PRELIMINARY DRAINAGE REPORT

STERLING HILLS SUBDIVISION FILING NO. 16
Sterling Hills Pkwy & E Villanova Pl
Aurora, Colorado

PREPARED FOR:
Calamar
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PREPARED BY:
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Contact: Scott Brown
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DATE:
February 14, 2024
Revised November 13, 2024

Approved For One Year From This Date	
______________________	
Aurora Water - Drainage Division	Date

ENGINEER'S STATEMENT

I affirm that this report and plan for the Final drainage design for Sterling Hills Subdivision Filing No. 16 was prepared by me (or under my direct supervision) in accordance with the provisions of the Storm Drainage Design and Technical Criterial for the owners thereof. I understand that the City of Aurora does not and will not assume liability for drainage facilities designed by others.

____ ____________________

Scott Brown, PE 0045900 Date
For and on behalf of Galloway & Company, Inc.

DEVELOPER'S CERTIFICATION

"Calamar hereby certifies that the drainage facilities for Sterling Hills Subdivision Filing No. 16 shall be constructed according to the design presented in this report. I understand that the City of Aurora does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that the City of Aurora reviews drainage plans pursuant to the Municipal Code; but cannot, on behalf of Sterling Hills Subdivision Filing No. 16, guarantee that final drainage design review will absolve Calamar and/or their successors and/or assigns of future liability for improper design."

____ ____________________

Authorized Signature Date
Calamar

Note: PDR approval is required prior to Civil Plan Approval.

TABLE OF CONTENTS

A. INTRODUCTION

1. LOCATION

The Calamar 55+ at Sterling Hills project - referred to herein as the 'site' or 'project site' - is generally located 0.30 miles east of S Tower Road and 0.50 miles south of E Illif Ave in Aurora, Colorado. The project site is bordered to the northwest by Sterling Hills Pkwy and a multi-family development; to the northeast by E Villanova Pl and single-family development; to the southeast by a multi-family development; to the southwest by E Water Drive. The project site is part of the Southwest Quarter of Section 27, T. 4 S., R. 66 W. of the 6^{th} P.M., County of Arapahoe, State of Colorado. On the following page is a Vicinity Map showing the project location and the surrounding area.

2. PROPOSED DEVELOPMENT

The proposed Calamar 55+ at Sterling Hills project site covers ±9.08 acres. Proposed improvements include a senior assisted-living building, garages, covered and uncovered parking areas, internal driveways and sidewalk, pedestrian sidewalk connections, wet/dry utilities, retaining walls, and landscaping areas. Proposed stormwater infrastructure will be private.

3. CHANGES TO MASTER DRAINAGE REPORT

No changes proposed at this time.

4. VARIANCES

A variance is being requested for the maximum velocity in the swale along the southeastern boundary of the site. Per table 7-2 of the City of Aurora Storm Drainage Design and Technical Criteria Manual, the maximum allowable velocity for the swale is 7.0 ft/s. The purpose of this swale is to convey the emergency overflow from the existing 50' inlets in Villanova Street. There is a significant amount of flow to these inlets, therefore the emergency overflow is over 230 cfs. With this large amount of flow and the steep longitudinal slope that is controlled by the existing grades to the southeast of the project site, it is very difficult to design a grass swale that can convey this amount of flow within the allowable velocity threshold. The proposed design will include installation of a liner (P550 turf reinforced mat) in order to create a stable channel even though the velocities will exceed the allowable threshold.

A variance is being requested for the emergency overflow path of the inlet at Design Point 3 because its emergency overflow path is toward the inlets at Design Points 1 and 4 which have overflow paths into Design Point 3. The inlet at Design Point 3 will instead be designed to handle two times the 100-year flow rate to provide redundancy for this low spot and therefore an emergency overflow path is no longer required.

B. HISTORIC DRAINAGE

1. DESCRIPTION OF PROPERTY AND DRAINAGE BASIN

The Calamar 55+ at Sterling Hills project site covers 9.08 acres, 8.17 acres of which is undeveloped overlot-graded land and a swale, and 0.91 acres contains a section of E Water Drive and the initial length of a drainage channel on the west side of E Water Drive. The project pad site was overlot-graded in a previous development effort. Existing drainage patterns are such that on-site runoff is collected by the existing swale along the SE edge of the site and is piped under E Water Drive to the drainage channel. The swale also captures some surface runoff from Subdivision Filing No. 13. Originally the swale was constructed as a drainage channel named Tributary 440702 but was redesigned and reconstructed with *Final Drainage Study for Subdivision Filing No. 11 (COA #202205)* so that flows from Subdivision Filings

No. 8-10 are piped underneath a swale which now only conveys emergency overflow from the two 50-foot sump inlets in E Villanova Place. The existing storm sewer main collects flows from Filings 8-10 at the inlets in E Villanova Pl, Subdivision Filing No. 13, and runoff generated in E Water Drive. Surface runoff flows from the swale also enter the storm sewer just before the pipe reaches E Water Drive. Combined on- and off-site flows in the storm sewer are routed under E Water Drive and outfall to the drainage channel on the southwest side of E Water Drive. The channel ultimately carries all runoff collected to a sub-regional detention and water quality pond to the west of Subdivision Filing No. 11 designed and constructed with *Final Drainage Report for Subdivision Filing No. 9 (COA #200017*) and redesigned with *Final Drainage Report for Sterling Hills West Metropolitan District – Filing No. 11 Detention Pond Improvements (EDN #220214)*.

According to the Natural Resources Conservation Service (NRCS) Web Soil Survey, the project site consists of a mix of soil types and Hydrologic Soil Groups (HSGs) including:

- Nunn Loam, HSG “C”
- Renohill-Buick Loams, HSG “D”

The predominant on-site HSG is “D”. Group D soils have a very slow infiltration rate when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission. See Appendix A for the soils report for the site.

The project site is located within FEMA Firm Panel 08005C0192L, effective 9/4/2020. The site is entirely in Zone X of an unnamed creek, aka No Name Creek. Said creek is located to the south of the project site, and no proposed improvements described in this report will impact the creek or floodplain. Refer to Appendix A for a FIRMette map of the project location.

There are no irrigation facilities within 100 feet of the project site and proposed development.

Offsite stormwater from Subdivision Filings 8-10 enters the site at the eastern corner, where it is piped from the inlets in E Villanova Pl and is routed underneath the existing swale. These flows are considered in the stormwater analysis of the project site since all proposed runoff from the site will be collected by the same storm sewer main. Emergency overflow from the inlets in Villanova will overtop the curb and flow south to the swale. A portion of stormwater from Subdivision Filing No. 13 enters the existing sewer main via piped flows and flows in the swale which drains to an existing inlet on the sewer main. Runoff flows from Subdivision Filing No. 13 and Subdivision Filing No. 11 that flow into E Water Drive enter the two 15-foot sump inlets in E Water Drive and combine with piped flows from the existing storm sewer. Thus these offsite flows are also considered in the project’s total stormwater discharge to the existing drainage channel southwest of E Water Drive.

Stormwater generated on the project site and travelling through the site ultimately outfalls to the sub-regional water quality and detention pond west of Subdivision Filing No. 11. This pond was originally designed in the Master Drainage Plan (MDR) *Final Drainage Report for Sterling Hills Subdivision Filing No. 9 (COA #200017)* to capture runoff from Subdivision Filings No. 8, 9, and 10, which Subdivision Filing No. 16 is a portion of the original Filing No. 9. Since the development of Filing No. 11 additional subdivisions have been developed and the pond received updates and recertification in 2020 with *Final Drainage Report Sterling Hills West Metropolitan District Filing No. 11 Detention Pond Improvements (COA #220214FD1)* where the pond was rehabilitated to provide water quality and detention for 234.0 acres (including the 9.08 acre project site area) with impervious area of 46.8%. *Filing No. 11* assumed that the project site would develop with 51.5% impervious area in their tributary calculations. The proposed Calamar development will continue to utilize this pond to provide water quality and detention for most of the project site.

C. DESIGN CRITERIA

1. HYDROLOGIC CRITIERIA

For urban catchments that are not complex and are generally 160 acres or less in size, it is acceptable that the design storm runoff be analyzed using the Rational Method. The Rational Method is often used when only the peak flow rate or total volume of runoff is needed (e.g., storm sewer sizing or simple detention basin sizing). The Rational Method was used to estimate the peak flow at each design point. For preliminary design, no routing (i.e., time attenuation) calculations were completed; this work will occur at Final Design. When a total flow is reported within this preliminary drainage report, assume it is simply a summation of all upstream flows.

The Rational Method is based on the Rational Formula:

$$Q = CiA$$

Where:

Q = the maximum rate of runoff, cfs

C = a runoff coefficient that is the ratio between the runoff volume from an area and the average rate of rainfall depth over a given duration for that area

i = average intensity of rainfall in inches per hour for a duration equal to the Time of Concentration (T_c)

A = area, acres

The 2-year and 100-year storm events are the basis for the preliminary drainage system design. The 2-year storm is considered the minor storm event. It has a fifty percent probability of exceedance during any given year. The 100-year storm is considered the major storm event. It has a one percent probability of exceedance during any given year. The following depths were used as the one-hour point precipitation depths in the Rational Method calculation per City of Aurora *Storm Drainage Design and Technical Criteria* and NOAA Atlas 14: 0.86 inches for the 2-year event; 2.43 inches for the 100-year event. See Appendix B for Rational Method calculations and peak flows for each storm event at each design point. A table of point precipitation frequency estimates from NOAA Atlas 14 is included in Appendix A.

Detention volume for on-site runoff was calculated using Mile High Flood District's Detention spreadsheet, MHFD-Detention v4.06.

2. HYDRAULIC CRITERIA

Street inlets within the Calamar 55+ at Sterling Hills project site will be sized in the Final Drainage Report using the Mile High Flood District Street and Inlet Hydraulics workbook, MHFD-Inlet v5.03. Pipes will be sized using Bentley FlowMaster. The system will be sized using the 2-year event and 100-year events. The 2-year drainage system, at a minimum, must be designed to transport runoff from the 2-year recurrence interval storm event with minimal disruption to the urban environment. The 100-year drainage system, as a minimum, must be designed to convey runoff from the 100-year recurrence interval flood to minimize life hazards and health, damage to structures, and interruption to traffic and services. All proposed storm infrastructure will be privately owned and maintained by the property owner.

Preliminary sizing of the water quality and detention pond was done using Mile High Flood District's Detention spreadsheet, MHFD-Detention v4.06.

Hydraulic analysis of the proposed storm system (inlets and pipes) will be conducted as part of Final Design and included in the Final Drainage Report.

D. DRAINAGE PLAN

1. GENERAL CONCEPT

The proposed development is divided into 16 basins. The site will ultimately consist of ground covered by pavement, rooftop, and landscaping. Runoff from B, C and D basins will be conveyed by curb and gutter to inlets, then routed to the existing storm sewer main along the southeast edge of the project site. Runoff from A basins will drain to proposed Pond A, and emergency overflows will travel to the existing swale. Proposed Pond A will provide full-spectrum detention for all A basins so that the proposed development does not exceed the planned tributary percent impervious area to the sub-regional pond calculated in *Final Drainage Report Sterling Hills West Metropolitan District Filing No. 11 Detention Pond Improvements (COA #220214FD1)*. The proposed site imperviousness listed in *Filing No. 11* is 51.5%, which is less than the percent impervious of 58.2% proposed in this report. Therefore, a small amount of full-spectrum detention is needed on-site to reduce the impervious area the proposed development contributes to the existing sub-regional pond. Outflows from the pond will be piped to the existing storm sewer along the southeast side of the site. Further discussion is found on page 11. Runoff from D basins will either be collected by an existing modified Type D inlet at the south corner of the pad area of the site or will follow existing drainage patterns in E Water Drive and enter the existing storm sewer at the existing sump inlets in E Water Drive. All runoff from the project site captured by storm sewer ultimately discharges to the downstream sub-regional detention pond re-designed in *Filing No. 11* to the west which is maintained by the Sterling Hills West Metropolitan District. This proposed drainage plan will not adversely affect downstream or upstream developments and maintains drainage patterns described in the MDR *Filing No. 9 (COA #200017)*.

2. SPECIFIC DETAILS

The following is a detailed description of the proposed on-site developed drainage patterns and off-site patterns. Refer to the Preliminary Drainage Plans submitted separately from this report.

Basin A-1 (0.26 ac, Q_2 = 0.4 cfs, Q_{100} = 1.2 cfs): a basin located in the northwest corner of the project site. It is comprised of landscape area, asphalt paving, sidewalks, and some roof area. Runoff in this basin is generally conveyed via sheet flow and curb and gutter to a proposed Type 13 sump inlet in the street at **Design Point 1**. Runoff collected here is routed to the inlet at Design Point 3. Emergency flows will bypass the inlet and flow to the proposed inlet at Design Point 3 in Basin A-3.

Basin A-2 (0.07 ac, Q_2 = 0.1 cfs, Q_{100} = 0.2 cfs): a basin located on the north side of the site. It is comprised primarily of landscape area. Runoff in this basin is generally conveyed via sheet flow and drainage swales to a proposed landscape inlet in a sump at **Design Point 2**. Runoff in this basin combines with flows from Design Point 1 and flow through proposed storm sewer to the inlet at Design Point 3. Emergency flows will pond until flows cross into Basin A-3 and flow to the proposed inlet at Design Point 3.

Basin A-3 (0.16 ac, Q_2 = 0.3 cfs, Q_{100} = 0.9 cfs): a basin located on the north of the site, southeast of Basin A-2. It contains landscape area, paved road and sidewalk area, and some roof area. Runoff in this basin is generally conveyed via sheet flow and curb and gutter to a proposed Type 13 sump inlet in the street at **Design Point 3**. Runoff collected from this basin combines with flows from Design Point 1 and 2 and moves through proposed storm sewer to the proposed inlet at Design Point 4 in Basin A-4.

Emergency flows will bypass the inlet and flow to the proposed inlet at Design Point 1 in Basin A-1 or the proposed inlet at Design Point 4 in Basin A-4.

Basin A-4 (0.22 ac, Q_2 = 0.4 cfs, Q_{100} = 1.1 cfs): a basin located on the north of the site, east of Basin A-3. It contains landscape area, paved road and sidewalk area, and a little roof area. Runoff in this basin is generally conveyed via sheet flow and curb and gutter to a proposed Type 13 sump inlet in the street at **Design Point 4**. Runoff collected from this basin combines with flows from Design Point 3 and moves through proposed storm sewer to the proposed detention pond at Design Point 7 in Basin A-7. Emergency flows will bypass the inlet and flow to the proposed inlet at Design Point 3 in Basin A-3.

Basin A-5 (0.11 ac, Q_2 = 0.1 cfs, Q_{100} = 0.2 cfs): a basin located on the north of the site, north of Basin A-4. It is comprised primarily of landscape area. Runoff in this basin is generally conveyed via sheet flow and drainage swales to a proposed landscape inlet in a sump at **Design Point 5**. Runoff in this basin combines with flows from Design Point 4 and flows through proposed detention pond at Design Point 7. Emergency flows will pond until flows cross into Basin A-4 and flow to the proposed inlet at Design Point 4.

Basin A-6 (0.26 ac, Q_2 = 0.6 cfs, Q_{100} = 1.7 cfs): a basin located on the north of the site, south of Basins A-3 and A-4. This area encompasses the norther portion of the roof and will convey flows to the proposed roof drain system, which will be directly connected to the storm sewer to the north. Runoff collected from this basin combines with flows from Design Points 4 and 5 and moves through proposed storm sewer to the proposed detention pond at Design Point 7.

Basin A-7 (0.57 ac, Q_2 = 0.3 cfs, Q_{100} = 0.7 cfs): a basin located in the northeast corner of the site. This area encompasses the proposed detention pond and is primarily comprised of landscaping. Runoff from this basin will be conveyed via overland flow the proposed detention pond **Design Point 7**. Once the flows have been released from the outlet structure, flows will discharge to the existing 48" public storm sewer system (EDN #202205) located on the east side of the site. Emergency flows will overtop the pond, discharge into the existing drainage swale on the east side of the site, and to an existing inlet at Design Point 14 in Basin D-2.

Basin B-1 (0.57 ac, Q_2 = 1.3 cfs, Q_{100} = 3.8 cfs): located near the center of the project site, this basin contains the roof area along the inner parking area. Runoff will sheet flow to and be collected by the proposed roof drain system. This roof drain system will be directly connected to the storm sewer system located in the center of the project site.

Basin B-2 (1.24 ac, Q_2 = 2.3 cfs, Q_{100} = 6.5 cfs): a basin located in the center of the project site, this basin contains car port roof area, landscape area, and paved road and sidewalk area. Runoff in this basin is generally conveyed via sheet flow and curb and gutter to a proposed Type R sump inlet at **Design Point 9**. Flows collected by this inlet combine with flows from the roof area of Basin B-1 and are routed via storm sewer to the manhole in Basin B-3. Emergency flows will flow into Basin B-3 and to the proposed inlet at Design Point 10.

Basin B-3 (1.19 ac, Q_2 = 2.0 cfs, Q_{100} = 5.7 cfs): a basin located on the east side of the project site. This basin contains landscape area, car port roofs, paved roads, and sidewalk area. Runoff in this basin is generally conveyed via sheet flow and curb and gutter to the proposed Type R sump inlet at **Design Point 10**. Flows to Design Point 10 combine with flows from Design Points 8 and 9 and are routed through proposed storm sewer to Design Point B [the existing 48" public storm sewer system (EDN

#202205)]. Emergency flows will pond until flows cross into Basin D-3 and flow to the existing inlet at Design Point 15.

Basin C-1 (0.36 ac, Q_2 = 0.4 cfs, Q_{100} = 1.2 cfs): a basin located in the northwest corner of the project site. This basin contains landscape area, green infrastructure pavement, sidewalks, and a drainage swale. Runoff in this basin sheet flows to the drainage swale and the concentrated flows are conveyed to a proposed landscape inlet in a sump at **Design Point 11**. Flows collected by the proposed inlet will be conveyed via storm sewer to Design Point C [the existing 48" public storm sewer system (EDN #202205)]. Emergency flows from this area will discharge to the proposed Type 13 inlet in a sump condition located at Design Point 1 in Basin A-1.

Basin C-2 (0.50 ac, Q_2 = 1.2 cfs, Q_{100} = 3.4 cfs): a basin located in the center of the project site from. This basin contains the roof area of the western and southern portions of the building. Runoff in this basin sheet flows to the proposed roof drain system, which will be directly connected to the storm sewer system that runs along the south face of the building. Flows from the basin will combine with flows from Basin C-1 and flow through the storm sewer system to Design Point C [the existing 48" public storm sewer system (EDN #202205)].

Basin D-1 (1.24 ac, Q_2 = 1.1 cfs, Q_{100} = 3.1 cfs): located along southwest edge of the project site, this basin contains landscape area and an existing paved road area for East Water Drive. Runoff from this basin sheet flows to the existing curb and gutter, which conveys concentrated flows to an existing Type R inlet located in a sump at **Design Point 13**. Flows continue through existing storm sewer to Design Point 15.

Basin D-2 (0.68 ac, Q_2 = 0.2 cfs, Q_{100} = 0.7 cfs): a basin located on the east side of the project site, it contains landscape area for the west portion of the existing drainage swale. Runoff from this basin will be conveyed via overland flow to the swale and then to an existing inlet at **Design Point 14**. Emergency flows will pond until crossing into Basin D-3, located in East Water Drive, to the existing inlet at Design Point 15.

Basin D-3 (0.72 ac, Q_2 = 0.9 cfs, Q_{100} = 2.4 cfs): a basin located in the southeast corner of the project site. This basin contains landscaping, paved roads, and sidewalks. Runoff from this basin is generally conveyed by curb and gutter to the existing 15' Type R inlet at **Design Point 15** on the north side of E Water Drive. Flows from the Basin will combine with flows from Basins D-1 and D-2. Additional offsite flows from Subdivision Filing No. 11 and Filing No. 13 are collected by the existing inlet at Design Point 15 to combine with runoff collected from Basin D-3. Flows continue through existing storm sewer to the existing 15' Type R inlet at Design Point D, which collects additional offsite flows before continuing to Basin E-1. Emergency flows at the existing inlets will overtop the curb and flow into the swale or drainage channel.

Basin E-1 (0.92 ac, Q_2 = 0.4 cfs, Q_{100} = 1.2 cfs): a basin comprised of the project site area south of E Water Drive, it consists of undeveloped land and a drainage channel. Runoff from this basin sheet flows to the drainage channel and concentrated flows combine with outfalling flows from Design Point A, B, C, and D and travel west via open channel to **Design Point E** and ultimately the sub-regional detention pond.

