREET WATER AND SANITARY SEWER PLAN AND PROFILES



VICINITY MAP

NOTES

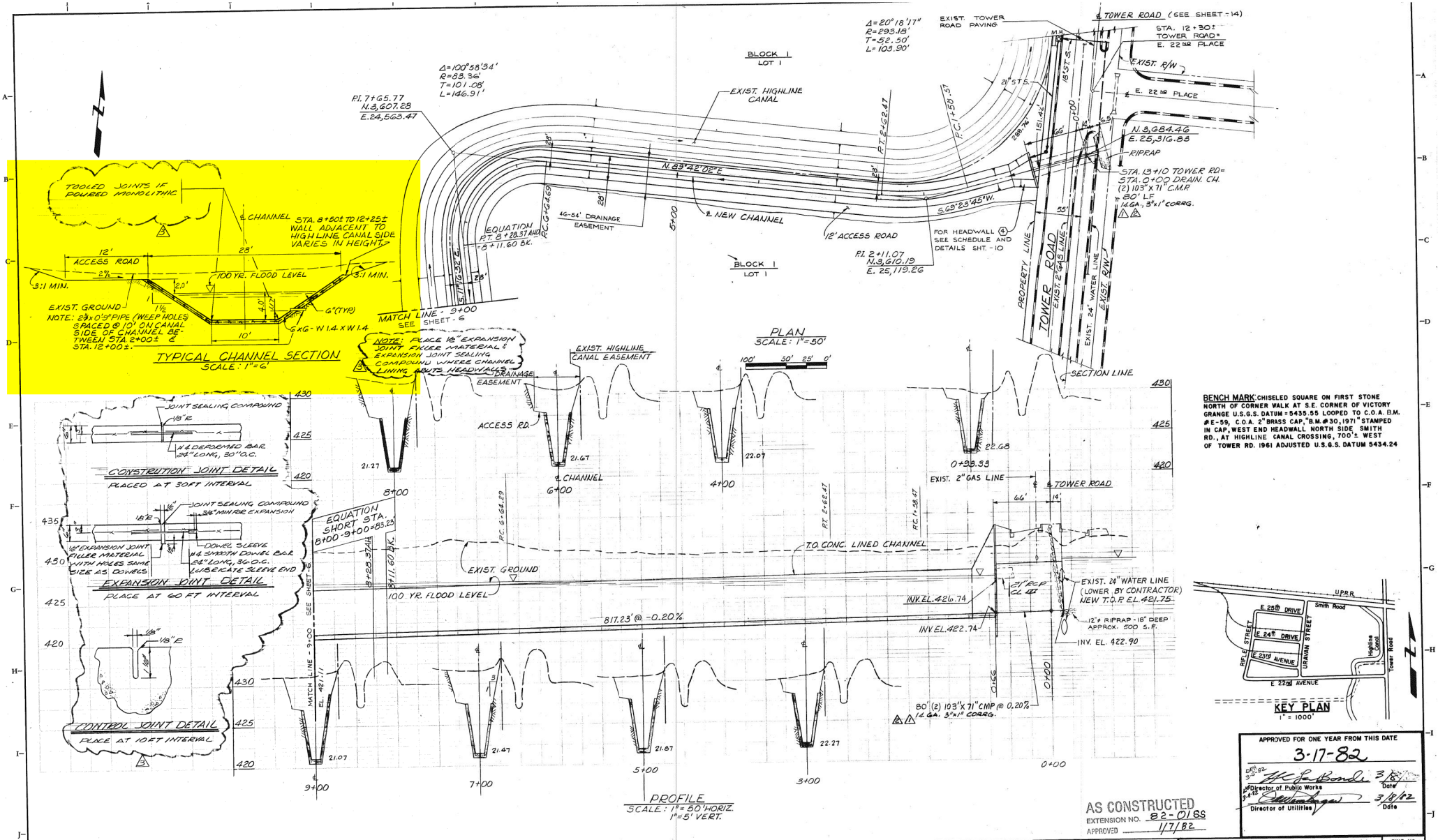
1. CITY OF AURORA PLAN REVIEW IS ONLY FOR GENERAL CONFORMANCE WITH CITY OF AURORA DESIGN CRITERIA AND THE CITY CODE. THE CITY IS NOT RESPONSIBLE FOR THE ACCURACY AND ADEQUACY OF THE DESIGN, OF DIMENSIONS, AND ELEVATIONS WHICH SHALL BE CONFIRMED AND CORRELATED AT THE JOB SITE. THE CITY OF AURORA THROUGH THE APPROVAL OF THIS DOCUMENT ASSUMES NO RESPONSIBILITY OTHER THAN AS STATED ABOVE FOR THE COMPLETENESS AND/OR ACCURACY OF THIS DOCUMENT.
2. ALL ROADWAY CONSTRUCTION SHALL CONFORM TO CITY OF AURORA ROADWAY DESIGN STANDARDS AND SPECIFICATIONS, DATED MARCH 1981.
3. ALL SANITARY SEWER CONSTRUCTION SHALL CONFORM TO CITY OF AURORA SANITARY SEWER DESIGN STANDARDS AND SPECIFICATIONS, DATED JUNE 1977.
4. ALL STORM DRAINAGE CONSTRUCTION SHALL CONFORM TO CITY OF AURORA STORM SEWER CONSTRUCTION STANDARDS AND SPECIFICATIONS, DATED MAY 1973.
5. ALL WATER DISTRIBUTION CONSTRUCTION SHALL CONFORM TO CITY OF AURORA WATER DISTRIBUTION DESIGN STANDARDS AND SPECIFICATIONS, DATED AUGUST 1977.
6. ALL MATERIALS AND WORKMANSHIP SHALL BE SUBJECT TO INSPECTION BY THE CITY OF AURORA. THE CITY OF AURORA RESERVES THE RIGHT TO ACCEPT OR REJECT ANY SUCH MATERIALS AND WORKMANSHIP THAT DOES NOT CONFORM TO CITY OF AURORA STANDARDS AND SPECIFICATIONS.
7. THE CONTRACTOR SHALL NOTIFY THE CITY OF AURORA PUBLIC IMPROVEMENT INSPECTION SECTION, 695–7504, TWENTY-FOUR (24) HOURS PRIOR TO THE BEGINNING OF CONSTRUCTION.