Currently the two existing 50-foot Type R sump inlets in E Villanova Place cannot capture all of the 100-year flows in the major event (230.3 cfs at Design Point A) which leads to flows overtopping the south-side curb and flowing into the existing swale. Using the MHFD-Inlet spreadsheet to calculate one inlet capacity, 10.1 inches of ponding is needed for each inlet to capture all 100-year flows, however, the current ponding depth is 0.5 inches less (9.6 inches of ponding) and thus flows overtop into the swale. See Appendix C for inlet capacity calculations. To create the ponding depth needed, a small berm will be graded behind the south-side inlet in-between the sidewalk and the existing swale. To provide protection for the swale in the emergency condition when emergency flows from E Villanova Place overtops the proposed berm, Galloway proposes lining the swale with turf reinforcement mat (TRM), specifically RollMax P550 from North American Green. Channel stabilization calculations are provided in Appendix C, and cross-sections of the swale are shown on the accompanying Preliminary Drainage Plans.

The proposed full spectrum detention pond, Pond A, will be located in Basin A-7 and will be designed to provide WQ, EURV, and 100-year detention for all A basins, which covers 1.66 acres and is 53.3% impervious. This is such that the impervious area the whole project site contributes to the sub-regional detention pond is no more than the impervious area assumed of the site in *Filing No. 11 Detention Pond Improvements (COA #220214FD1)*. Providing full-spectrum detention for all A basins removes 0.89 acres of impervious area (1.66 acres * 53.5% impervious) contributing runoff to the sub-regional pond, making it so that the project site only contributes 4.36 acres of impervious area (7.41 acres * 58.9% impervious). This is less impervious area than Filing No. 11 assumed for the project site in the pond rehabilitation calculations which was 4.67 acres (9.08 acres *51.5%). Therefore, the proposed site conforms to the rehabilitated capacity of the sub-regional pond.

Since the site is within an airport influence zone, so the pond is required to drain within 48 hours. Pond A will hold 0.030 ac-ft for the WQCV and release it in 24 hours, 0.085 ac-ft for the EURV+WQCV and release it in 40 hours, and 0.153 ac-ft for the total 100-year volume releasing in 48 hours. Outflow will be released through an outlet structure that includes an orifice plate to control EURV and WQ release rates, and an outlet pipe with a restrictor plate to control the 100-year release rate. These elements will be included in Final Design. Emergency overflow from Pond A will overtop the southeast bank and flow into Basin D-1 and the existing swale, onto the existing modified Type D inlet. Pond A will be privately owned and maintained by the property owner. Calculations for Pond A are provided in Appendix C.

For the total flows released from the Site, please refer to the table below:

Discharged From	*100-year Flows [cfs]*
Site	19.2
Pond A	2.0
Total from Proposed Site	**21.2**
Allowed from Site based on the approved Final Drainage Plan for Filing No. 14	**55.7**

Permanent stormwater control measures (SCMs) utilized with the proposed development include the proposed Pond A and the existing sub-regional detention pond. Both provide water quality and detention for the proposed development, as shown in this report's calculations and in *Filing No. 11 Detention Pond Improvements (COA #220214FD1).* Bioretention or a sand filter will be included with Pond A's final design.

E. CONCLUSIONS

1. COMPLIANCE WITH STANDARDS

The drainage design presented in the this Preliminary Drainage Report for the proposed Calamar 55+ at Sterling Hills development has been prepared in accordance with the design criteria and presented in the City of Aurora *Storm Drainage Design and Technical Criteria* manual and the Mile High Flood District *Urban Storm Drainage Criteria Manual Volume 1, 2 and 3*.

2. SUMMARY OF CONCEPTS

The proposed stormwater drainage design presented in this report follows existing drainage patterns and does not contribute additional runoff to the downstream sub-regional detention pond. The proposed Calamar 55+ at Sterling Hills development will not adversely affect the downstream and surrounding developments.

F. LIST OF REFERENCES

1. *Final Drainage Report for Sterling Hills Subdivision Filing No. 9*, Carroll & Lange, Inc., August 16, 2000.
   (COA #200017)

2. *Final Drainage Report Sterling Hills West Metropolitan District Filing No. 11 Detention Pond Improvements*, Wright Water Engineers, Inc., March 27, 2020.
   (COA #220214FD1)

3. *Final Drainage Study for Sterling Hills Subdivision Filing No. 11*, Jehn & Associates, Inc., August 8, 2002.
   (COA #202205)

4. Flood Insurance Rate Map – Arapahoe County, Colorado and Incorporated Areas Community Panel No. 08005C0192L, Effective September 4, 2020.

5. Point Precipitation Frequency Estimates – Aurora, Colorado, USA, available through NOAA Atlas 14 Precipitation Frequency Data Server, Retrieved February 2024.

6. Soil Map – Arapahoe County Area, Colorado as available through the Natural Resources Conservation Service National Cooperative Soil Survey web site via Web Soil Survey 2.0.

7. *Sterling Hills Subdivision Filing No. 15 Preliminary Drainage Report*, Dewberry & J3, August 16, 2019.
   (COA #220133)

8. Storm Drainage Design and Technical Criteria, City of Aurora, Effective November 9, 2023.

9. Urban Storm Drainage Criteria Manual, Mile High Flood District, January 2016 (with current revisions).

APPENDIX A

Exhibits and Figures

VICINITY MAP

SCALE: 1"=2000'

Map—Hydrologic Soil Group (Sterling Hills Pkwy & Villanova Pl)

Map Scale: 1:2,010 if printed on A portrait (8.5" x 11") sheet.

Meters 0 25 50 100 150

Feet 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

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

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

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: Arapahoe County, Colorado
Survey Area Data: Version 19, 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 imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group (Sterling Hills Pkwy & Villanova Pl)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
NlB	Nunn loam, 1 to 3 percent slopes	C	0.2	1.9%
RhD	Renohill-Buick loams, 3 to 9 percent slopes	D	8.9	98.1%
Totals for Area of Interest			**9.1**	**100.0%**

Rating Options—Hydrologic Soil Group (Sterling Hills Pkwy & Villanova Pl)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

NOAA Atlas 14, Volume 8, Version 2
Location name: Aurora, Colorado, USA*
Latitude: 39.6694°, Longitude: -104.7669°
Elevation: 5618 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.227** (0.183-0.284)	**0.282** (0.226-0.352)	**0.377** (0.302-0.473)	**0.463** (0.369-0.583)	**0.590** (0.458-0.778)	**0.696** (0.526-0.926)	**0.808** (0.589-1.10)	**0.928** (0.649-1.30)	**1.10** (0.737-1.57)	**1.23** (0.803-1.78)
10-min	**0.333** (0.268-0.416)	**0.412** (0.331-0.516)	**0.553** (0.443-0.692)	**0.678** (0.540-0.853)	**0.864** (0.671-1.14)	**1.02** (0.769-1.36)	**1.18** (0.862-1.61)	**1.36** (0.950-1.90)	**1.61** (1.08-2.30)	**1.80** (1.18-2.60)
15-min	**0.406** (0.326-0.507)	**0.503** (0.404-0.629)	**0.674** (0.540-0.844)	**0.827** (0.658-1.04)	**1.05** (0.818-1.39)	**1.24** (0.938-1.65)	**1.44** (1.05-1.96)	**1.66** (1.16-2.31)	**1.96** (1.32-2.80)	**2.20** (1.43-3.18)
30-min	**0.560** (0.450-0.699)	**0.692** (0.556-0.865)	**0.924** (0.740-1.16)	**1.13** (0.900-1.42)	**1.44** (1.12-1.90)	**1.69** (1.28-2.25)	**1.96** (1.43-2.67)	**2.25** (1.57-3.14)	**2.66** (1.78-3.81)	**2.98** (1.94-4.31)
60-min	**0.707** (0.569-0.883)	**0.864** (0.695-1.08)	**1.14** (0.916-1.43)	**1.40** (1.11-1.76)	**1.78** (1.38-2.34)	**2.09** (1.58-2.79)	**2.43** (1.78-3.32)	**2.80** (1.96-3.91)	**3.32** (2.23-4.75)	**3.73** (2.43-5.39)
2-hr	**0.854** (0.692-1.06)	**1.04** (0.838-1.29)	**1.36** (1.10-1.70)	**1.66** (1.33-2.08)	**2.11** (1.66-2.77)	**2.50** (1.90-3.30)	**2.90** (2.13-3.92)	**3.34** (2.36-4.64)	**3.97** (2.69-5.64)	**4.48** (2.94-6.41)
3-hr	**0.947** (0.769-1.17)	**1.14** (0.925-1.41)	**1.49** (1.20-1.84)	**1.81** (1.46-2.25)	**2.30** (1.81-3.00)	**2.72** (2.08-3.58)	**3.16** (2.34-4.26)	**3.65** (2.58-5.03)	**4.34** (2.95-6.13)	**4.90** (3.23-6.96)
6-hr	**1.14** (0.932-1.40)	**1.36** (1.12-1.67)	**1.77** (1.44-2.17)	**2.14** (1.73-2.64)	**2.70** (2.14-3.49)	**3.17** (2.44-4.13)	**3.68** (2.73-4.90)	**4.22** (3.01-5.77)	**5.00** (3.43-7.00)	**5.63** (3.75-7.93)
12-hr	**1.39** (1.15-1.69)	**1.67** (1.37-2.03)	**2.16** (1.77-2.63)	**2.59** (2.11-3.17)	**3.22** (2.56-4.11)	**3.75** (2.90-4.83)	**4.31** (3.22-5.67)	**4.90** (3.52-6.61)	**5.73** (3.96-7.92)	**6.40** (4.29-8.92)
24-hr	**1.70** (1.40-2.04)	**2.02** (1.67-2.44)	**2.57** (2.12-3.11)	**3.05** (2.50-3.71)	**3.75** (2.99-4.73)	**4.32** (3.36-5.50)	**4.91** (3.69-6.39)	**5.53** (4.00-7.38)	**6.40** (4.45-8.74)	**7.08** (4.79-9.77)
2-day	**2.02** (1.68-2.41)	**2.36** (1.97-2.83)	**2.95** (2.45-3.54)	**3.47** (2.86-4.17)	**4.20** (3.37-5.24)	**4.80** (3.76-6.05)	**5.41** (4.10-6.97)	**6.06** (4.41-8.00)	**6.95** (4.87-9.40)	**7.65** (5.22-10.5)
3-day	**2.19** (1.83-2.60)	**2.56** (2.14-3.05)	**3.19** (2.66-3.81)	**3.74** (3.10-4.48)	**4.51** (3.63-5.59)	**5.13** (4.04-6.43)	**5.78** (4.39-7.39)	**6.45** (4.71-8.45)	**7.36** (5.18-9.89)	**8.08** (5.54-11.0)
4-day	**2.32** (1.94-2.75)	**2.71** (2.28-3.22)	**3.38** (2.83-4.03)	**3.96** (3.29-4.72)	**4.77** (3.84-5.88)	**5.41** (4.27-6.75)	**6.08** (4.64-7.75)	**6.77** (4.96-8.84)	**7.71** (5.44-10.3)	**8.45** (5.81-11.4)
7-day	**2.65** (2.24-3.13)	**3.10** (2.61-3.65)	**3.84** (3.22-4.54)	**4.47** (3.73-5.30)	**5.35** (4.34-6.55)	**6.05** (4.79-7.49)	**6.77** (5.19-8.55)	**7.51** (5.53-9.71)	**8.51** (6.04-11.3)	**9.28** (6.42-12.5)
10-day	**2.96** (2.50-3.48)	**3.43** (2.90-4.03)	**4.21** (3.55-4.95)	**4.87** (4.08-5.75)	**5.79** (4.71-7.05)	**6.52** (5.19-8.03)	**7.27** (5.59-9.14)	**8.04** (5.94-10.3)	**9.07** (6.47-12.0)	**9.87** (6.86-13.2)
20-day	**3.84** (3.28-4.48)	**4.36** (3.71-5.08)	**5.22** (4.43-6.10)	**5.94** (5.01-6.96)	**6.94** (5.68-8.36)	**7.73** (6.19-9.42)	**8.53** (6.61-10.6)	**9.35** (6.97-11.9)	**10.4** (7.51-13.6)	**11.3** (7.92-14.9)
30-day	**4.56** (3.90-5.28)	**5.15** (4.40-5.97)	**6.12** (5.21-7.12)	**6.93** (5.87-8.08)	**8.03** (6.59-9.60)	**8.89** (7.14-10.8)	**9.74** (7.58-12.0)	**10.6** (7.94-13.4)	**11.7** (8.48-15.2)	**12.6** (8.89-16.6)
45-day	**5.42** (4.66-6.26)	**6.17** (5.29-7.12)	**7.36** (6.29-8.51)	**8.33** (7.08-9.67)	**9.62** (7.91-11.4)	**10.6** (8.53-12.7)	**11.5** (9.01-14.1)	**12.5** (9.37-15.6)	**13.7** (9.91-17.6)	**14.6** (10.3-19.0)
60-day	**6.14** (5.29-7.06)	**7.05** (6.06-8.11)	**8.49** (7.28-9.79)	**9.63** (8.22-11.1)	**11.1** (9.16-13.1)	**12.2** (9.87-14.6)	**13.3** (10.4-16.2)	**14.3** (10.8-17.8)	**15.6** (11.3-19.9)	**16.5** (11.7-21.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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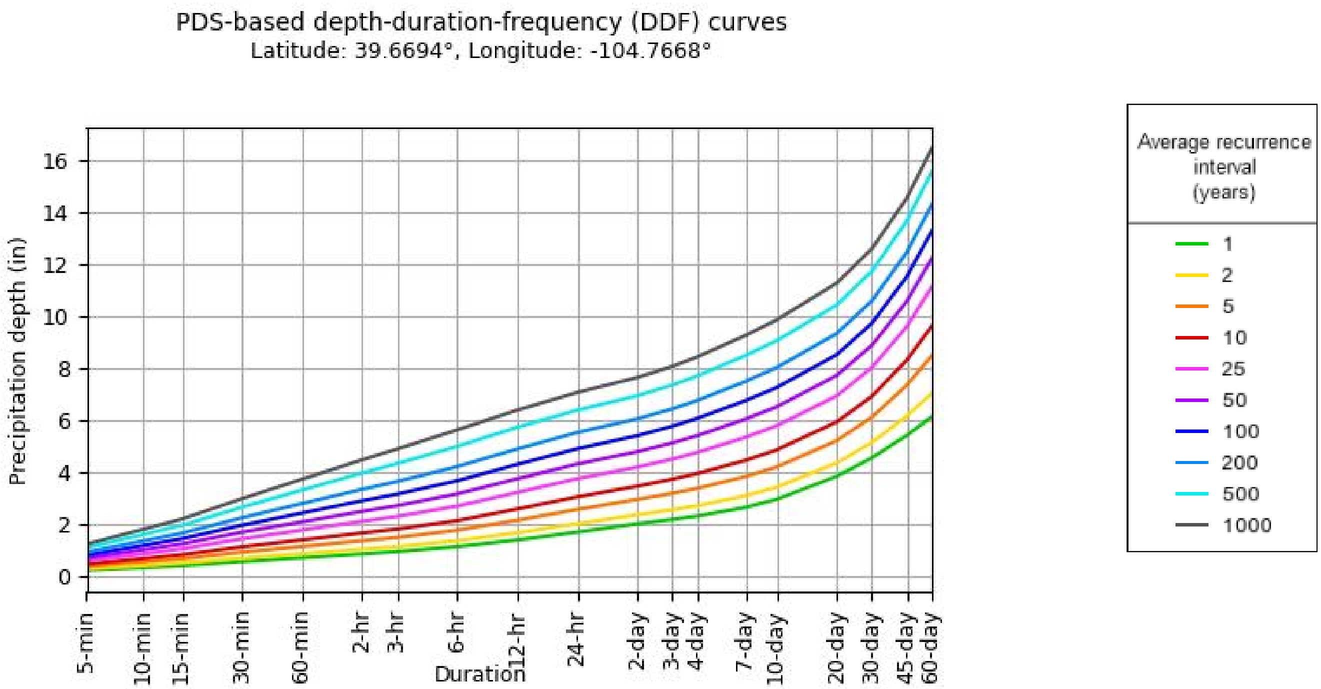
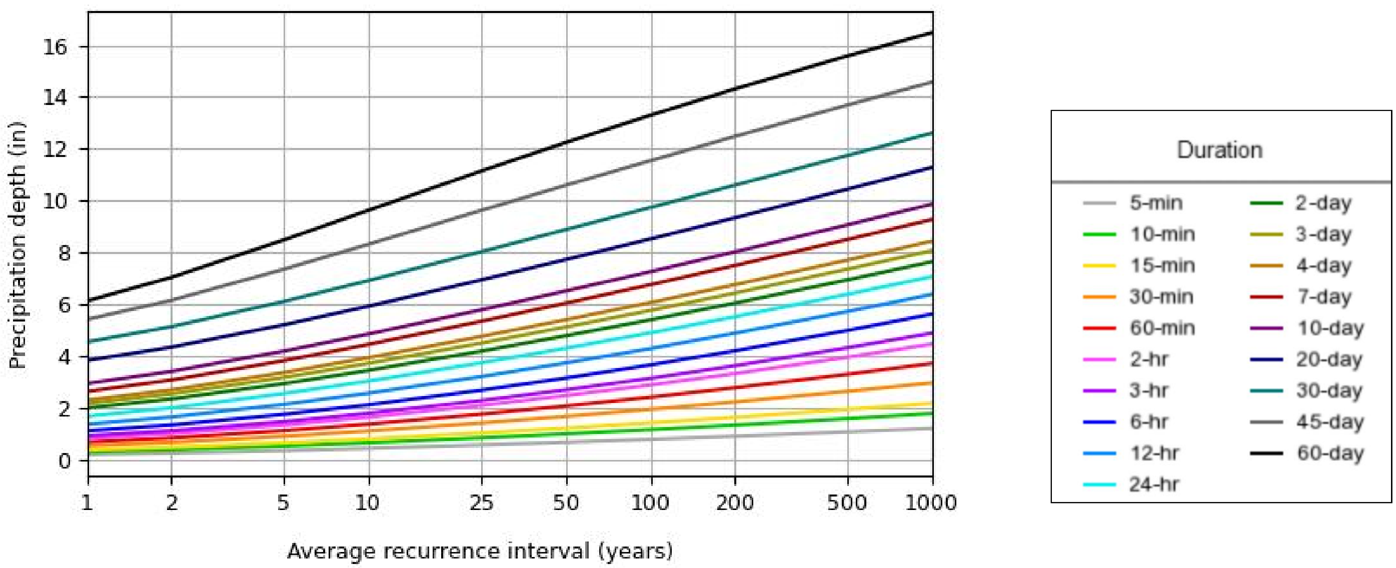
PF graphical





NOAA Atlas 14, Volume 8, Version 2 Created (GMT): Wed Aug 7 19:20:10 2024

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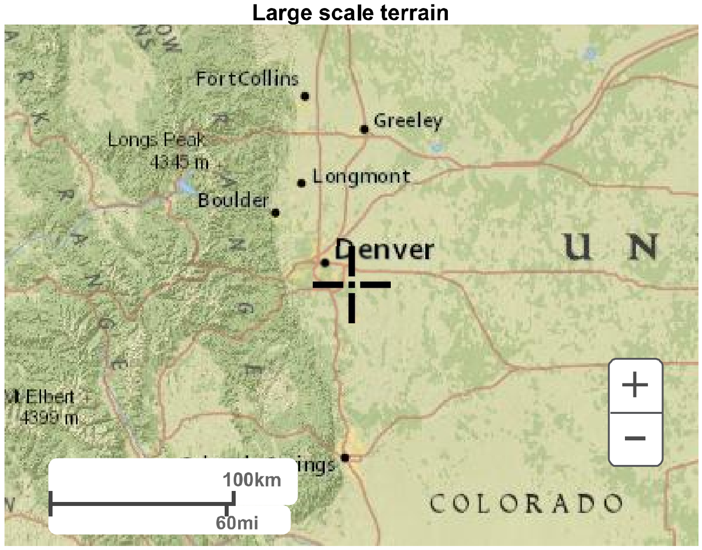
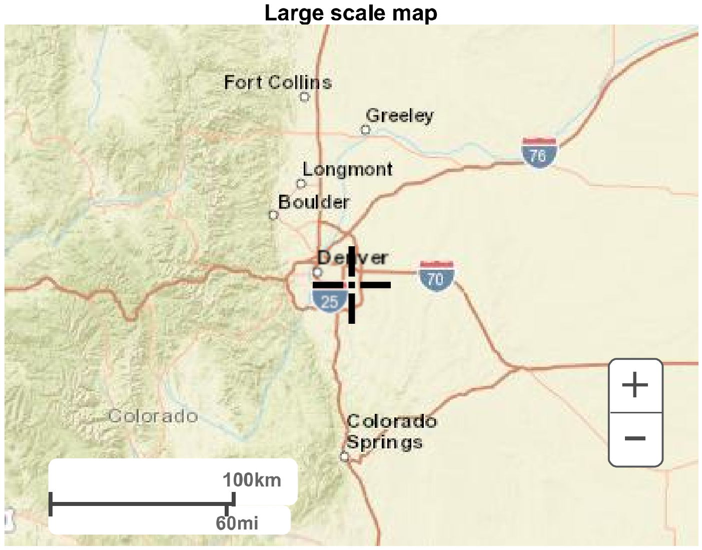
Maps & aerials