8. LOCATION OF EXISTING UTILITIES SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO ACTUAL CONSTRUCTION. FOR INFORMATION CONTACT: DENVER INTER—UTILITY GROUP, 534–6700.
9. THE CONTRACTOR SHALL HAVE ONE (1) SIGNED COPY OF THE PLANS (APPROVED BY THE CITY OF AURORA) AND ONE (1) COPY OF THE APPROPRIATE DESIGN AND CONSTRUCTION STANDARDS AND SPECIFICATIONS AT THE JOB SITE AT ALL TIMES.
10. CONCRETE SHALL NOT BE PLACED UNTIL THE FORMS HAVE BEEN INSPECTED AND A POUR SLIP ISSUED. POUR SLIPS WILL NOT BE ISSUED UNLESS THE CONTRACTOR HAS, AT THE JOB SITE, A COPY OF THE APPROVED PLANS BEARING THE SIGNATURE OF THE DIRECTOR OF PUBLIC WORKS AND WITH THE "APPROVED FOR CURB AND GUTTER ONLY" BLOCK INITIALED BY THE DIRECTOR OF PUBLIC WORKS' REPRESENTATIVE.
11. PAVING SHALL NOT START UNTIL A SOIL REPORT AND PAVEMENT DESIGN IS APPROVED BY THE CITY ENGINEER AND SUBGRADE COMPACTION TESTS ARE TAKEN AND APPROVED BY THE CITY ENGINEER.
12. ALL STATIONING IS BASED ON CENTERLINE OF ROADWAYS UNLESS OTHERWISE NOTED.
13. ALL ELEVATIONS ARE CENTERLINE UNLESS OTHERWISE NOTED.
14. COMPLY WITH STEARNS-ROGER SUPPLEMENTAL CONSTRUCTION SPECIFICATIONS ALONG WITH THE CITY OF AURORA'S CONSTRUCTION SPECIFICATIONS.
15. THE CONTRACTOR SHALL NOTIFY "COLORADO INTERSTATE GAS" PRIOR TO BEGINNING CONSTRUCTION, (364 - 2631).
16. STANDARD CITY OF AURORA HANDICAP RAMPS ARE TO BE CONSTRUCTED AT ALL CURB RETURNS AND AT ALL "T" INTERSECTIONS.