Small scale terrain

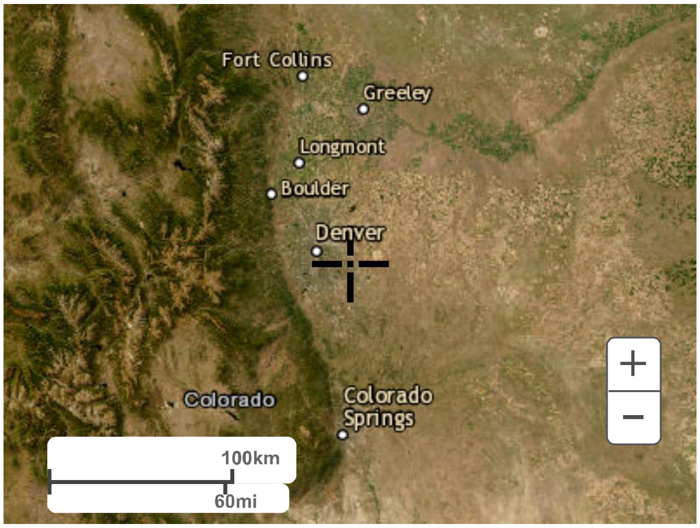
Large scale terrain



Large scale map



Large scale aerial



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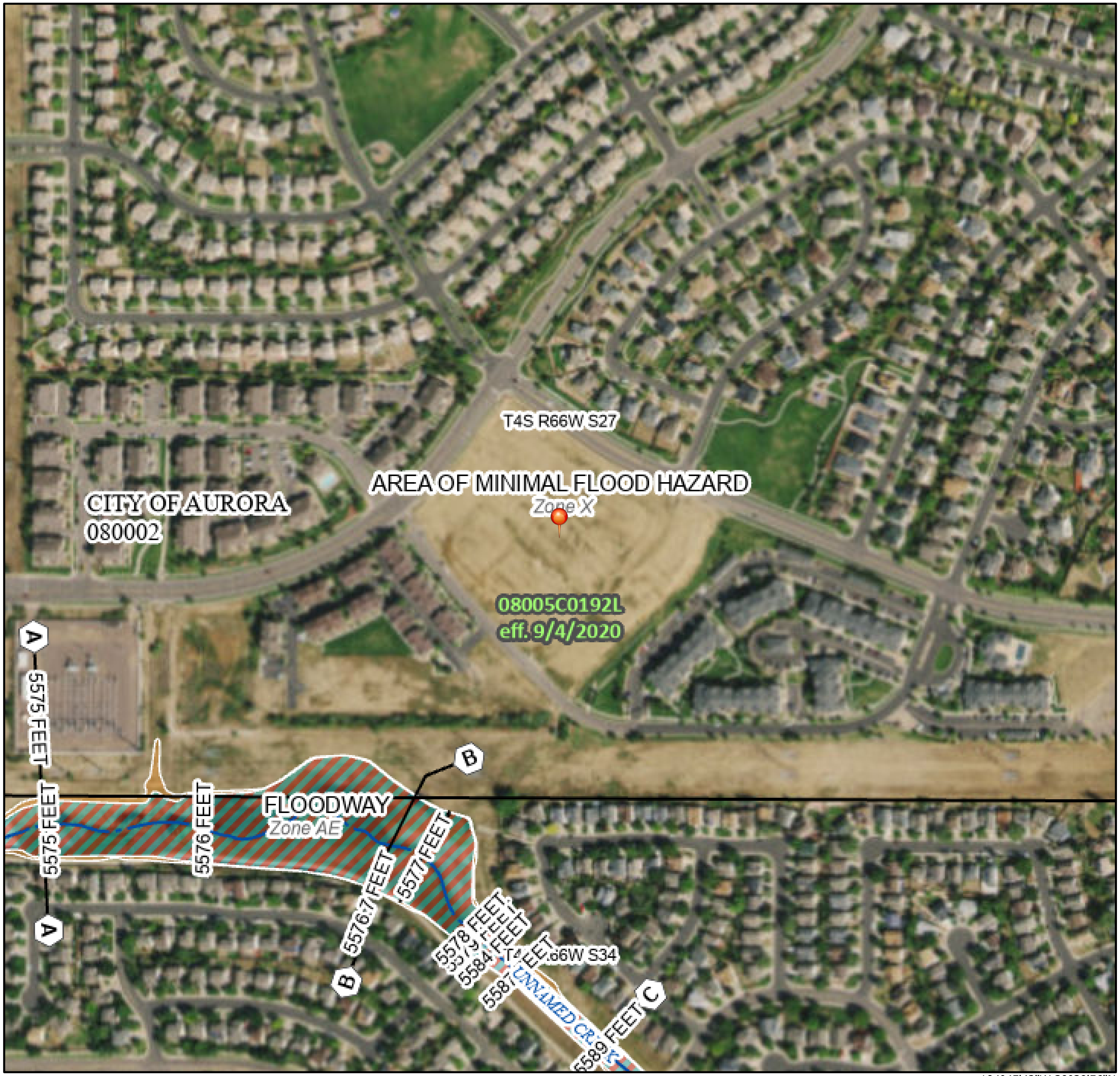
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

National Flood Hazard Layer FIRMette

FEMA

104°46'19"W 39°40'24"N



104°45'42"W 39°39'56"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 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
	8 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 2/6/2024 at 12:25 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.

APPENDIX B

Hydrologic Computations

COMPOSITE % IMPERVIOUS CALCULATIONS

Subdivision: Sterling Hills Subdivision Filing No. 15
Location: User Defined

Project Name: Calamar Senior Living - Sterling Hills
Project No.: CLM000007
Calculated By: ETA
Checked By: CMV
Date: 8/16/24

Basin ID	Total Area (ac)	Paved Roads/Concrete Walks/ Roofs			Landscaping			Grass Pavement			Basins Total Weighted % Imp.
		% Imp.	Area (ac)	Weighted % Imp.	% Imp.	Area (ac)	Weighted % Imp.	% Imp.	Area (ac)	Weighted % Imp.	
A-1	0.26	95%	0.15	52.7%	20%	0.10	7.7%	45%	0.02	2.7%	63.1%
A-2	0.07	95%	0.01	11.1%	20%	0.06	17.7%	45%	0.00	0.0%	28.8%
A-3	0.16	95%	0.12	74.0%	20%	0.03	4.4%	45%	0.00	0.0%	78.4%
A-4	0.22	95%	0.19	79.6%	20%	0.04	3.2%	45%	0.00	0.0%	82.8%
A-5	0.11	95%	0.01	4.3%	20%	0.11	19.1%	45%	0.00	0.0%	23.4%
A-6	0.26	95%	0.26	95.0%	20%	0.00	0.0%	45%	0.00	0.0%	95.0%
A-7	0.57	95%	0.01	2.4%	20%	0.56	19.5%	45%	0.00	0.0%	21.9%
To Proposed Pond	1.66	95%	0.75	42.7%	20%	0.90	10.8%	45%	0.02	0.4%	53.9%
B-1	0.57	95%	0.57	95.0%	20%	0.00	0.0%	45%	0.00	0.0%	95.0%
B-2	1.24	95%	0.99	76.0%	20%	0.25	4.0%	45%	0.00	0.0%	80.0%
B-3	1.19	95%	0.88	70.0%	20%	0.31	5.3%	45%	0.00	0.0%	75.2%
C-1	0.36	95%	0.10	25.9%	20%	0.18	9.9%	45%	0.08	10.5%	46.3%
C-2	0.50	95%	0.50	95.0%	20%	0.00	0.0%	45%	0.00	0.0%	95.0%
D-1	1.24	95%	0.39	29.8%	20%	0.83	13.4%	45%	0.02	0.7%	43.9%
D-2	0.68	95%	0.00	0.0%	20%	0.68	20.0%	45%	0.00	0.0%	20.0%
D-3	0.72	95%	0.40	52.2%	20%	0.32	9.0%	45%	0.00	0.0%	61.2%
E-1	0.92	95%	0.01	1.0%	20%	0.91	19.8%	45%	0.00	0.0%	20.8%
To Regional Pond	7.41	95%	3.83	49.1%	20%	3.48	9.4%	45%	0.10	0.6%	59.1%
Total Site	9.08	95%	4.58	47.9%	20%	4.38	9.7%	45%	0.12	0.6%	58.2%

STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: Sterling Hills Subdivision Filing No. 15
Location: User Defined

Project Name: Calamar Senior Living - Sterling Hills
Project No.: CLM000007
Calculated By: ETA
Checked By: CMV
Date: 8/16/24

SUB-BASIN DATA							INITIAL/OVERLAND (Sheet Flow) (T_i)			Shallow Concentrated Flows (T_t)					Tc CHECK (URBANIZED BASINS)			FINAL
BASIN ID	D.A. (AC)	Hydrologic Soils Group	Impervious (%)	C_{100}	C_5	C_2	L (FT)	S (%)	T_i (MIN)	L (FT)	S (%)	Cv	VEL. (FPS)	T_t (MIN)	COMP. T_c (MIN)	TOTAL LENGTH (FT)	Regional T_c (MIN)	T_c (MIN)
A-1	0.26	D	63.1	0.74	0.55	0.50	138	9.4	5.6	0	0.0	20.0	0.0	0.0	5.6	138.0	15.3	5.6
A-2	0.07	D	28.8	0.60	0.27	0.21	17	14.7	2.6	77	2.0	7.0	1.0	1.3	3.9	94.0	21.1	5.0
A-3	0.16	D	78.4	0.80	0.67	0.63	58	5.2	3.5	0	0.0	20.0	0.0	0.0	3.5	58.0	12.7	5.0
A-4	0.22	D	82.8	0.82	0.71	0.68	95	0.7	8.0	0	0.0	20.0	0.0	0.0	8.0	95.0	11.9	8.0
A-5	0.11	D	23.4	0.58	0.23	0.16	17	14.7	2.7	88	5.7	7.0	1.7	0.9	3.6	105.0	22.0	5.0
A-6	0.26	D	95.0	0.87	0.81	0.79	35	2.0	2.5	0	0.0	20.0	0.0	0.0	2.5	35.0	9.9	5.0
A-7	0.57	D	21.9	0.57	0.21	0.15	205	8.3	11.5	0	0.0	7.0	0.0	0.0	11.5	205.0	22.3	11.5
To Proposed Pond	1.66	D	53.9	0.70	0.47	0.42	-	-	-	-	-	-	-	-	-	-	-	11.5
B-1	0.57	D	95.0	0.87	0.81	0.79	35	2.0	2.5	0	0.0	20.0	0.0	0.0	2.5	35.0	9.9	5.0
B-2	1.24	D	80.0	0.81	0.69	0.65	151	2.6	6.7	0	0.0	20.0	0.0	0.0	6.7	151.0	12.4	6.7
B-3	1.19	D	75.2	0.79	0.65	0.61	250	6.0	7.2	41	3.5	20.0	3.7	0.2	7.4	291.0	13.2	7.4
C-1	0.36	D	46.3	0.67	0.41	0.35	56	29.0	3.1	124	1.5	20.0	2.4	0.8	3.9	180.0	18.1	5.0
C-2	0.50	D	95.0	0.87	0.81	0.79	35	2.0	2.5	0	0.0	20.0	0.0	0.0	2.5	35.0	9.9	5.0
D-1	1.24	D	43.9	0.66	0.39	0.33	247	9.5	9.7	193	1.8	20.0	2.7	1.2	10.9	440.0	18.5	10.9
D-2	0.68	D	20.0	0.57	0.20	0.14	250	8.8	12.7	366	2.3	7.0	1.1	5.7	18.3	616.0	22.6	18.3
D-3	0.72	D	61.2	0.73	0.53	0.48	250	5.9	9.1	240	1.3	20.0	2.3	1.8	10.9	490.0	15.6	10.9
E-1	0.92	D	20.8	0.57	0.20	0.14	0	0.0	0.0	399	1.0	7.0	0.7	9.5	9.5	399.0	22.5	9.5
To Regional Pond	7.41	D	59.1	0.73	0.52	0.46	-	-	-	-	-	-	-	-	-	-	-	18.3
Total Site	9.08	D	58.2	0.72	0.51	0.45	-	-	-	-	-	-	-	-	-	-	-	18.3

NOTES:
$T_i = (0.395*(1.1 - C_5)*(L)^{0.5})/((S)^{0.33})$, S in ft/ft
$T_t = L/60V$ (Velocity From Fig. 501)
Velocity $V = Cv*S^{0.5}$, S in ft/ft
$T_{regional} = (26-17I) + [L_t/(60(14I+9)(S_t^{1/2}))]$
For Urbanized basins a minimum T_c of 5.0 minutes is required.
For non-urbanized basins a minimum T_c of 10.0 minutes is required

Type of Land Surface	Cv
Heavy Meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

Galloway

STANDARD FORM SF-3
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Subdivision: Sterling Hills Subdivision Filing No. 15
Location: User Defined
Design Storm: 2-Year P1 = 0.864 inches

Project Name: Calamar Senior Living - Sterling Hills
Project No.: CLM000007
Calculated By: ETA
Checked By: CMV
Date: 8/16/24

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Slope (%)	Street Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	Tt (min)	
	A											67.8									Total flows at DP A (66.4 CFS upstream tributary from Filing No. 9 Report)
	1	A-1	0.26	0.55	5.6	0.15	2.84	0.4													Flows to inlet at DP 1. Then flows through sewer to DP 3.
	2	A-2	0.07	0.27	5.0	0.02	2.93	0.1													Flows to inlet at DP 2. Then flows through sewer to DP 3.
	3	A-3	0.16	0.67	5.0	0.11	2.93	0.3													Flows to inlet at DP 3.
									18.3	0.28	1.78	0.5									Total flows in the storm sewer at DP 3 (DP 1,2, 3). Flows then move through storm sewer to DP 4.
	4	A-4	0.22	0.71	8.0	0.16	2.54	0.4													Flows to inlet at DP 4. Then flows through sewer to DP 7.
									18.3	0.44	1.78	0.8									Total flows in the storm sewer at DP 4 (DP 1,2, 3, 4). Flows then move through storm sewer to DP 7.
	5	A-5	0.11	0.23	5.0	0.03	2.93	0.1													Flows to inlet at DP 5. Then flows through sewer to DP 7.
	6	A-6	0.26	0.81	5.0	0.21	2.93	0.6													Roof drain flows from DP 6 that are conveyed to DP 7.
									18.3	0.68	1.78	1.2									Total flows in the storm sewer after DP 4 (DP1, 2, 3, 4, 5, 6). Flows then move through storm sewer to Pond at DP 7.
	7	A-7	0.57	0.21	11.5	0.12	2.21	0.3													Flows into the pond at DP 7.
									18.3	0.80	1.78	1.4									Total flows to the pond at DP 7 (DP 1, 2, 3, 4, 5, 6, 7). Flows then discharge to the existing storm sewer DP A (EDN202205).
	B											71.5									Total flows at DP B
	8	B-1	0.57	0.81	5.00	0.46	2.93	1.3													Roof drain flows from DP 8 to the storm sewer downstream of DP 9.
	9	B-2	1.24	0.69	6.67	0.86	2.70	2.3													Flows to inlet at DP 9. Then flows through sewer to DP B.
	10	B-3	1.19	0.65	7.35	0.77	2.61	2.0													Flows to inlet at DP 10. Then flows through sewer to DP B.
									18.3	2.09	1.78	3.7									Total flows in the existing storm sewer to DP B (DP 8, 9, 10). Flows then move through storm sewer to DP C.

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

Equation 5-1

Galloway

STANDARD FORM SF-3
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Subdivision: Sterling Hills Subdivision Filing No. 15
Location: User Defined
Design Storm: 2-Year P1 = 0.864 inches

Project Name: Calamar Senior Living - Sterling Hills
Project No.: CLM000007
Calculated By: ETA
Checked By: CMV
Date: 8/16/24

STREET		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
	Design Point	Basin ID	Area (Ac)	Runoff Coeff.	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Slope (%)	Street Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	Tt (min)	
	C											72.5									Total flows at DP C Flows then move through storm sewer to DP D.
	11	C-1	0.36	0.41	5.00	0.15	2.93	0.4													Flows to inlet at DP 14. Then flows through sewer to DP C.
	12	C-2	0.50	0.81	5.00	0.41	2.93	1.2													Roof drain flows from DP 12 that are conveyed to DP C.
									18.3	0.56	1.78	1.0									Total flows in the storm sewer to DP C (DP 11, 12). Flows then move through storm sewer to DP D.
	D											74.3									Total flows at DP D
	13	D-1	1.24	0.39	10.9	0.48	2.26	1.1													Flows to inlet at DP 13. Then flows through sewer to DP 15.
	14	D-2	0.68	0.20	18.3	0.14	1.78	0.2													Flows to inlet at DP 14. Then flows through sewer to DP 15.
									18.3	0.62	1.78	1.1									Total flows in the storm sewer at DP 14 (DP 13, 14). Flows then move through storm sewer to DP D.
	15	D-3	0.72	0.53	10.9	0.38	2.26	0.9													Flows to inlet at DP 15.
									18.3	1.00	1.78	1.8									Total flows in the storm sewer at DP 15 (DP 13, 14, 15). Flows then move through storm sewer to DP D.
	E											74.6									Total flows at DP E
	16	E-1	0.92	0.20	9.5	0.18	2.38	0.4													Flows to open channel at DP 16
									18.3	0.18	1.78	0.3									Flows to open channel at DP 16

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

Equation 5-1

Galloway

STANDARD FORM SF-3
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Subdivision: Sterling Hills Subdivision Filing No. 15
Location: User Defined
Design Storm: 100-Year P1 = 2.43 inches

Project Name: Calamar Senior Living - Sterling Hills
Project No.: CLM000007
Calculated By: ETA
Checked By: CMV
Date: 8/16/24

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
STREET	Design Point	Basin ID	Area (Ac)	Runoff Coeff.	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Slope (%)	Street Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	Tt (min)	REMARKS
	A											234.3									Total flows at DP A (230.3 CFS upstream tributary from Filing No. 9 Report)
	1	A-1	0.26	0.55	5.6	0.15	7.99	1.2													Flows to inlet at DP 1. Then flows through sewer to DP 3.
	2	A-2	0.07	0.27	5.0	0.02	8.24	0.2													Flows to inlet at DP 2. Then flows through sewer to DP 3.
	3	A-3	0.16	0.67	5.0	0.11	8.24	0.9													Flows to inlet at DP 3.
									18.3	0.28	5.00	1.4									Total flows in the storm sewer at DP 3 (DP 1,2, 3). Flows then move through storm sewer to DP 4.
	4	A-4	0.22	0.71	8.0	0.16	7.14	1.1													Flows to inlet at DP 4. Then flows through sewer to DP 7.
									18.3	0.44	5.00	2.2									Total flows in the storm sewer at DP 4 (DP 1,2, 3, 4). Flows then move through storm sewer to DP 7.
	5	A-5	0.11	0.23	5.0	0.03	8.24	0.2													Flows to inlet at DP 5. Then flows through sewer to DP 7.
	6	A-6	0.26	0.81	5.0	0.21	8.24	1.7													Roof drain flows from DP 6 that are conveyed to DP 7.
									18.3	0.68	5.00	3.4									Total flows in the storm sewer after DP 4 (DP1, 2, 3, 4, 5, 6). Flows then move through storm sewer to Pond at DP 7.
	7	A-7	0.57	0.21	11.5	0.12	6.20	0.7													Flows into the pond at DP 7.
									18.3	0.80	5.00	4.0									Total flows to the pond at DP 7 (DP 1, 2, 3, 4, 5, 6, 7). Flows then discharge to the existing storm sewer DP A (EDN202205).
	B											244.8									Total flows at DP B
	8	B-1	0.57	0.81	5.00	0.46	8.24	3.8													Roof drain flows from DP 8 to the storm sewer downstream of DP 9.
	9	B-2	1.24	0.69	6.67	0.86	7.59	6.5													Flows to inlet at DP 9. Then flows through sewer to DP B.
	10	B-3	1.19	0.65	7.35	0.77	7.35	5.7													Flows to inlet at DP 10. Then flows through sewer to DP B.
									18.3	2.09	5.00	10.5									Total flows in the existing storm sewer to DP B (DP 8, 9, 10). Flows then move through storm sewer to DP C.