APPROVED FOR ONE YEAR FROM THIS DATE

1-6-82

Ted Fousse for	12-23-81
Director of Public Works	Date
	12/29/81
Planning and Traffic Engineer	Date
	12/24/81
Director of Utilities	Date
	12-23-81
Fire Department	Date

1/18



NO.	REVISIONS	DATE	BY	CH'D	APP'D
1	REVISED GAGE.	1/7/82	JLH		
2	REVISED GAGE.	2/11/82	JLH		
3	ADDED CHANNEL JOINT DETAIL	3/8/82	DB		

NO.	REFERENCE DRAWINGS

PRINT RECORD	
DATE	
FOR	
REVISED	
CUSTOMER	
FIELD	
INTRA CO.	

ENG. RECORD		
DRAWN	J.L.H.	3/81
CHECKED	DB	4/81
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		

DRAWING STATUS	
ISSUED	DATE
PRELIMINARY	6-17-81
FOR COMMENTS AND/OR APPROVAL	6-17-81
APPROVED FOR CONSTRUCTION 1-6-82	
REVISED & APPROVED FOR CONSTRUCTION REV. 2	

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED WITHOUT ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

TOWER CENTER FOR INDUSTRY
FILINGS 1, 2, & 3

DRAINAGE CHANNEL

PLAN AND PROFILE

DWG. NO. 5

SHEET NO.