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

Equation 5-1

Galloway

STANDARD FORM SF-3
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Subdivision: Sterling Hills Subdivision Filing No. 15
Location: User Defined
Design Storm: 100-Year P1 = 2.43 inches

Project Name: Calamar Senior Living - Sterling Hills
Project No.: CLM000007
Calculated By: ETA
Checked By: CMV
Date: 8/16/24

STREET		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
	Design Point	Basin ID	Area (Ac)	Runoff Coeff.	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Slope (%)	Street Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	Tt (min)	
	C											247.6									Total flows at DP C Flows then move through storm sewer to DP D.
	11	C-1	0.36	0.41	5.0	0.15	8.24	1.2													Flows to inlet at DP 14. Then flows through sewer to DP C.
	12	C-2	0.50	0.81	5.0	0.41	8.24	3.4													Roof drain flows from DP 12 that are conveyed to DP C.
									18.3	0.56	5.00	2.8									Total flows in the storm sewer to DP C (DP 11, 12). Flows then move through storm sewer to DP D.
	D											252.6									Total flows at DP D
	13	D-1	1.24	0.39	10.9	0.48	6.36	3.1													Flows to inlet at DP 13. Then flows through sewer to DP 15.
	14	D-2	0.68	0.20	18.3	0.14	5.00	0.7													Flows to inlet at DP 14. Then flows through sewer to DP 15.
									18.3	0.62	5.00	3.1									Total flows in the storm sewer at DP 14 (DP 13, 14). Flows then move through storm sewer to DP D.
	15	D-3	0.72	0.53	10.9	0.38	6.35	2.4													Flows to inlet at DP 15.
									18.3	1.00	5.00	5.0									Total flows in the storm sewer at DP 15 (DP 13, 14, 15). Flows then move through storm sewer to DP D.
	E											253.5									Total flows at DP E
	16	E-1	0.92	0.20	9.5	0.18	6.71	1.2													Flows to open channel at DP 16
									18.3	0.18	5.00	0.9									Flows to open channel at DP 16

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

Equation 5-1

Galloway

DETENTION POND TRIBUTARY AREAS

Subdivision: Sterling Hills Subdivision Filing No. 15
Location: User Defined

Project Name: Calamar Senior Living - Sterling Hills
Project No.: CLM000007
Calculated By: ETA
Checked By: CMV
Date: 8/16/24

Pond 100

Basin	Area	% Imp
A-1	0.26	63.1%
A-2	0.07	28.8%
A-3	0.16	78.4%
A-4	0.22	82.8%
A-5	0.11	23.4%
A-6	0.26	95.0%
A-7	0.57	21.9%
Total	1.66	53.9%

Galloway

APPENDIX C

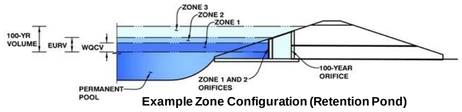
Hydraulic Computations

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: Calamar - Sterling Hills

Basin ID: Onsite Detention Pond



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB			
Watershed Area =	1.66	acres		
Watershed Length =	512	ft		
Watershed Length to Centroid =	256	ft		
Watershed Slope =	0.060	ft/ft		
Watershed Imperviousness =	53.90%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	100.0%	percent		
Target WQCV Drain Time =	24.0	hours	Drain Time Too Short	
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) =	0.030	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.085	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.86 in.) =	0.056	acre-feet	0.86	inches
5-yr Runoff Volume (P1 = 1.14 in.) =	0.085	acre-feet	1.14	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	0.117	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.78 in.) =	0.172	acre-feet	1.78	inches
50-yr Runoff Volume (P1 = 2.09 in.) =	0.214	acre-feet	2.09	inches
100-yr Runoff Volume (P1 = 2.43 in.) =	0.265	acre-feet	2.43	inches
500-yr Runoff Volume (P1 = 3.32 in.) =	0.389	acre-feet	3.32	inches
Approximate 2-yr Detention Volume =	0.055	acre-feet		
Approximate 5-yr Detention Volume =	0.084	acre-feet		
Approximate 10-yr Detention Volume =	0.101	acre-feet		
Approximate 25-yr Detention Volume =	0.121	acre-feet		
Approximate 50-yr Detention Volume =	0.131	acre-feet		
Approximate 100-yr Detention Volume =	0.153	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.030	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.055	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.067	acre-feet
Total Detention Basin Volume =	0.153	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		
5614	--	1.00	--	--	--	1,292	0.030	646	0.015
5615	--	2.00	--	--	--	2,028	0.047	2,306	0.053
5616	--	3.00	--	--	--	2,869	0.066	4,754	0.109
5617	--	4.00	--	--	--	3,814	0.088	8,096	0.186
5618	--	5.00	--	--	--	4,864	0.112	12,435	0.285
5619	--	6.00	--	--	--	6,171	0.142	17,952	0.412
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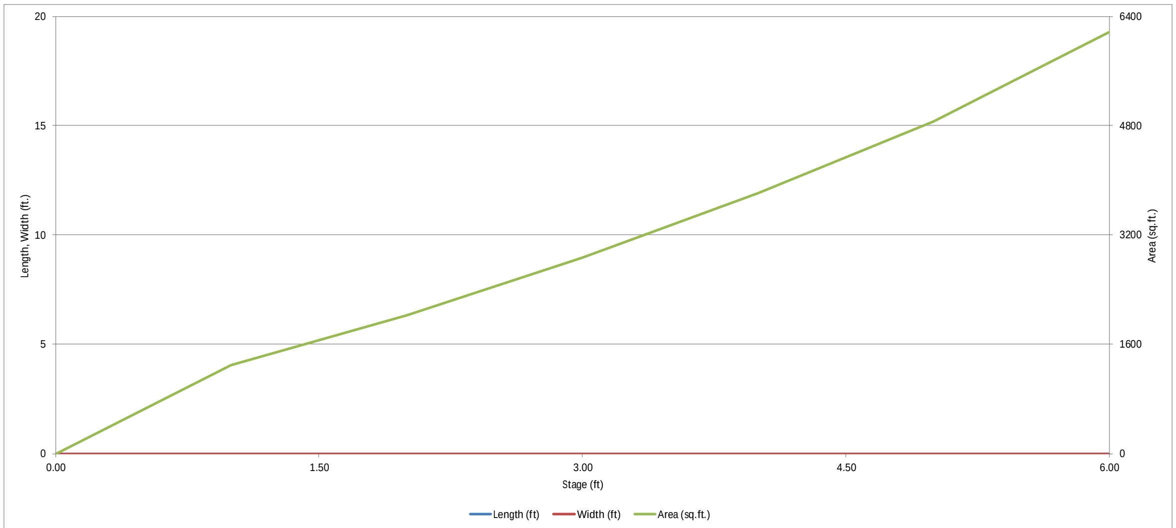
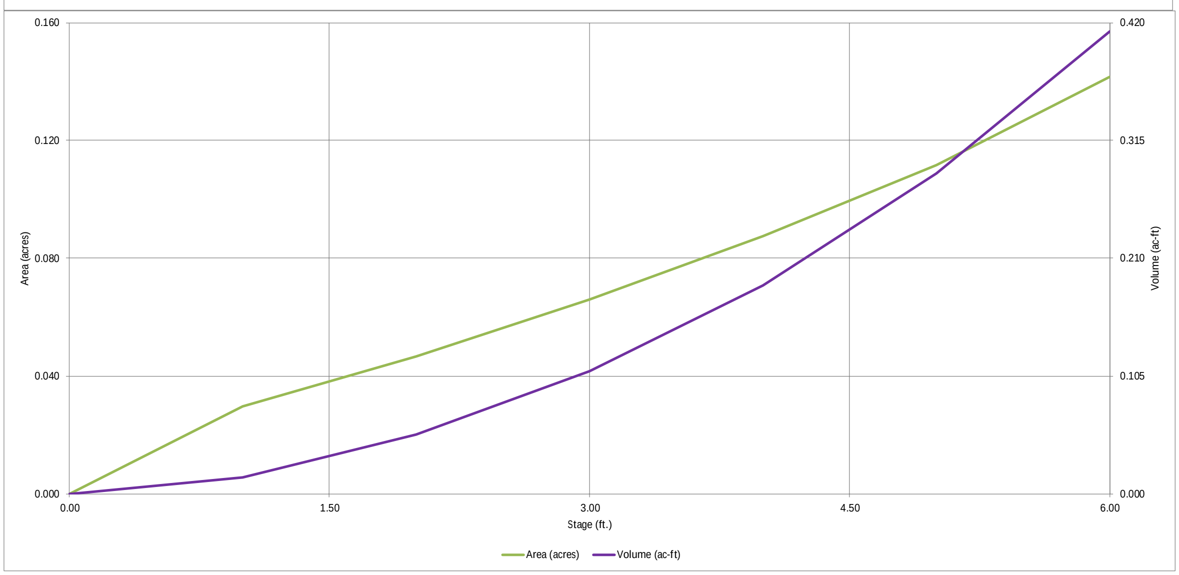
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



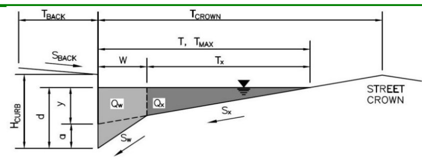


ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Lot 1, Block 1, Sterling Hills Subdivision Filing No. 14

Inlet ID: Villanova Inlets



Gutter Geometry:

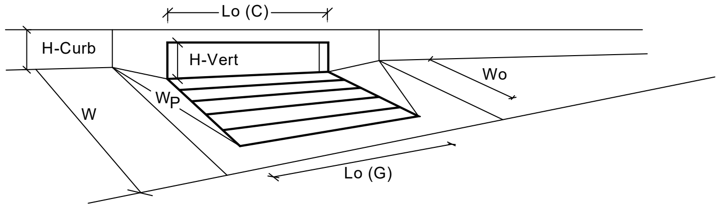
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	13.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.015		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.012		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	23.2		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.035		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	23.2	23.2	ft
Warning 02 Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	7.0	11.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

MINOR STORM Allowable Capacity is not applicable to Sump Condition
MAJOR STORM Allowable Capacity is not applicable to Sump Condition

	Minor Storm	Major Storm	
Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLEΤ IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)



CDOT Type R Curb Opening

Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	7.0	10.9	Override Depths
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	50.00	50.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.42	0.74	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.84	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**43.3**	**116.1**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	33.2	115.2	cfs

TO BE FINALIZED IN FDR
NOT APPROVED IN PDR

DP 1

Type 13 Inlet Capacity Chart

Subdivision: Sterling Hills Filing No. 15
Location: Aurora, CO

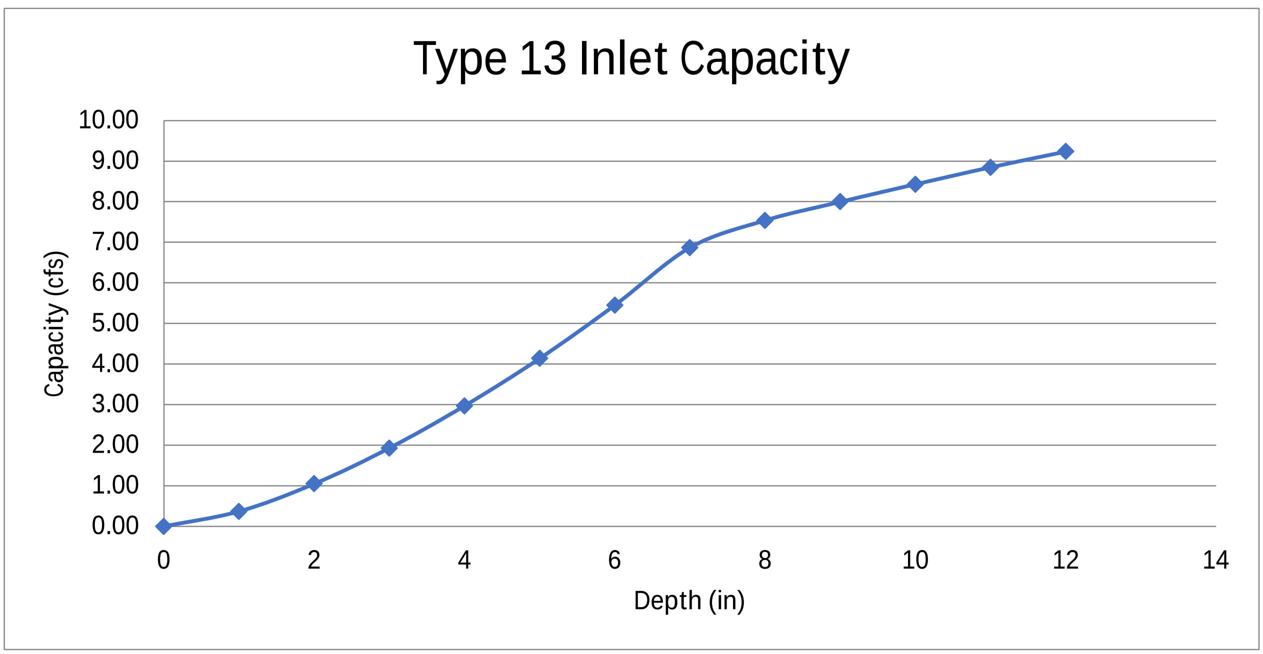
Project Name: Calamar 55+
Project No.: CLM07
Calculated By: Casey Volt
Checked By: Scott Brown
Date: 8/15/24

100-year runoff to inlet = 1.2 cfs.

3" depth required + 1" to account for the grate depression = 4"

Type 13 Inlet Capacity

Depth (in)	Capacity (cfs)
0	0.00
1	0.37
2	1.05
3	1.93
4	2.97
5	4.14
6	5.45
7	6.87
8	7.54
9	8.00
10	8.43
11	8.85
12	9.24



Capacity was calculated using the MHFD Detention v2.35 spreadsheet
Calculation accounts for the both the weir and orifice equations
Calculations include a 50% clogging factor.

DP 2

TO BE FINALIZED IN FDR
NOT APPROVED IN PDR

ADS Nyloplast

Nyloplast Inlet Capacity Table

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Input

Type of Grate	6" Drop In
Head (ft)	1.5

Properties

Orifice Flow Area (in)	9.98
Orifice Flow Area (ft)	0.07
Weir Flow Perimeter (in)	16.40
Weir Flow Perimeter (ft)	1.37

Solution

Capacity (cfs)	0.41
Capacity (gpm)	182.18

100-year runoff to inlet = 0.1 cfs.

$$Q_{weir} = CLH^{3/2}$$

$C = 3.33$ *Weir Discharge Coefficient*

$L =$ *Perimeter of Grate Opening* (ft)

$H =$ *Flow Height of Water Surface Above Weir* (ft)

$$Q_{orifice} = CA\sqrt{2gh}$$

$C = 0.60$ *Orifice Discharge Coefficient*

$A =$ *Area of the Orifice* (ft^2)

$g =$ *Gravitational Constant* $\left(32.2\frac{ft}{s^2}\right)$

$H =$ *Depth of Water Above Center of Orifice* (ft)

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DP 2

TO BE FINALIZED IN FDR
NOT APPROVED IN PDR

ADS Nyloplast

Nyloplast Inlet Capacity Table

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Input

Type of Grate	6" Drop In
Head (ft)	0.1

Required head/depth for 100-yr flow to inlet (0.1 cfs)

Properties

Orifice Flow Area (in)	9.98
Orifice Flow Area (ft)	0.07
Weir Flow Perimeter (in)	16.40
Weir Flow Perimeter (ft)	1.37

Solution

Capacity (cfs)	0.10
Capacity (gpm)	47.04

$$Q_{weir} = CLH^{3/2}$$

$C = 3.33$ *Weir Discharge Coefficient*

$L =$ *Perimeter of Grate Opening (ft)*

$H =$ *Flow Height of Water Surface Above Weir (ft)*

$$Q_{orifice} = CA\sqrt{2gh}$$

$C = 0.60$ *Orifice Discharge Coefficient*

$A =$ *Area of the Orifice* (ft^2)

$g =$ *Gravitational Constant* $\left(32.2\frac{ft}{s^2}\right)$

$H =$ *Depth of Water Above Center of Orifice (ft)*

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NOT APPROVED IN PDR

DP 3

Type 13 Inlet Capacity Chart

Subdivision: Sterling Hills Filing No. 15
Location: Aurora, CO

Project Name: Calamar 55+
Project No.: CLM07
Calculated By: Casey Volt
Checked By: Scott Brown
Date: 8/15/24

100-year runoff to inlet = 0.9 cfs.

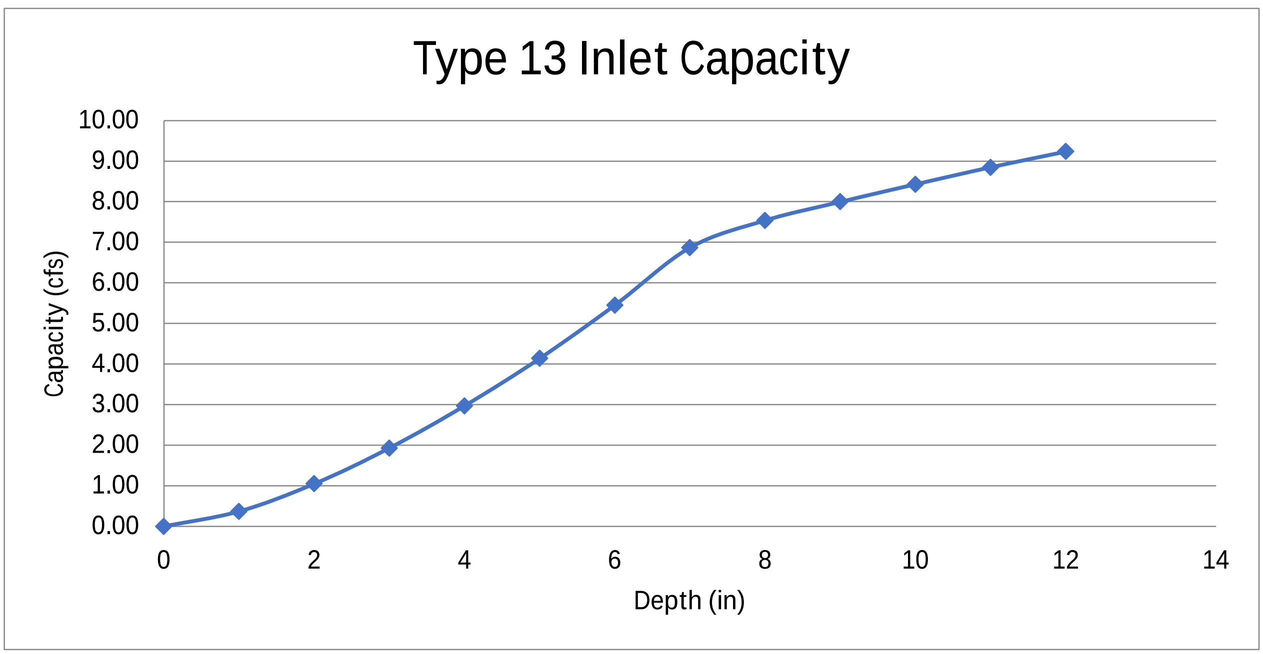
2" depth required + 1" to account for the grate depression = 3"

2x 100-year runoff to inlet = 1.8 cfs

3" depth required + 1" to account for the grate depression = 4"

Type 13 Inlet Capacity

Depth (in)	Capacity (cfs)
0	0.00
1	0.37
2	1.05
3	1.93
4	2.97
5	4.14
6	5.45
7	6.87
8	7.54
9	8.00
10	8.43
11	8.85
12	9.24



Capacity was calculated using the MHFD Detention v2.35 spreadsheet
Calculation accounts for the both the weir and orifice equations
Calculations include a 50% clogging factor.

TO BE FINALIZED IN FDR
NOT APPROVED IN PDR

DP 4

Type 13 Inlet Capacity Chart

Subdivision: Sterling Hills Filing No. 15
Location: Aurora, CO

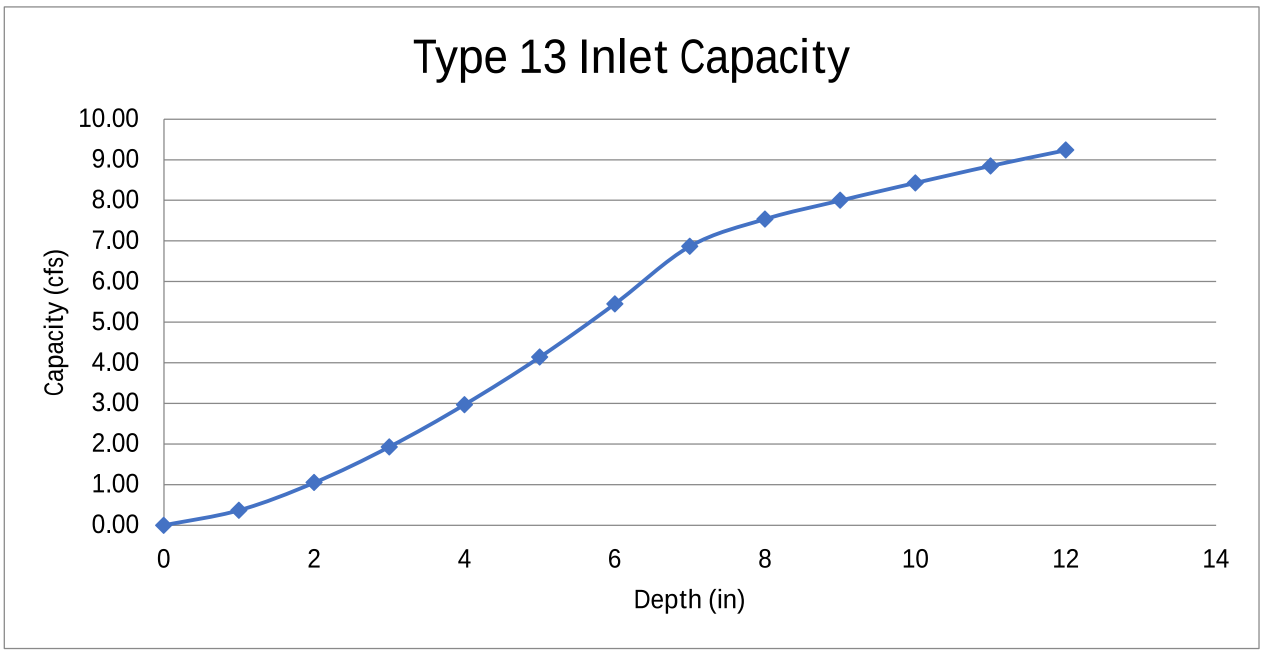
Project Name: Calamar 55+
Project No.: CLM07
Calculated By: Casey Volt
Checked By: Scott Brown
Date: 8/15/24

100-year runoff to inlet = 1.1 cfs.

3" depth required + 1" to account for the grate depression = 4"

Type 13 Inlet Capacity

Depth (in)	Capacity (cfs)
0	0.00
1	0.37
2	1.05
3	1.93
4	2.97
5	4.14
6	5.45
7	6.87
8	7.54
9	8.00
10	8.43
11	8.85
12	9.24



Capacity was calculated using the MHFD Detention v2.35 spreadsheet
Calculation accounts for the both the weir and orifice equations
Calculations include a 50% clogging factor.

DP 5

TO BE FINALIZED IN FDR
NOT APPROVED IN PDR

ADS Nyloplast

Nyloplast Inlet Capacity Table

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Input	
Type of Grate	6" Drop In
Head (ft)	1.5

Properties	
Orifice Flow Area (in)	9.98
Orifice Flow Area (ft)	0.07
Weir Flow Perimeter (in)	16.40
Weir Flow Perimeter (ft)	1.37

Solution		
Capacity (cfs)	0.41	100-year runoff to inlet = 0.1 cfs.
Capacity (gpm)	182.18	

$$Q_{weir} = CLH^{3/2}$$

$C = 3.33$ *Weir Discharge Coefficient*

$L =$ *Perimeter of Grate Opening (ft)*

$H =$ *Flow Height of Water Surface Above Weir (ft)*

$$Q_{orifice} = CA\sqrt{2gh}$$

$C = 0.60$ *Orifice Discharge Coefficient*

$A =$ *Area of the Orifice* (ft^2)

$g =$ *Gravitational Constant* $\left(32.2\frac{ft}{s^2}\right)$

$H =$ *Depth of Water Above Center of Orifice (ft)*

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DP 5

TO BE FINALIZED IN FDR
NOT APPROVED IN PDR

ADS Nyloplast

Nyloplast Inlet Capacity Table

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Input

Type of Grate	6" Drop In
Head (ft)	0.1

Required head/depth for 100-yr flow to inlet (0.1 cfs)

Properties

Orifice Flow Area (in)	9.98
Orifice Flow Area (ft)	0.07
Weir Flow Perimeter (in)	16.40
Weir Flow Perimeter (ft)	1.37

Solution

Capacity (cfs)	0.10
Capacity (gpm)	47.04

$$Q_{weir} = CLH^{3/2}$$
$C = 3.33$ *Weir Discharge Coefficient*
$L =$ *Perimeter of Grate Opening (ft)*
$H =$ *Flow Height of Water Surface Above Weir (ft)*

$$Q_{orifice} = CA\sqrt{2gh}$$
$C = 0.60$ *Orifice Discharge Coefficient*
$A =$ *Area of the Orifice* (ft^2)
$g =$ *Gravitational Constant* $\left(32.2\frac{ft}{s^2}\right)$
$H =$ *Depth of Water Above Center of Orifice (ft)*

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MHFD-Inlet, Version 5.03 (August 2023)

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INLET MANAGEMENT

Worksheet Protected

INLET NAME	DP 9	DP 10
Site Type (Urban or Rural)	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET
Hydraulic Condition	In Sump	In Sump
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	2.3	2.0
Major Q_{Known} (cfs)	6.5	5.7

Bypass (Carry-Over) Flow from Upstream

Inlets must be organized from upstream (left) to downstream (right) in order for byp

Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)		
Percent Impervious		
NRCS Soil Type		

Watershed Profile

Overland Slope (ft/ft)		
Overland Length (ft)		
Channel Slope (ft/ft)		
Channel Length (ft)		

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)		
One-Hour Precipitation, P_1 (inches)		

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)		
One-Hour Precipitation, P_1 (inches)		

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	2.3	2.0
Major Total Design Peak Flow, Q (cfs)	6.5	5.7
Minor Flow Bypassed Downstream, Q_b (cfs)	N/A	N/A
Major Flow Bypassed Downstream, Q_b (cfs)	N/A	N/A

TO BE FINALIZED IN FDR
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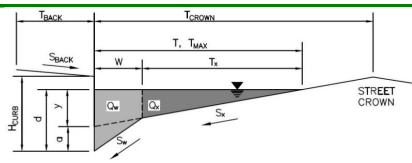
MHFD-Inlet, Version 5.03 (August 2023)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Calamar Aurora - Sterling Hills & Villanova
Inlet ID: DP 9



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.040	ft/ft
Warning 01 Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.035	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	80.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.009	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	80.0	80.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

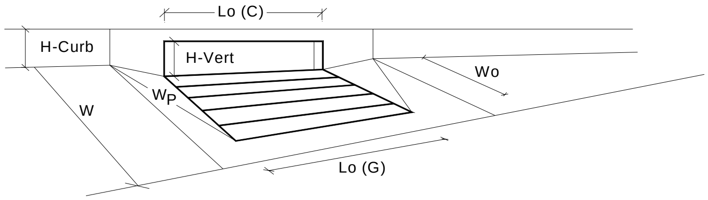
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is not applicable to Sump Condition MAJOR STORM Allowable Capacity is not applicable to Sump Condition	Q_{allow} =	SUMP	SUMP	cfs

Warning 01: Manning's n-value does not meet the USDCM recommended design range.

TO BE FINALIZED IN FDR
NOT APPROVED IN PDR

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)



Design Information (Input)	CDOT Type R Curb Opening	MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	3.2	5.6	inches
Grate Information		MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	1.00	1.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.19	0.38	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.96	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	1.7	5.2	cfs
WARNING: Inlet Capacity < Q Peak for Minor and Major Storms	$Q_{PEAK\ REQUIRED}$ =	2.3	6.5	cfs

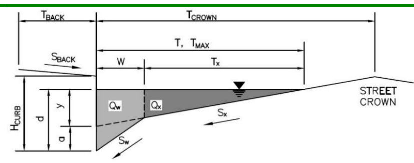
TO BE FINALIZED IN FDR
NOT APPROVED IN PDR

MHFD-Inlet, Version 5.03 (August 2023)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Calamar Aurora - Sterling Hills & Villanova
Inlet ID: DP 10



Gutter Geometry:

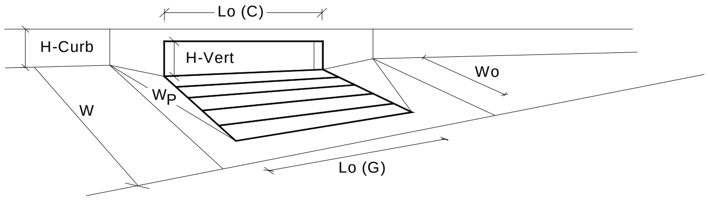
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	26.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.060		ft/ft
Warning 01 Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.035		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	60.0		ft
Gutter Width	W =	1.00		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	60.0	60.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is not applicable to Sump Condition MAJOR STORM Allowable Capacity is not applicable to Sump Condition	Q_{allow} =	SUMP	SUMP	cfs

Warning 01: Manning's n-value does not meet the USDCM recommended design range.

TO BE FINALIZED IN FDR
NOT APPROVED IN PDR

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)



		MINOR	MAJOR	
Design Information (Input) — CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	3.0	5.1	inches
Grate Information		MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	1.00	1.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.17	0.34	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.93	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	1.4	4.4	cfs
WARNING: Inlet Capacity < Q Peak for Minor and Major Storms	$Q_{PEAK\ REQUIRED}$ =	2.0	5.7	cfs

DP 11

TO BE FINALIZED IN FDR
NOT APPROVED IN PDR

ADS Nyloplast

Nyloplast Inlet Capacity Table

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Input	
Type of Grate	12" Pedestrian
Head (ft)	0.95

Properties	
Orifice Flow Area (in)	50.60
Orifice Flow Area (ft)	0.35
Weir Flow Perimeter (in)	43.25
Weir Flow Perimeter (ft)	3.60

Solution	
Capacity (cfs)	1.64
Capacity (gpm)	735.08

100-year runoff to inlet = 0.8 cfs.

$$Q_{weir} = CLH^{3/2}$$

$C = 3.33$ *Weir Discharge Coefficient*

$L =$ *Perimeter of Grate Opening (ft)*

$H =$ *Flow Height of Water Surface Above Weir (ft)*

$$Q_{orifice} = CA\sqrt{2gh}$$

$C = 0.60$ *Orifice Discharge Coefficient*

$A =$ *Area of the Orifice* (ft^2)

$g =$ *Gravitational Constant* $\left(32.2 \frac{ft}{s^2}\right)$

$H =$ *Depth of Water Above Center of Orifice (ft)*

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DP 11

TO BE FINALIZED IN FDR
NOT APPROVED IN PDR

ADS
Nyloplast

Nyloplast Inlet Capacity Table

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Input	
Type of Grate	12" Pedestrian
Head (ft)	0.5

Properties	
Orifice Flow Area (in)	50.60
Orifice Flow Area (ft)	0.35
Weir Flow Perimeter (in)	43.25
Weir Flow Perimeter (ft)	3.60

Solution	
Capacity (cfs)	1.19
Capacity (gpm)	533.28

100-year runoff to inlet = 0.8 cfs.

$Q_{weir} = CLH^{3/2}$

$C = 3.33$ *Weir Discharge Coefficient*

$L =$ *Perimeter of Grate Opening* (ft)

$H =$ *Flow Height of Water Surface Above Weir* (ft)

$Q_{orifice} = CA\sqrt{2gh}$

$C = 0.60$ *Orifice Discharge Coefficient*

$A =$ *Area of the Orifice* (ft^2)

$g =$ *Gravitational Constant* $\left(32.2\frac{ft}{s^2}\right)$

$H =$ *Depth of Water Above Center of Orifice* (ft)

REV 2.1.21

Worksheet for DP 1 Emergency Overflow

Project Description

Solve For	Headwater Elevation

Input Data

Discharge	1.20	ft³/s
Crest Elevation	0.00	ft
Tailwater Elevation	0.00	ft
Coefficient of Discharge	0.58	
Angle	178.86	degrees

Results

Headwater Elevation	0.12	ft
Headwater Height Above Crest	0.12	ft
Tailwater Height Above Crest	0.00	ft
Flow Area	1.41	ft²
Velocity	0.85	ft/s
Wetted Perimeter	23.78	ft
Top Width	23.78	ft

Worksheet for DP 2 Emergency Overflow

Project Description

Solve For	Headwater Elevation

Input Data

Discharge	0.10	ft³/s
Crest Elevation	0.00	ft
Tailwater Elevation	0.00	ft
Coefficient of Discharge	0.58	
Angle	174.67	degrees

Results

Headwater Elevation	0.08	ft
Headwater Height Above Crest	0.08	ft
Tailwater Height Above Crest	0.00	ft
Flow Area	0.14	ft²
Velocity	0.71	ft/s
Wetted Perimeter	3.49	ft
Top Width	3.49	ft

Worksheet for DP 3 Emergency Overflow

Project Description

Solve For	Headwater Elevation

Input Data

Discharge	0.90	ft³/s
Crest Elevation	0.00	ft
Tailwater Elevation	0.00	ft
Coefficient of Discharge	0.58	
Angle	178.86	degrees

Results

Headwater Elevation	0.11	ft
Headwater Height Above Crest	0.11	ft
Tailwater Height Above Crest	0.00	ft
Flow Area	1.12	ft²
Velocity	0.81	ft/s
Wetted Perimeter	21.19	ft
Top Width	21.19	ft

Worksheet for DP 4 Emergency Overflow

Project Description

Solve For	Headwater Elevation

Input Data

Discharge	1.10	ft³/s
Crest Elevation	0.00	ft
Tailwater Elevation	0.00	ft
Coefficient of Discharge	0.58	
Angle	178.86	degrees

Results

Headwater Elevation	0.11	ft
Headwater Height Above Crest	0.11	ft
Tailwater Height Above Crest	0.00	ft
Flow Area	1.31	ft²
Velocity	0.84	ft/s
Wetted Perimeter	22.97	ft
Top Width	22.96	ft

Worksheet for DP 5 Emergency Overflow

Project Description

Solve For	Headwater Elevation

Input Data

Discharge	0.10	ft³/s
Crest Elevation	0.00	ft
Tailwater Elevation	0.00	ft
Coefficient of Discharge	0.58	
Angle	171.00	degrees

Results

Headwater Elevation	0.10	ft
Headwater Height Above Crest	0.10	ft
Tailwater Height Above Crest	0.00	ft
Flow Area	0.13	ft²
Velocity	0.79	ft/s
Wetted Perimeter	2.55	ft
Top Width	2.54	ft

Worksheet for DP 9 Emergency Overflow

Project Description

Solve For	Headwater Elevation

Input Data

Discharge	6.50	ft³/s
Crest Elevation	0.00	ft
Tailwater Elevation	0.00	ft
Coefficient of Discharge	0.58	
Angle	177.28	degrees

Results

Headwater Elevation	0.33	ft
Headwater Height Above Crest	0.33	ft
Tailwater Height Above Crest	0.00	ft
Flow Area	4.57	ft²
Velocity	1.42	ft/s
Wetted Perimeter	27.74	ft
Top Width	27.73	ft

Worksheet for DP 10 Emergency Overflow

Project Description

Solve For	Headwater Elevation

Input Data

Discharge	5.70	ft³/s
Crest Elevation	0.00	ft
Tailwater Elevation	0.00	ft
Coefficient of Discharge	0.58	
Angle	178.82	degrees

Results

Headwater Elevation	0.22	ft
Headwater Height Above Crest	0.22	ft
Tailwater Height Above Crest	0.00	ft
Flow Area	4.86	ft²
Velocity	1.17	ft/s
Wetted Perimeter	43.44	ft
Top Width	43.44	ft

Worksheet for DP 11 Emergency Overflow

Project Description

Solve For	Headwater Elevation

Input Data

Discharge	0.80	ft^3/s
Crest Elevation	0.00	ft
Tailwater Elevation	0.00	ft
Coefficient of Discharge	0.58	
Angle	178.67	degrees

Results

Headwater Elevation	0.11	ft
Headwater Height Above Crest	0.11	ft
Tailwater Height Above Crest	0.00	ft
Flow Area	0.99	ft^2
Velocity	0.81	ft/s
Wetted Perimeter	18.43	ft
Top Width	18.43	ft

North American Green
5401 St. Wendel-Cynthiana Rd.
Poseyville, Indiana 47633
Tel. 800.772.2040
>Fax 812.867.0247
www.nagreen.com
ECMDS v7.0

CHANNEL ANALYSIS

> > > Drainage swale (upstream)

Name	Drainage swale (upstream)
Discharge	230.3
Channel Slope	0.09
Channel Bottom Width	0
Left Side Slope	4
Right Side Slope	9
Low Flow Liner	
Retardence Class	D 2-6 in
Vegetation Type	Sod Former
Vegetation Density	Very Good 80-95%
Soil Type	Clay Loam (CL)

P550

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
P550 Unvegetated	Straight	230.3 cfs	16.09 ft/s	1.48 ft	0.023	3.3 lbs/ft2	8.33 lbs/ft2	0.4	UNSTABLE	E
Underlying Substrate	Straight	230.3 cfs	16.09 ft/s	1.48 ft	0.023	3.6 lbs/ft2	4.11 lbs/ft2	0.88	UNSTABLE	E
P550 Reinforced Vegetation	Straight	230.3 cfs	18.75 ft/s	1.37 ft	0.018	14 lbs/ft2	7.72 lbs/ft2	1.81	STABLE	E
Underlying Substrate	Straight	230.3 cfs	18.75 ft/s	1.37 ft	0.018	5.68 lbs/ft2	3.81 lbs/ft2	1.49	STABLE	E

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CHANNEL ANALYSIS

> > > Drainage swale (downstream)

Name	Drainage swale (downstream)
Discharge	233.1
Channel Slope	0.04
Channel Bottom Width	0
Left Side Slope	4
Right Side Slope	4
Low Flow Liner	
Retardence Class	D 2-6 in
Vegetation Type	Sod Former
Vegetation Density	Very Good 80-95%
Soil Type	Clay Loam (CL)

P550

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
P550 Unvegetated	Straight	233.1 cfs	12.19 ft/s	2.19 ft	0.025	3.3 lbs/ft2	5.46 lbs/ft2	0.6	UNSTABLE	E
Underlying Substrate	Straight	233.1 cfs	12.19 ft/s	2.19 ft	0.025	3.6 lbs/ft2	2.65 lbs/ft2	1.36	STABLE	E
P550 Reinforced Vegetation	Straight	233.1 cfs	13.7 ft/s	2.06 ft	0.022	14 lbs/ft2	5.15 lbs/ft2	2.72	STABLE	E
Underlying Substrate	Straight	233.1 cfs	13.7 ft/s	2.06 ft	0.022	7.95 lbs/ft2	2.5 lbs/ft2	3.18	STABLE	E

Tract A Channel - 100 year

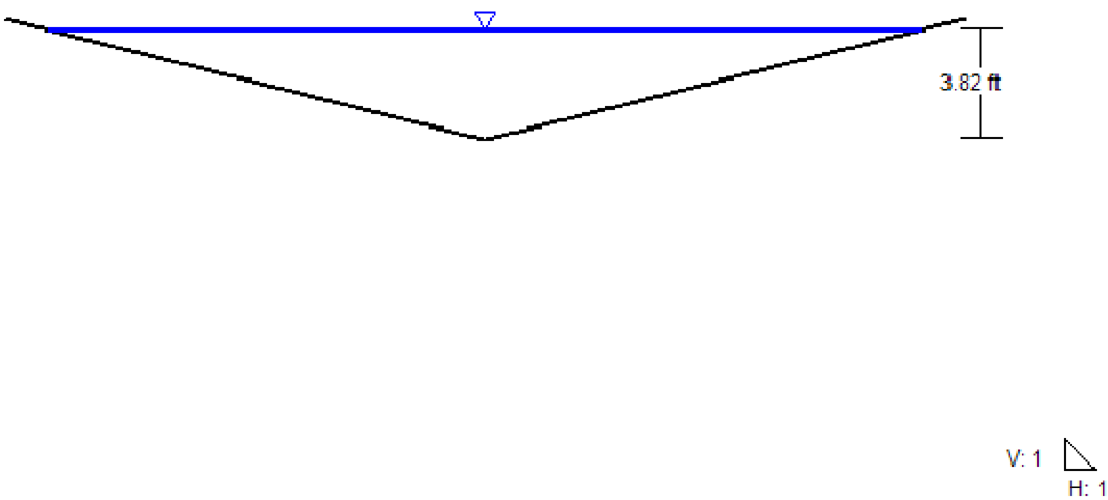
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.045	
Channel Slope	0.00750	ft/ft
Normal Depth	3.82	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Discharge	251.00	ft³/s

Cross Section Image



APPENDIX D

Supporting Documentation

Filing No. 13 constructed the apartment buildings east of the Site, on the other side of the swale. Drainage from *Filing No.13* drains and connects to the existing storm infrastructure constructed with *Filing No. 9 and Filing No. 11*. No additional storm infrastructure improvements associated with *Filing No.11* impact Filing No. 15.

Filing No. 14 proposed residential units on the same site as Filing No. 15. These plans were not constructed though, so there are no storm infrastructure that impacts Filing No. 15.

Offsite Basin Routing

The previously developed offsite drainage Basins have been incorporated into the Basin calculations. These offsite flows are shown on the Preliminary Drainage Map, attached separately, as Offsite (OS) 1 through 8 within rectangles. These Basins represent flows that interact with flows from the Site at existing storm infrastructure. These Offsite flows have been incorporated in order to check the adequacy of the existing storm system with the additional flows generated from the Site.