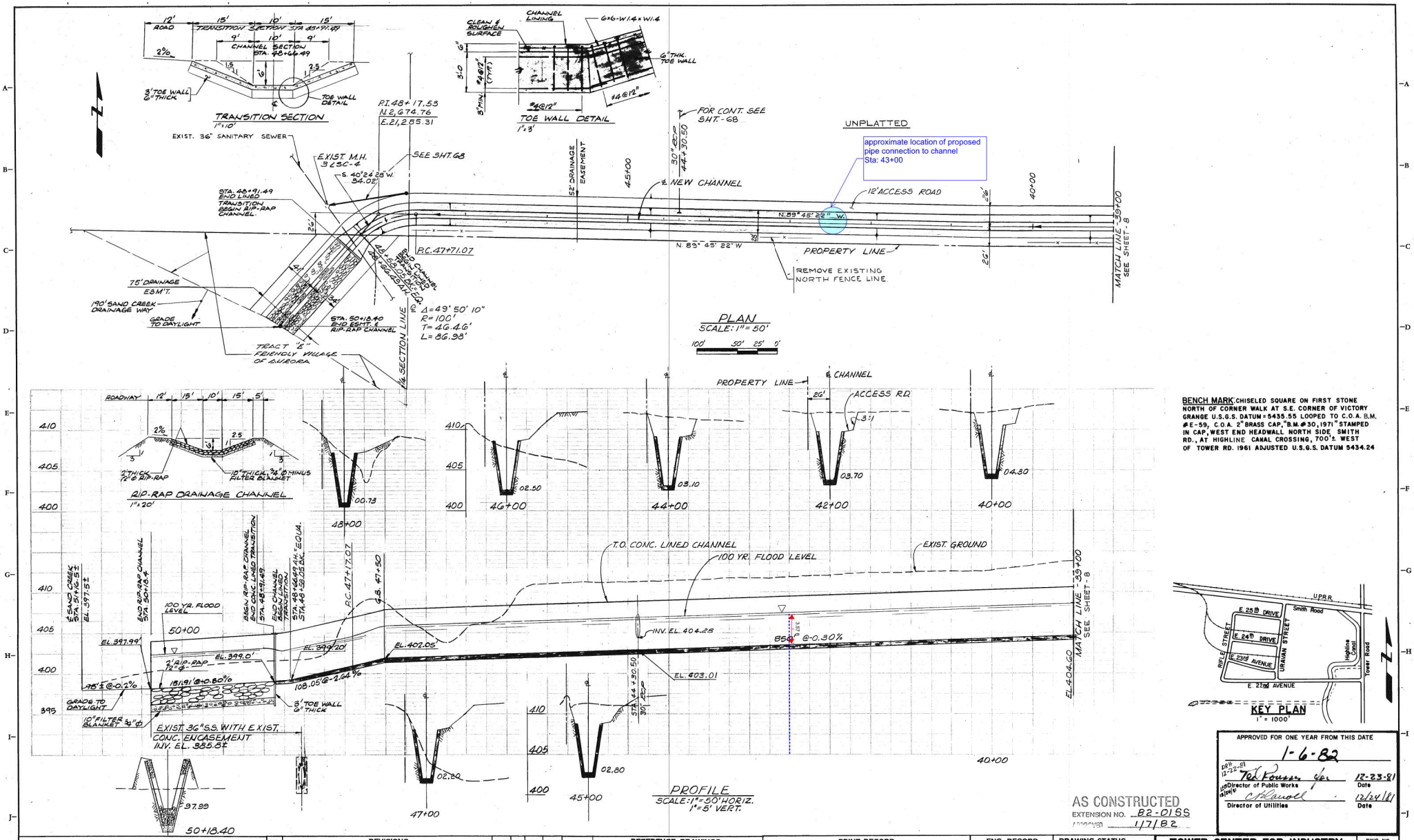
SCALE AS NOTED

ORDER NO. C-24694 REV. 3

stearns-roger architects

REV. 3-9-82

CB-2-1320



BENCH MARK: CHISELED SQUARE ON FIRST STONE NORTH OF CORNER WALK AT S.E. CORNER OF VICTORY GRANGE U.S.G.S. DATUM = 5435.55 LOOPED TO C.O.A. B.M. # E-59, C.O.A. 2" BRASS CAP, "B.M. # 30, 1971" STAMPED IN CAP, WEST END HEADWALL NORTH SIDE SMITH RD., AT HIGHLINE CANAL CROSSING, 700'± WEST OF TOWER RD. 1961 ADJUSTED U.S.G.S. DATUM 5434.24

APPROVED FOR ONE YEAR FROM THIS DATE
1-6-82

Director of Public Works — 12-23-81 Date

Director of Utilities — 12/24/81 Date

AS CONSTRUCTED
EXTENSION NO. 82-0155
APPROVED 1/7/82

NO.	REVISIONS	DATE	BY	CH'D	APP'D

REFERENCE DRAWINGS	NO.

PRINT RECORD	DATE
FOR	
REVISED	
CUSTOMER	
FIELD	
INTRA CO.	

ENG. RECORD		
DRAWN	JLH	3/81
CHECKED	DB	5/81
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		

DRAWING STATUS ISSUED	DATE
PRELIMINARY	6-17-81
FOR COMMENTS AND/OR APPROVAL	6-17-81
APPROVED FOR CONSTRUCTION	
REVISED & APPROVED FOR CONSTRUCTION REV.	

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

TOWER CENTER FOR INDUSTRY
FILINGS 1, 2, & 3

DRAINAGE CHANNEL

PLAN AND PROFILE

DWG. NO. 9

SHEET NO.

SCALE AS NOTED

ORDER NO. C-24694

REV. 0

stearns-roger architects LTD. P.O. BOX 5888 DENVER, COLORADO 80217

C8-2-1320

Form 22200-C1