Offsite Basin OS1 corresponds with the Basins from the *Final Drainage Report for Sterling Hills Filing No. 9* (C.O.A. #200017) that are tributary to the *Filing No.9 Design Point 19*. The Basin represents flows intercepted by the two existing 50-ft Type R inlets in E. Villanova Place and the piped flows already captured by the *Filing No. 9* storm infrastructure. These flows are piped through the Site via the existing 48-in. HDPE pipe within the existing 50-ft drainage easement. OS1 combines with the flows from OS2 on Site at JP1, as shown in the rational method worksheet for Sterling Hills Filing No.15. Basin OS1 consists of pipe flow downstream of *Design Point 19* from the *Final Drainage Report for Sterling Hills Filing No. 9* (C.O.A. #200017), Q2 = 66.4 cfs and Q100 = 230.3 cfs.

OS2 corresponds with the Sub-Basins tributary to *Design Point 12* from *Sterling Hills Filing No.13's Final Drainage Report* (COA #204133FDR) (Reference 8). These flows are piped in the existing 48-in HDPE pipe within the existing 16-ft drainage easement. OS2 combines with the flows from OS1 on Site at JP1, as shown in the rational method worksheet for Sterling Hills Filing No.15. Basin OS2 consists of pipe flow downstream of *Design Point 12* from the *Final Drainage Report for Sterling Hills Filing No. 13* (C.O.A. #204133), Q2 = 1.7 cfs and Q100 = 6.5 cfs.

Offsite Basin OS3 consists of surface flow from Basin OS-07 from the *Final Drainage Report for Sterling Hills Filing No. 13*. These flows sheet flow to an existing Type D inlet at Design Point C1 where they combine with flows generated from Sub-Basin C. This surface flows combines with the piped runoff of OS1 and OS2 in the existing 48-in HDPE pipe. This combined flow is piped to Design Point E1. Basin OS3 consists of surface flow from *Basin OS-07* from the *Final Drainage Report for Sterling Hills Filing No. 13* (C.O.A. #204133), Area = 0.67 acres, C2 = 0.25, C100 = 0.35, Q100= 1.7 cfs.

Offsite Basin OS4 consists of pipe flow from the Basins tributary to *Design Point 13* from the *Final Drainage Report for Filing No. 13*. Flows from this Basin are conveyed in an existing 30-in. RCP pipe within the existing 16' drainage easement from *Filing No.13*. OS4 combines with flows on-Site at the existing 15' sump inlet at Design Point E1. Basin Os4 consists of pipe flow downstream of *Design Point 13* from the *Final Drainage Report for Sterling Hills Filing No. 13* (C.O.A. #204133), Q2 = 5.4 cfs and Q100 = 20.6 cfs.

Offsite Basin OS5 consists of Basins tributary to *Design Point 19* from the *Final Drainage Report for Sterling Hills Filing No. 13* (C.O.A. 204133). Flows from OS5 combine with on-Site runoff at the existing 15-ft sump inlets on the north side of E. Water Drive. at Design Point E1. Offsite Basin OS6 consists of Basins tributary to *Design Point 11* from the *Final Drainage Report for Sterling Hills Filing No. 13*. Offsite Basin OS8 consists of gutter flow from Basin H from the *Final Drainage Report for Sterling Hills Filing No. 11* (C.O.A. #202105). In the 100-year event, flows generated in these Basins are conveyed in E. Water Drive to the two existing 15-ft Type R sump inlets at Design Point E1, which is a low point for the Site. Basin OS5 consists of gutter flow at *Design Point 19* from the *Final Drainage Report for Sterling Hills Filing No. 13* (C.O.A. 204133), Q2 = 3.4 cfs and Q100 = 33.2 cfs.

Offsite Basins OS6 and OS8 flows consist of the flows that are conveyed to the existing 15-ft Type R inlet on the south side of East Water Drive while OS5 flows are conveyed to the existing 15-ft type R inlet on the north side of the road. OS5 combines with runoff generated from on-Site, Basin E and the bypass flows from Basin B, at this location. Basin OS6 consists of gutter flow at *Design Point 11* from the *Final Drainage Report for Sterling Hills Filing No. 13* (C.O.A. #204133), Q2 = 5.6 cfs and Q100 = 33.1 cfs. Basin OS8 consists of gutter flow from *Basin H* from the *Final Drainage Report for Sterling Hills Filing No. 11* (C.O.A. #202105), Area = 0.34 acres, C2 = 0.65, C100 = 0.73 (Q2 = 0.9 cfs and Q100 = 2.2 cfs).

Offsite Basin OS7 consists of surface flow from Basin OS-08 from the *Final Drainage Report for Sterling Hills Filing No. 13*. This joins Site runoff in Basin F that contributes flow to the drainage swale. These combined flows continue to surface flow through the existing drainage swale to the ultimate outfall in the existing sub-regional water quality and detention pond downstream of the Site. Basin OS7 consists of surface flow from *Basin OS-08* from the *Final Drainage Report for Sterling Hills Filing No. 13* (C.O.A. #204133), Area = 0.24 acres, C2 = 0.18, C100 = 0.22, Q100=0.5 cfs.

See Appendix C, Existing Drainage Evaluations, for excerpts from *Filing No. 9, Filing No. 11, and Filing No. 13* approved plans, drainage maps, and calculations with highlights that correspond to the information above.

E. Villanova Place Sump Inlet Discussion

The existing inlet capacity and ponding depth have been discussed several times with the City throughout the preliminary drainage report review. The most current conversation was about the available ponding depth for the capture of the 100-yr flows at the existing twin 50-ft Type R Sump inlets at E. Villanova Place. A copy of this email thread is included in Appendix E, City Correspondence, and is used for the basis of the design presented wherein.

The available ponding depth at the pair of 50-ft Type R sump inlets on E. Villanova Place is a few inches deficient to fully capture the 100-yr flows at the inlets. Per *Filing No. 9*, the pair of 50-ft inlets receive 230.3 cfs at the corresponding *Design Point 19* in the 100-yr event. Current UD Inlet methodology with the City's clogging factor, results in approximately 10.1 inches of ponding depth required to fully capture the 100-yr flows at this location. This ponding depth will not inundate surrounding developments or overflow west and impact the entrance of S. Biscay Way at E. Villanova Place. The existing sidewalk and tree lawn will be modified to provide 10.1 inches of ponding depth, and this will be reflected in the final construction documents and Final Drainage Report for the Site. A copy of the conversations discussing the ponding depth at this inlet has been included in Appendix E, City Correspondence.

Existing Drainage Swale Discussion

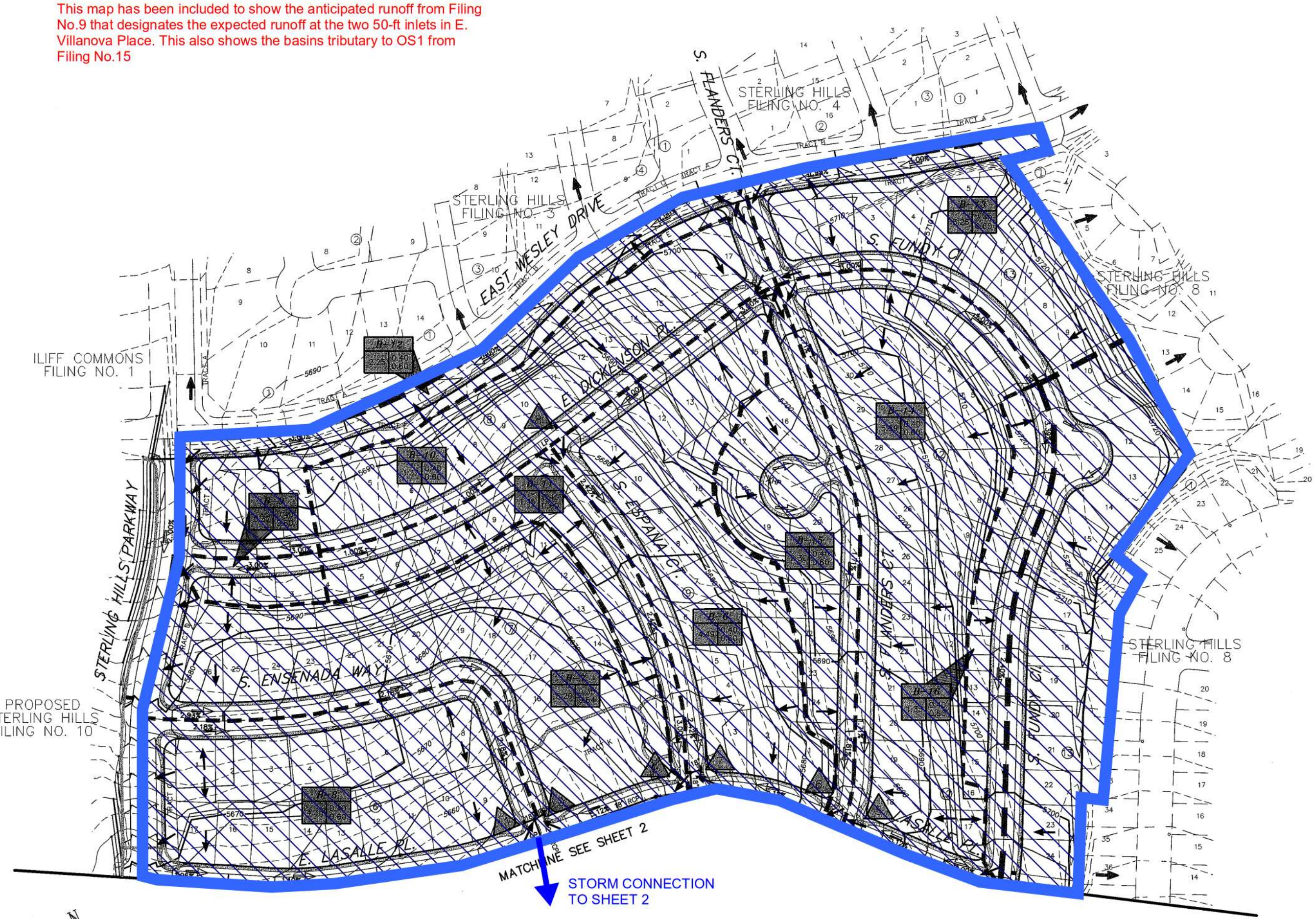
Since the 100-yr storm interception ponding depth at the E. Villanova Place 50-ft Type R sump inlets will be provided at this location, the existing grass lined swale will continue to be in compliance with Section 3.50 from the City of Aurora Storm Drainage and Technical Criteria Manual. Per email conversations with the City, Filing No. 15 has requested a variance for 50% clogging factor for the upstream inlets. In addition, Filing No. 15 will further analyze the erosive forces of the runoff in the emergency situation in the Final Drainage Report to determine whether further protections will be needed for the emergency overflow in the swale. Currently, a 20-ft wide section of Type M riprap has been proposed within the swale. This Type M Soil riprap that the Preliminary Drainage Plan conceptually shows, is subject to change pending further analysis of the flows captured by the upstream inlets and erosive velocities of overtopping flows. Cross-sections of the swale in this emergency condition have been supplied on the exhibit titled "Sterling Hills Subdivision Filing No.15 Overflow Swale Cross Sections Exhibit" provided in Appendix D, Emergency Overflow Swale Evaluation.

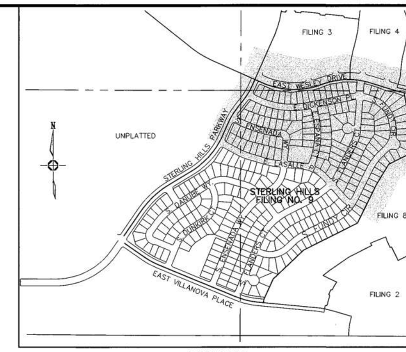
Filing No.9 Basins Tributary to the Twin 50-ft Inlets
Tributary Areas to Offsite Basin OS1
(COA #200017FDR)

990213 1/5

FILING 9 DRAINAGE MAP
(COA #200017FDR)

This map has been included to show the anticipated runoff from Filing No.9 that designates the expected runoff at the two 50-ft inlets in E. Villanova Place. This also shows the basins tributary to OS1 from Filing No.15





KEY MAP
1" = 600'

DESIGN POINT	BASIN	LOCAL FLOWS Q_2	LOCAL FLOWS Q_{100}	TOTAL FLOWS Q_2	TOTAL FLOWS Q_{100}	INLET SIZE
	A-1	2.1	8.9			
	A-2	6.2	25.0			
	A-3	2.1	8.7			
	A-4	4.8	19.9			
	A-5	1.6	6.7			
1	A-3 & A-4			6.6		
1	A-3 & A-4 B-4 & B-16				42.3	
2	A-2 TO A-4			11.2		
2	A-2 TO A-4 B-4 & B-16				66.4	
3	A-1 to A-4 OS-1			13.3		10' TYPE "R"
3	OS-1 A-1 to A-4 B-14 & B-16				72.7	
4	OS-1, B-4 A-1 to A-5 B-14 to B-16				87.3	
	B-1	4.2	16.8			
	B-2	1.9	7.6			
	B-3	2.6	10.5			
	B-4	1.2	5.0			
	B-5	3.3	14.0			
	B-6	4.0	15.9			
	B-7	4.6	21.6			
11	B-8	3.8	17.0			5' TYPE "R"
	B-9	0.5	1.9			
	B-10	3.5	14.3			
	B-11	1.9	8.0			
	B-12	2.2	9.2			
	B-13	3.1	13.3			
	B-14	5.4	22.9			
	B-15	2.4	9.8			
	B-16	1.5	6.2			
5	B-14 & B-16			6.7	28.2	
6	B-15				9.8	
6	B-14 to B-16			8.8		
7	B-6				15.9	
7	B-6 B-14 to B-16			12.4		10' TYPE "R"
8	B-10 & B-13			5.8	23.5	
9	B10 B-11 & B-13			6.9		
9	B-6 & B-10 B-11 & B-13				42.3	
10	B-7 B-9 to B-13			12.5		10' TYPE "R"
10	B-6 & B-7 B-9 to B-13				66.2	
12	B-3			2.6		5' TYPE "R"
12	B-3 & B-8				71.0	
13	B-4 & B-5			4.3		5' TYPE "R"
13	B-5 to B-7 B-9 to B-13				71.0	
14	A-5 & B-1			5.5		5' TYPE "R"
14	B-1 B-5 to B-7 B-9 to B-13 & 4				148.9	

DESIGN POINT	BASIN	LOCAL FLOWS Q_2	LOCAL FLOWS Q_{100}	TOTAL FLOWS Q_2	TOTAL FLOWS Q_{100}	INLET SIZE
15	B-2			1.9		5' TYPE "R"
15	B-8 B-2 to B-3 & 14				172.2	
	C-1	4.2	16.2			
	C-2	4.3	18.9			
	C-3	2.2	10.1			
	C-4	5.1	20.8			
	C-5	2.9	15.0			
	C-6	0.4	1.6			
	C-7	0.4	0.9			
16	C-2 to C-4			9.5	42.5	15' TYPE "R"
17	C-8			4.5		15' TYPE "R"
17	C-2 to C-4 C-8				46.7	
18	C-1 C-5 to C-7			8.2		
18	C-1 to C-8 & 15				226.6	50' TYPE "R" (100 YEAR)
19	OS-2 & OS-3 & 18			57.0	230.3	50' TYPE "R" (100 YEAR)
20	B-1 & 19			65.0	266.6	177.0 CFS TO DET. POND 89.6 CFS TO ST. SEWER
21				65.2	266.9	
	D-1	28.3	120.0			
25	D-2	9.9	31.5			EX. 18" RCP F.E.S.
26	D-3	36	13.2			EX. 18" RCP F.E.S.
	OS-1	1.4	5.8			
	OS-2	1.4	5.5			
	OS-3	1.0	4.0			
	OS-4	1.8	5.0			
	OS-5	5.4	18.7			
	OS-6	4.8	14.3			
22	OS-5 & 21			81.2	276.0	25' TYPE "R" (100 YEAR)
23	OS-5 & OS-6 & 21			83.4	281.2	25' TYPE "R" (100 YEAR) 138.6 CFS TO DET. POND 142.6 CFS TO PSCO CHANNEL
24					133.7	OUTLET STRUCTURE
27	OS-4 & D-3			9.9	16.9	5' TYPE "R"

NOTE: ALL INLETS SIZED FOR 2-YEAR STORM UNLESS OTHERWISE NOTED

LEGEND

- BASIN DESIGNATION
- COMPOSITE RUNOFF COEFFICIENTS C_2 AND C_{100}
- BASIN AREA IN ACRES
- DESIGN POINT
- DIRECTION OF FLOW
- STREET SLOPE
- BASIN BOUNDARY
- SUB-BASIN BOUNDARY
- EXISTING CONTOUR
- PROPOSED CONTOUR
- PROPOSED STORM SEWER W/INLET
- EXISTING STORM SEWER

CALL UTILITY NOTIFICATION CENTER OF COLORADO
1-800-922-1987
CALL 2 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

City of Aurora 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 jobsite. The City of Aurora through the approval of the document assumes no other responsibilities other than stated above for completeness and/or accuracy of this document.

CITY OF AURORA BENCHMARK 15-070
3" DIAM. BRASS CAP IN CONCRETE BEING 33' E. OF COR. TO SECS. 22, 23, 26, 27, T4S, R66W MON. IS 1.5' M/L S OF NEW CHAIN LINK FE. AND 2-1/2 FT. E OF N-S BARBWIRE FE. FOR PLAINS CONSERVATION CENTER TO THE SOUTH. REV. DESC. ON 8-10-93.
ELEVATION = 5647.31

PREPARED UNDER THE DIRECT SUPERVISON OF
JOHN E. CARROLL REGISTERED 10862 10/28/99 PROFESSIONAL ENGINEER STATE OF COLORADO
FOR AND ON BEHALF OF CARROLL & LANGE, INC.

No.	Revisions	Date	By	Chk
10				
9				
8				
7				
6				
5				
4				
3	PER C.O.A. COMMENTS	10/27/99	CJK	
2	PER C.O.A. COMMENTS	10/12/99	CJK	
1	PER C.O.A. COMMENTS	9/21/99	CJK	

APPROVED FOR ONE YEAR FROM THIS DATE
11-10-99

R.D. 11-2-99 D R Hogan 11/3/99
Director of Public Works Date

11-4-99 Dave Ellen for J.G. 11/4/99
Director of Utilities Date

Carroll & Lange INC
Professional Engineers & Land Surveyors
165 South Union Blvd., Suite 156
Lakewood, Colorado 80228
(303) 980-0200

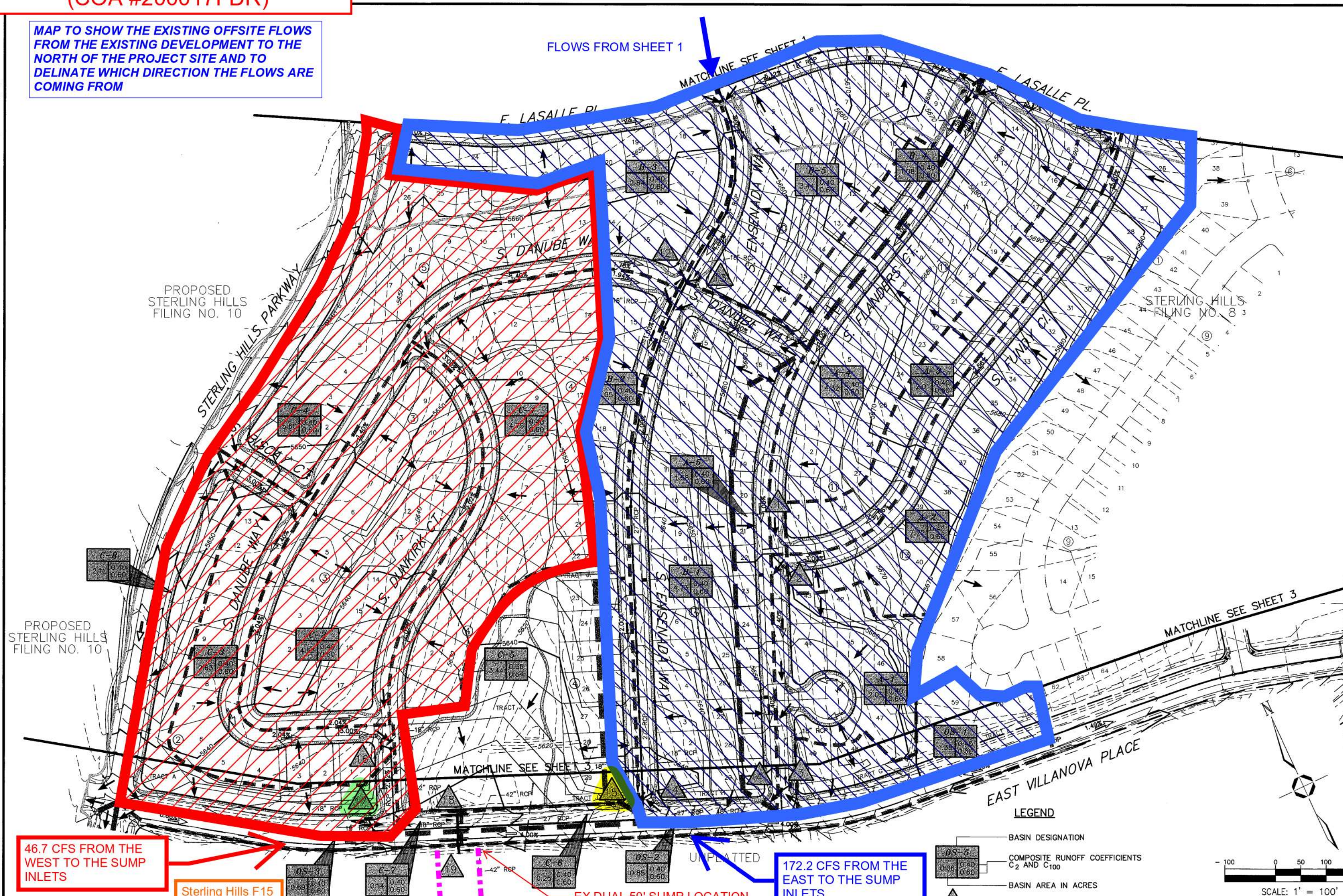
Project: STERLING HILLS SUBDIVISION FILING NO. 9
Title: PRELIMINARY DRAINAGE MAP

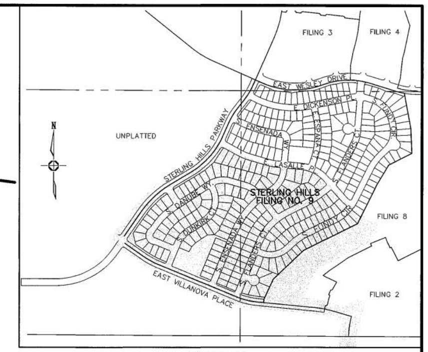
Designed By: CJK	Scale: 1" = 100'	Sheet C2 1 of 3
Drawn By: MAP		Job No. 2116
Checked By:	Date: 7-2-99	File No. 2116-DR1

27 18:19:18 1999 CARROL ...-DRAINAGE\2116-dr1.dwg

FILING 9 DRAINAGE MAP
(COA #200017FDR)

MAP TO SHOW THE EXISTING OFFSITE FLOWS FROM THE EXISTING DEVELOPMENT TO THE NORTH OF THE PROJECT SITE AND TO DELINATE WHICH DIRECTION THE FLOWS ARE COMING FROM





KEY MAP
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	A-1	2.1	8.9			
	A-2	6.2	25.0			
	A-3	2.1	8.7			
	A-4	4.8	19.9			
	A-5	1.6	6.7			
1	A-3 & A-4			6.6		
1	A-3 & A-4 B-4 & B-16				42.3	
2	A-2 TO A-4			11.2		
2	A-2 TO A-4 B-4 & B-16				66.4	
3	A-1 to A-4 OS-1			13.3		10' TYPE "R"
3	OS-1 A-1 to A-4 B-14 & B-16				72.7	
4	OS-1, B-4 A-1 to A-5 B-14 to B-16				87.3	
	B-1	4.2	16.8			
	B-2	1.9	7.6			
	B-3	2.6	10.5			
	B-4	1.2	5.0			
	B-5	3.3	14.0			
	B-6	4.0	15.9			
	B-7	4.6	21.6			
11	B-8	3.8	17.0			5' TYPE "R"
	B-9	0.5	1.9			
	B-10	3.5	14.3			
	B-11	1.9	8.0			
	B-12	2.2	9.2			
	B-13	3.1	13.3			
	B-14	5.4	22.9			
	B-15	2.4	9.8			
	B-16	1.5	6.2			
5	B-14 & B-16			6.7	28.2	
6	B-15				9.8	
6	B-14 to B-16			8.8		
7	B-6				15.9	

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DESIGN POINT	BASIN	LOCAL FLOWS Q_2	LOCAL FLOWS Q_{100}	TOTAL FLOWS Q_2	TOTAL FLOWS Q_{100}	INLET SIZE
7	B-6 B-14 to B-16			12.4		10' TYPE "R"
8	B-10 & B-13			5.8	23.5	
9	B10 B-11 & B-13			6.9		
9	B-6 & B-10 B-11 & B-13				42.3	
10	B-7 B-9 to B-13			12.5		10' TYPE "R"
10	B-6 & B-7 B-9 to B-13				66.2	
12	B-3			2.6		5' TYPE "R"
12	B-3 & B-8				71.0	
13	B-4 & B-5			4.3		5' TYPE "R"
13	B-5 to B-7 B-9 to B-13				71.0	
14	A-5 & B-1			5.5		5' TYPE "R"
14	B-1 B-5 to B-7 B-9 to B-13 & 4				148.9	
15	B-2			1.9		5' TYPE "R"

DESIGN POINT	BASIN	LOCAL FLOWS Q_2	LOCAL FLOWS Q_{100}	TOTAL FLOWS Q_2	TOTAL FLOWS Q_{100}	INLET SIZE
15	B-8 B-2 to B-3 & 14				172.2	
	C-1	4.2	16.2			
	C-2	4.3	18.9			
	C-3	2.2	10.1			
	C-4	5.1	20.8			
	C-5	2.9	15.0			
	C-6	0.4	1.6			
	C-7	0.4	0.9			
16	C-2 to C-4			9.5	42.5	15' TYPE "R"
17	C-8			4.5		15' TYPE "R"
17	C-2 to C-4 C-8				46.7	
18	C-1 C-5 to C-7			8.2		
18	C-1 to C-8 & 15				226.6	50' TYPE "R" (100 YEAR)
19	OS-2 & OS-3 & 18			57.0	230.3	50' TYPE "R" (100 YEAR)
20	B-1 & 19			65.0	266.6	177.0 CFS TO DET. POND 89.6 CFS TO ST. SEWER
21				65.2	266.9	

DESIGN POINT	BASIN	LOCAL FLOWS Q_2	LOCAL FLOWS Q_{100}	TOTAL FLOWS Q_2	TOTAL FLOWS Q_{100}	INLET SIZE
	D-1	28.3	120.0			
25	D-2	9.9	31.5			EX. 18" RCP F.E.S.
26	D-3	36	13.2			EX. 18" RCP F.E.S.
	OS-1	1.4	5.8			
	OS-2	1.4	5.5			
	OS-3	1.0	4.0			
	OS-4	1.8	5.0			
	OS-5	5.4	18.7			
	OS-6	4.8	14.3			
22	OS-5 & 21			81.2	276.0	25' TYPE "R" (100 YEAR)
23	OS-5 & OS-6 & 21			83.4	281.2	25' TYPE "R" (100 YEAR) 138.6 CFS TO DET. POND 142.6 CFS TO PSCO CHANNEL
24					133.7	OUTLET STRUCTURE
27	OS-4 & D-3			9.9	16.9	5' TYPE "R"

NOTE: ALL INLETS SIZED FOR 2-YEAR STORM UNLESS OTHERWISE NOTED

LEGEND

- BASIN DESIGNATION
- COMPOSITE RUNOFF COEFFICIENTS C_2 AND C_{100}
- BASIN AREA IN ACRES
- DESIGN POINT
- DIRECTION OF FLOW
- 4.00% STREET SLOPE
- BASIN BOUNDARY
- SUB-BASIN BOUNDARY
- 5260 EXISTING CONTOUR
- 5260 PROPOSED CONTOUR
- PROPOSED STORM SEWER W/INLET
- EXISTING STORM SEWER

-100 0 50 100 200
SCALE: 1' = 100'

CITY OF AURORA BENCHMARK 15-070
3" DIAM. BRASS CAP IN CONCRETE BEING 33' E. OF COR. TO SECS. 22, 23, 26, 27, T4S, R66W MON. IS 1.5' M/L S OF NEW CHAIN LINK FE. AND 2-1/2 FT. E OF N-S BARBWIRE FE. FOR PLAINS CONSERVATION CENTER TO THE SOUTH. REV. DESC. ON 8-10-93.
ELEVATION = 5647.31

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APPROVED FOR ONE YEAR FROM THIS DATE
11-10-99

D R Hogan 11/3/99
Director of Public Works Date

Director of Utilities 11/4/99
Date

PREPARED UNDER THE DIRECT SUPERVISON OF
JOHN E. CARROLL REGISTERED 10862 10/27/99 PROFESSIONAL ENGINEER STATE OF COLORADO
FOR AND ON BEHALF OF CARROLL & LANGE, INC.

No.	Revisions	Date	By	Chk
10				
9				
8				
7				
6				
5				
4				
3	PER C.O.A. COMMENTS	10/27/99	CJK	
2	PER C.O.A. COMMENTS	10/12/99	CJK	
1	PER C.O.A. COMMENTS	9/21/99	CJK	

Carroll & Lange inc
Professional Engineers & Land Surveyors
165 South Union Blvd., Suite 156
Lakewood, Colorado 80228
(303) 980-0200

Project: STERLING HILLS SUBDIVISION FILING NO. 9
Title: PRELIMINARY DRAINAGE MAP
Designed By: CJK | Scale: 1" = 100' | Sheet 2 of 3
Drawn By: MAJ | Job No. 2116
Checked By: | Date: 7-2-99 | File No. 2116-DR2

990213 2/5

FILING 9 DRAINAGE MAP
(COA #200017FDR)

This map has been included to show the anticipated runoff from Filing No.9 that designates the expected runoff at the two 50-ft inlets in E. Villanova Place. This also shows the basins tributary to OS1 from Filing No.15

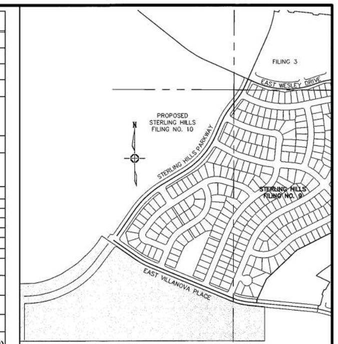
990213 3/5

DESIGN POINT	BASIN	LOCAL FLOWS Q_2	LOCAL FLOWS Q_{100}	TOTAL FLOWS Q_2	TOTAL FLOWS Q_{100}	INLET SIZE
	A-1	2.1	8.9			
	A-2	6.2	25.0			
	A-3	2.1	8.7			
	A-4	4.8	19.9			
	A-5	1.6	6.7			
1	A-3 & A-4			6.6		
1	A-3 & A-4 B-4 & B-16				42.3	
2	A-2 TO A-4			11.2		
2	A-2 TO A-4 B-4 & B-16				66.4	
3	A-1 to A-4 OS-1			13.3		10' TYPE "R"
3	OS-1 A-1 to A-4 B-14 & B-16				72.7	
4	OS-1, B-4 A-1 to A-5 B-14 to B-16				87.3	
	B-1	4.2	16.8			

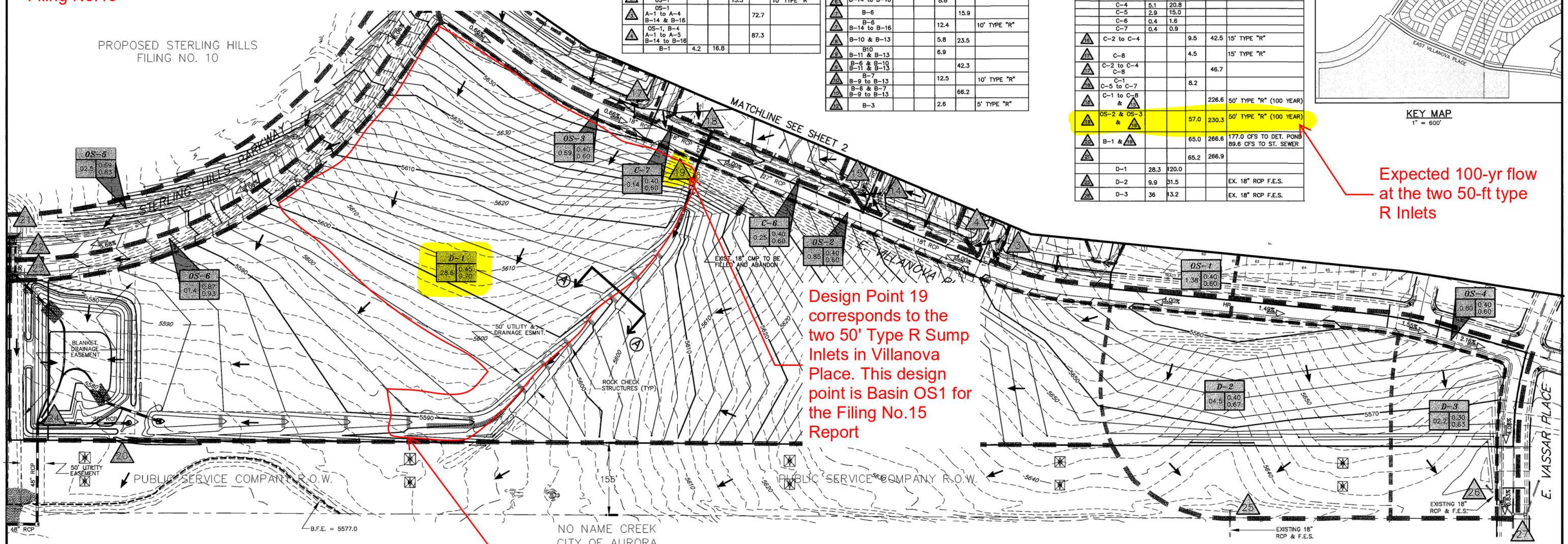
DESIGN POINT	BASIN	LOCAL FLOWS Q_2	LOCAL FLOWS Q_{100}	TOTAL FLOWS Q_2	TOTAL FLOWS Q_{100}	INLET SIZE
	B-2	1.9	7.6			
	B-3	2.6	10.5			
	B-4	1.2	5.0			
	B-5	3.3	14.0			
	B-6	4.0	15.9			
	B-7	4.6	21.6			
11	B-8	3.8	17.0			5' TYPE "R"
	B-9	0.5	1.9			
	B-10	3.5	14.3			
	B-11	1.9	8.0			
	B-12	2.2	9.2			
	B-13	3.1	13.3			
	B-14	5.4	22.9			
	B-15	2.4	9.8			
	B-16	1.5	6.2			
5	B-14 & B-16			6.7	28.2	
6	B-15				9.8	
6	B-14 to B-16			8.8		
7	B-6				15.9	
7	B-6 B-14 to B-16			12.4		10' TYPE "R"
8	B-10 & B-13			5.8	23.5	
9	B10 B-11 & B-13			6.9		
9	B-6 & B-10 B-11 & B-13				42.3	
10	B-7 B-9 to B-13			12.5		10' TYPE "R"
10	B-6 & B-7 B-9 to B-13				66.2	
12	B-3			2.6		5' TYPE "R"

DESIGN POINT	BASIN	LOCAL FLOWS Q_2	LOCAL FLOWS Q_{100}	TOTAL FLOWS Q_2	TOTAL FLOWS Q_{100}	INLET SIZE
12	B-3 & B-8				71.0	
13	B-4 & B-5			4.3		5' TYPE "R"
13	B-5 to B-7 B-9 to B-13				71.0	
14	A-5 & B-1			5.5		5' TYPE "R"
14	B-1 B-5 to B-7 B-9 to B-13 & 4				148.9	
15	B-2			1.9		5' TYPE "R"
15	B-8 B-2 to B-3 & 14				172.2	
	C-1	4.2	16.2			
	C-2	4.3	18.9			
	C-3	2.2	10.1			
	C-4	5.1	20.8			
	C-5	2.9	15.0			
	C-6	0.4	1.6			
	C-7	0.4	0.9			
16	C-2 to C-4			9.5	42.5	15' TYPE "R"
17	C-8			4.5		15' TYPE "R"
17	C-2 to C-4 C-8				46.7	
18	C-1 C-5 to C-7			8.2		
18	C-1 to C-8 & 15				226.6	50' TYPE "R" (100 YEAR)
19	OS-2 & OS-3 & 18			57.0	230.3	50' TYPE "R" (100 YEAR)
20	B-1 & 19			65.0	266.6	177.0 CFS TO DET. POND 89.6 CFS TO ST. SEWER
21				65.2	266.9	
	D-1	28.3	120.0			
25	D-2	9.9	31.5			EX. 18" RCP F.E.S.
26	D-3	36	13.2			EX. 18" RCP F.E.S.

Expected 100-yr flow at the two 50-ft type R Inlets



KEY MAP
1" = 600'



Design Point 19 corresponds to the two 50' Type R Sump Inlets in Villanova Place. This design point is Basin OS1 for the Filing No.15 Report

Approximate Filing No.15 Site boundary

DESIGN POINT	BASIN	LOCAL FLOWS Q_2	LOCAL FLOWS Q_{100}	TOTAL FLOWS Q_2	TOTAL FLOWS Q_{100}	INLET SIZE
	OS-1	1.4	5.8			
	OS-2	1.4	5.5			
	OS-3	1.0	4.0			
	OS-4	1.8	5.0			
	OS-5	5.4	18.7			
	OS-6	4.8	14.3			
22	OS-5 & 21			81.2	276.0	25' TYPE "R" (100 YEAR)
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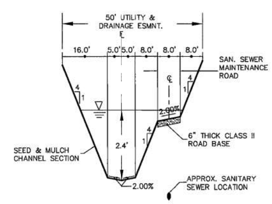
24					133.7	OUTLET STRUCTURE
27	OS-4 & D-3			9.9	16.9	5' TYPE "R"

NOTE: ALL INLETS SIZED FOR 2-YEAR STORM UNLESS OTHERWISE NOTED



CHANNEL SECTION A – A

Q_{100} = 263.1CFS
V_{100} = 5.94 FPS
S_{MIN} = 1.5%

SCALE: 1' = 100'

LEGEND

- BASIN DESIGNATION
- COMPOSITE RUNOFF COEFFICIENTS C_2 AND C_{100}
- BASIN AREA IN ACRES
- DESIGN POINT
- DIRECTION OF FLOW
- STREET SLOPE
- BASIN BOUNDARY
- SUB-BASIN BOUNDARY
- EXISTING CONTOUR
- PROPOSED CONTOUR
- PROPOSED STORM SEWER W/INLET
- EXISTING STORM SEWER

CALL UTILITY NOTIFICATION CENTER OF COLORADO
1-800-922-1987
CALL 2 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

APPROVED FOR ONE YEAR FROM THIS DATE
11-10-99

DR Hogan 11/3/99
Director of Public Works Date

Dana Edlen for J.G. 11/4/99
Director of Utilities Date

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CITY OF AURORA BENCHMARK 15-070
3" DIAM. BRASS CAP IN CONCRETE BEING 33' E. OF COR. TO SECS. 22, 23, 26, 27, T4S, R66W MON. IS 1.5' M/L S OF NEW CHAIN LINK FE. AND 2-1/2 FT. E OF N-S BARBWIRE FE. FOR PLAINS CONSERVATION CENTER TO THE SOUTH. REV. DESC. ON 8-10-93.
ELEVATION = 5647.31

PREPARED UNDER THE DIRECT SUPERVISON OF
JOHN E. CARROLL REGISTERED PROFESSIONAL ENGINEER 10862 10/29/99 STATE OF COLORADO
FOR AND ON BEHALF OF

No.	Revisions	Date	By	Chk
10				
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Project: STERLING HILLS SUBDIVISION FILING NO. 9
Title: PRELIMINARY DRAINAGE MAP
Designed By: CJK | Scale: 1" = 100' | Sheet 3 of 3
Drawn By: MAJ | Job No. 2116
Checked By: | Date: 7-2-99 | File No. 2116-DR3

DATE 5/11/99, Rev. 9/19/99, 1/7/00, 3/15/00, 5/12/00

CALCULATED BY CJK

CHECKED BY

STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN (RATIONAL METHOD PROCEDURE)

JOB No. 2116

PROJECT Stenning

DESIGN STORM 100-YR

STREET (1)	DESIGN POINT (2)	DIRECT RUNOFF: AREA DESIGN (3)	AREA (Ac) (4)	RUNOFF COEFF (5)	tc (min) (6)	(C)X(A) (Ac) (7)	I (in/hr) (8)	Q (cfs) (9)	TOTAL RUNOFF: tc (min) (10)	SUM C.A. (Ac) (11)	I (in/hr) (12)	Q (cfs) (13)	STREET: SLOPE (%) (14)	STREET FLOW (cfs) (15)	PIPE: DESIGN FLOW (cfs) (16)	SLOPE (%) (17)	PIPE SIZE (18)	TRAVEL TIME: LENGTH (ft) (19)	VELOCITY (fps) (20)	tt (min) (21)	REMARKS (22)
B-5 & (10)	(13)	B-5	3.44	0.60	14.0	2.06	6.8	14.0	25.6	16.16	4.7	76.0	1.8	76.0	Route to		(14)	1050	2.8	6.3	Tc=25.6+6.3=31.9
B-3 & (11)	(12)	B-3	2.84	0.60	15.8	1.70	6.2	10.5	18.1	4.31	5.7	24.6	1.8	24.6	Route to		(15)	1050	2.8	6.3	Tc=18.1+6.3=24.4
B-1		B-1	4.73	0.60	16.3	2.84	5.9	16.8													
B-1, (13), (14),	(14)								31.9	35.45	4.2	148.9									
B-2 & (12)		B-2	2.05	0.60	15.4	1.23	6.2	7.6	24.4	5.54	4.8	26.6									
B-2 to B-3, B-8, & (14)	(15)								30.3	40.99	4.2	172.2	4.0	172.2	Route to		(18)	350	4.0	1.5	Tc=30.3+1.5=31.8
C-4		C-4	5.60	0.60	15.2	3.36	6.2	20.8					2.0	20.8	Route to		(16)	750	2.8	4.5	Tc=15.2+4.5=19.7
C-3 to C-4		C-3	2.63	0.60	14.8	1.58	6.4	10.1	19.7	4.94	5.5	27.2									
C-2 to C-4	(16)	C-2	4.63	0.60	13.8	2.78	6.8	18.9	19.7	7.72	5.5	42.5	2.0	42.5	Route to		(17)	180	2.8	1.1	Tc=19.7+1.1=20.8
C-2 to C-4 & C-8	(17)	C-8	2.11	0.60	11.9	1.27	7.5	9.5	20.8	8.99	5.2	46.7	0.7	46.7	Route to		(18)	150	1.8	1.4	Tc=20.8+1.4=22.2
C-5		C-5	3.44	0.64	12.8	2.20	7.2	15.8													
C-1		C-1	4.75	0.60	18.0	2.85	5.7	16.2					0.7	16.2	Route to		(18)	120	1.8	1.1	Tc=18.0+1.1=19.1
C-7		C-7	0.14	0.60	5.0	0.08	10.8	0.9													
C-1, C-5 to C-7		C-6	0.25	0.60	5.0	0.15	10.8	1.6	19.1	5.28	5.5	29.0									
C-1 to C-8 & (15)	(18)								31.8	55.26	4.1	226.57	See inlet sizing calc's		92.1	0.8	42" RCP	30	9.6	0.1	Tc=31.8+0.1=31.9
	(34)	Storm sewer downstream of manhole between (18) & (19)							(Q-2=57.5) + (Q-100=86.4)			143.9			143.9	2.1	42" RCP	30	15.0	0.1	Tc=31.9+0.1=32.0
OS-2		OS-2	0.85	0.60	5.0	0.51	10.8	5.5	Q-2 @ (33) = 11.6 + Q-2 @ (31) = 45.9			= 57.5									
OS-2 & OS-3		OS-3	0.69	0.60	6.5	0.41	9.7	4.0	6.5	0.92	9.7	8.9	(See inlet calc's; inlet @ (19) intercepts 86.4 cfs.)								
OS-2 & OS-3 & (18)	(19)								31.8	56.18	4.1	230.3									
															230.3	5.2	42" RCP	120	23.9	0.1	Tc=32.0+0.1=32.1
													1.5	230.3	Channel thru BA			1450	5.8	4.2	Tc=32.1+4.2=36.3

(COA #200017FDR)

Amount of runoff generated within the upstream basins that is tributary to the two 50-ft inlets. Ponding depth will be provided at this location to capture the 100-yr flows.

STERLING HILLS FILING NO. 9

3/15/00

INLET SIZING

DESIGN POINT **16** (INLET #3)

FLOW CONDITION:	CONTINUOUS GRADE
Q-2 =	9.5 cfs
Q-2 @ 120%=	11.4 cfs
y =	0.5 ft.
a =	0.2 ft.
Qa/La=	0.4
La =	28.5
L/La =	0.53
a/y	0.4
Qi/Qa =	0.7
Qintercept =	(9.5)(0.7) = 6.7cfs
Qcarryover =	9.5-6.7 = 2.8cfs
USE **15'**	TYPE 'R' INLET

(COA #200017FDR)

DESIGN POINT **17** (INLET #17)

FLOW CONDITION:	SUMP
Q-2=	4.5 cfs
Q-2 @ 120%=	5.4 cfs
H =	9.0 in.
h =	6.0 in.
a =	3.0 in.
H/h =	1.5
Q/L =	1.8
L =	3.0 ft.
USE **5'**	TYPE 'R' INLET

DESIGN POINT **18** (INLET #2)

FLOW CONDITION:	SUMP
Q-100 =	86.4 cfs*
Q-100 @ 120%=	103.7 cfs
H =	12.0 in.
h =	6.0 in.
a =	3.0 in.
H/h =	2.0
Q/L =	2.4
L =	43.2 ft.
USE **50'**	TYPE 'R' INLET

Northern E. Villanova
PI inlet

STERLING HILLS FILING NO. 9

5/17/00

INLET SIZING

DESIGN POINT **19** (INLET #1)

FLOW CONDITION:	SUMP	
Q-100 =	86.4	cfs*
Q-100 @ 120% =	103.7	cfs
H =	12.0	in.
h =	6.0	in.
a =	3.0	in.
H/h =	2.0	
Q/L =	2.4	
L =	43.2	ft.
USE	**50'**	TYPE 'R' INLET

Southern E. Villanova Pl inlet

* Total Q-100 = 230.3cfs. Assume upstream inlets will capture Q-2 flows which totals 57.5 cfs. [(Q2 @ D.P. 32= 45.9) + (Q2 @ D.P.33= 11.6)= 57.5cfs.] This would leave 230.3-57.5= 172.8cfs. Assume split flow in half for both sides of street. Flow = 172.8/2=86.4cfs.

DESIGN POINT **22** (INLET #14)

(COA #200017FDR)

FLOW CONDITION:	SUMP	
Q-100	18.7	cfs
Q-100 @ 120% =	22.4	cfs
H =	9.0	in.
h =	6.0	in.
a =	3.0	in.
H/h =	1.5	
Q/L =	1.8	
L =	12.4	ft.
USE	**15'**	TYPE 'R' INLET

DESIGN POINT **23** (INLET #15)

FLOW CONDITION:	SUMP	
Q-100	14.3	cfs
Q-100 @ 120% =	17.2	cfs
H =	9.0	in.
h =	6.0	in.
a =	3.0	in.
H/h =	1.5	
Q/L =	1.8	
L =	9.6	ft.
USE	**15'**	TYPE 'R' INLET*

*Inlet has been oversized from 10' to 15' to accommodate two 36" RCP's tieing into to it from upstream.

Filing No.11 Basins Tributary to Offsite Basin OS8 and Design Point D1. Regrading of Drainage Channel and Piping of 100-yr Flow Underneath the Emergency Overflow Swale

(COA #202105)

FILING 11 DRAINAGE MAP(COA #202105)

This map has been included due to Filing No.11 changing the drainage channel to piped flow and regrades the channel as an Emergency Overflow Swale. Additionally, Filing No.11 constructed the Type R Inlet in E. Water Drive that is Design Point D1

DRAINAGE NOTES:

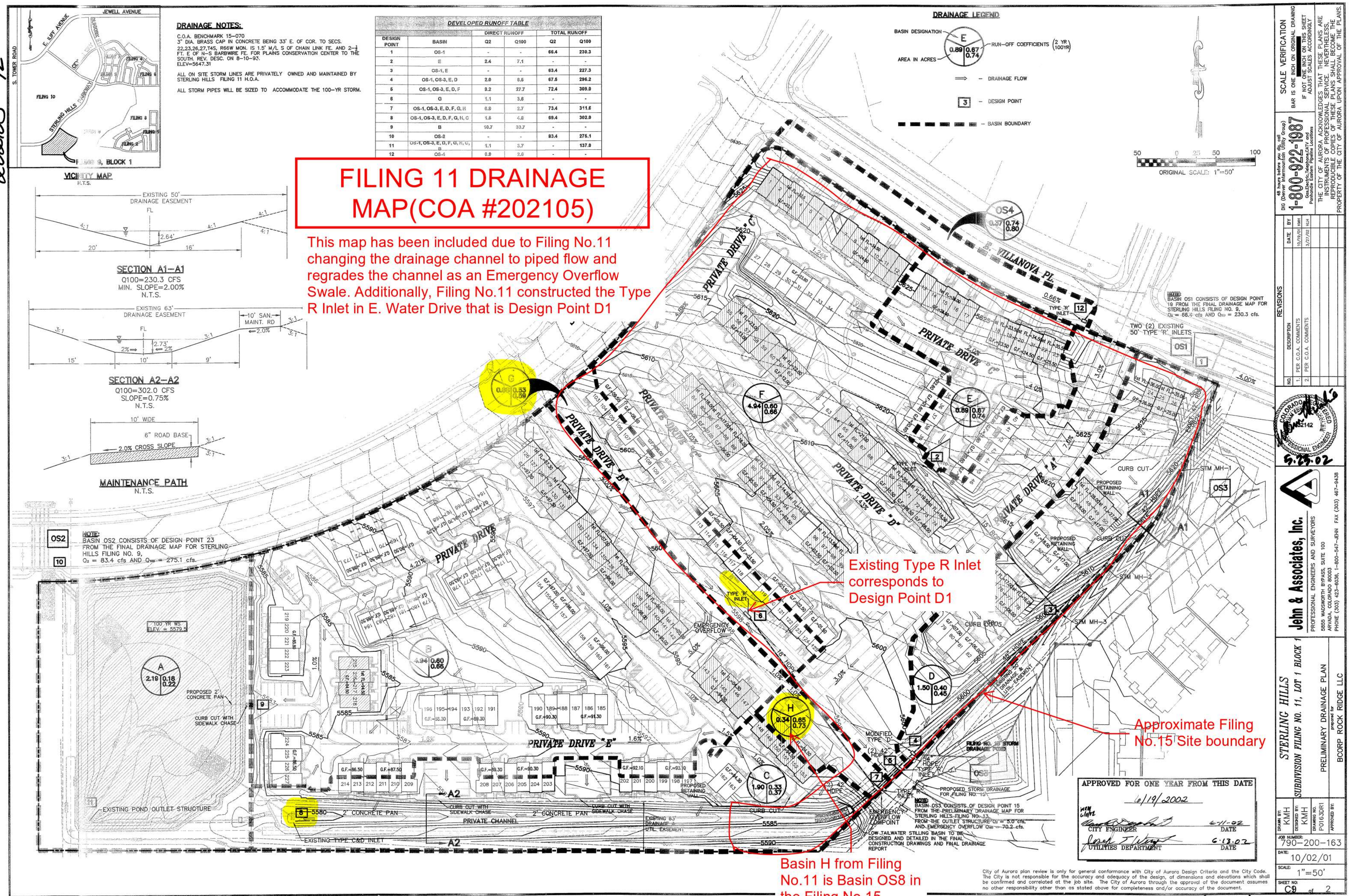
C.O.A. BENCHMARK 15–070
3" DIA. BRASS CAP IN CONCRETE BEING 33' E. OF COR. TO SECS. 22,23,26,27,T4S, R66W MON. IS 1.5' M/L S OF CHAIN LINK FE. AND 2–½ FT. E OF N–S BARBWIRE FE. FOR PLAINS CONSERVATION CENTER TO THE SOUTH. REV. DESC. ON 8–10–93.
ELEV=5647.31

ALL ON SITE STORM LINES ARE PRIVATELY OWNED AND MAINTAINED BY STERLING HILLS FILING 11 H.O.A.

ALL STORM PIPES WILL BE SIZED TO ACCOMMODATE THE 100–YR STORM.

DEVELOPED RUNOFF TABLE

DESIGN POINT	BASIN	DIRECT RUNOFF Q2	DIRECT RUNOFF Q100	TOTAL RUNOFF Q2	TOTAL RUNOFF Q100
1	OS-1	-	-	66.4	230.3
2	E	2.4	7.1	-	-
3	OS-1, E	-	-	63.4	227.3
4	OS-1, OS-3, E, D	2.0	6.5	67.5	296.2
5	OS-1, OS-3, E, D, F	9.2	27.7	72.4	309.0
6	G	1.1	3.6	-	-
7	OS-1, OS-3, E, D, F, G, H	0.9	2.7	73.4	311.6
8	OS-1, OS-3, E, D, F, G, H, C	1.5	4.8	69.4	302.0
9	B	10.7	33.7	-	-
10	OS-2	-	-	83.4	275.1
11	OS-1, OS-3, E, D, F, G, H, C, B	1.1	3.7	-	137.0
12	OS-4	0.9	2.6	-	-



(COA #202105)

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

CALCULATED BY:	KMH	JOB NO:	790-200-163
DATE:	6/1/01	PROJECT:	STERLING HILLS FILING NO. 11
CHECKED BY:	WEM	DESIGN STORM:	2 -YEAR

Flows to the Type R inlet that corresponds to Design Point D1 from Filing No.15

		DIRECT RUNOFF						TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			DESCRIPTION
DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	FLOW (CFS)	FLOW (CFS)	SLOPE (%)	PIPE DIA. (in)	LENGTH (ft)	VELOCITY (fps)	Tt (min)	
1	OS-1	-	-	-	-	-	-	25.8	36.70	1.80	[illegible]	[illegible]		66.4	6.21	42	155.5	22.0	0.12	42" RCP FROM DP-1 TO DP-3
		0.88	0.60	7.50	0.53	3.30	1.7	25.9	37.23	1.70	63.3	[illegible]		63.3	3.00	48	239.9	18.2	0.22	48" HDPE FROM DP-1.1 TO DP-3
		0.89	0.67	5.0	0.60	4.00	2.4	-	-	-	-	-	-	2.4	3.90	18	241.8	8.3	0.49	18" RCP FROM DP-2 TO DP-3
		-	-	-	-	-	-	26.1	37.83	1.65	62.4	-	-	62.4	3.00	48	257.6	17.5	0.25	48" HDPE FROM DP-3 TO DP-4
	[illegible]	0.67	0.25	11.7	0.17	2.80	0.5	-	-	-	[illegible]	[illegible] -	-							COMBINE W/ FLOW @ DP-4 DIRECT FLOW TO TYPE D
							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]									
4	OS-1, OS-3, OS-5, E, (D)	1.50	0.40	7.9	0.60	3.40	2.0	26.4	38.59	1.65	63.7	-	-	63.7	2.50	54	25.7	16.3	0.03	54"HDPE FROM DP-4 TO DP-6
-	FILING 13 BASIN **OS-6 TO DP-6 IN PIPE**	-	-	-	-	-	-	7.8	1.69	3.20	5.4	[illegible] -	-	5.4	5.00	30	145	10.2	0.24	30" RCP FROM OS-6 TO DP-6
-	FILING 13 BASIN **OS-7 TO DP-6**	-	-	-	-	-	-	13.5	1.34	2.55	3.4	[illegible] -	-							FILING 13 FLOWS TO LOW PT @ DP-6
5	G	0.68	0.53	8.4	0.36	3.20	1.1	-	-	-	-	-	-	1.1	1.31	18	248.1	4.5	0.92	18" HDPE FROM DP-5 TO DP-6
							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]									
6	OS-1, OS3, OS-5, OS-6 OS-7, D, E, (F), G	4.94	0.60	9.4	2.96	3.10	9.2	26.6	44.94	1.65	74.1	-	-	#####	3.0	(2) 42	39	14.3	0.05	2-42" HDPE FROM DP-6 TO DP-7
-	FILING 13 BASIN **OS-8 TO DP-7**	-	-	-	-	-	-	13.7	2.22	2.55	5.7	[illegible] -	-							FILING 13 FLOWS TO LOW PT @ DP-7
							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]									
7	OS-1, OS-3, OS-5,0S-6, OS-7, 0S8,D, E, F, G, (H)	0.34	0.65	5.0	0.22	4.00	0.9	26.7	47.38	1.65	78.2	0.75	73.4	78.2	3.0	(2) 42	39	14.5	0.04	2-42" HDPE FROM DP-7 TO HEAD WALL
8	OS-1, OS-3, OS-5 - 0S-8 (C),D, E, F, G, H	1.90	0.33	14.3	0.62	2.40	1.5	29.3	48.00	1.53	73.4	-	-				720	4.6	2.61	OPEN CHANNEL FROM HEAD WALL TO DP-8
9	B	4.94	0.60	6.4	2.96	3.60	10.7	-	-	-	-	-	-	-	-	-	-	-	-	
10	OS-2	-	-	-	-	-	-	25.4	46.31	1.80	[illegible]	[illegible] -					-	-	-	
11	A	2.19	0.18	11.3	0.39	2.80	1.1	-	-	-	[illegible]	[illegible]					-	-	-	
12	OS-4	0.37	0.74	8.1	0.27	3.20	0.9	-	-	-	0.9	[illegible]	[illegible]	0.8	2.0	18	25	6.0	0.07	18" RCP FROM DP-12 TO EX MANHOLE

[1]SEE FINAL DRAINAGE REPORT FOR STERLING HILLS SUBDIVISION FILING NO. 9
(CARROLL & LANGE, INC. OCTOBER 13, 1999)

[2]SEE PRELIMINARY DRAINAGE REPORT FOR STERLING HILLS SUBDIVISION FILING NO. 13.
(CARROLL & LANGE, INC. OCTOBER, 2001)

(COA #202105)

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

CALCULATED BY:	KMH	**JOB NO:**	790-200-163
DATE:	6/1/01	**PROJECT:**	STERLING HILLS FILING NO. 11
CHECKED BY:	WEM	**DESIGN STORM:**	100 -YEAR

		DIRECT RUNOFF						TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			DESCRIPTION
DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	FLOW (CFS)	FLOW (CFS)	SLOPE (%)	PIPE DIA. (in)	LENGTH (ft)	VELOCITY (fps)	Tt (min)	
1	OS-1	-	-	-	-	-	-	31.8	56.18	4.10	[illegible] (See Filing 9 Final Drainage Study)			230.3	6.21	42	155.5	22.0	0.12	42" RCP FROM DP-1 TO DP-3
1.1	OS-1, **(OS3)**	0.88	0.80	7.5	0.70	9.30	**6.5**	31.9	56.88	4.00	**227.5**			227.5	3.00	48	239.9	24.0	0.17	48" HDPE FROM DP-1.1 TO DP-3
2	E	0.89	0.74	5.0	0.66	10.80	**7.1**	-	-	-	-	-	-	7.1	3.90	18	241.8	11.3	0.36	18" RCP FROM DP-2 TO DP-3
3	OS-1, OS-3, E	-	-	-	-	-	-	32.1	57.54	3.93	**226.1**	-	-	226.1	3.00	48	257.6	24.0	0.18	48" HDPE FROM DP-3 TO DP-4
-	FILING 13 BASIN **OS-5 TO DP-4**	0.67	0.35	11.7	0.23	7.40	**1.7**	-	-	-	[illegible]	[illegible]								COMBINE W/ FLOW @ DP-4
							[illegible] DIRECT FLOW [illegible]					-	-							DIRECT FLOW TO TYPE D
4	OS-1, OS-3, OS-5, E, **(D)**	1.50	0.45	7.9	0.68	9.60	**6.5**	32.3	58.45	3.93	**231.5**			231.5	2.5	54	25.7	22.8	0.02	54" HDPE FROM DP-4 TO DP-6
-	FILING 13 BASIN **OS-6 TO DP-6 IN PIPE**	-	-	-	-	-	-	16.6	6.02	6.00	[illegible]			36.1	5.0	30	145	17.6	0.14	30" RCP FROM OS-6 TO DP-6
-	FILING 13 BASIN **OS-7 TO DP-6**	-	-	-	-	-	-	34.3	8.50	3.90	[illegible] (See Filing 13 Prelim. Drainage Study)	-	-							FILING 13 GUTTER FLOWS TO LOW PT @ DP-6
5	G	0.68	0.59	8.4	0.40	9.00	**3.6**	-	-	-	-	-	-	27.7	1.3	18	248.1	6.3	0.66	18" HDPE FROM DP-5 TO DP-6
							[illegible] DIRECT FLOW [illegible]													
6	OS-1, OS3, OS-5, OS-6 OS-7, D, E, **(F)**, G	4.94	0.66	9.4	3.26	8.50	**27.7**	32.4	76.63	3.90	**298.9**	0.75	12.8	287.4	3.0	(2)-42	39.0	20.0	0.03	2-42" HDPE FROM DP-6 TO DP-7
-	FILING 13 BASIN **OS-8 TO DP-7**	-	-	-	-	-	-	34.3	8.49	3.90	[illegible] (See Filing 13 Prelim. Drainage Study)	-	-							FILING 13 GUTTER FLOWS TO LOW PT @ DP-7
							[illegible] DIRECT FLOW TO DP-7 [illegible]													
7	OS-1, OS-3, OS-5,0S-6, OS-7, 0S8,D, E, F, G, **(H)**	0.34	0.73	5.0	0.25	10.80	**2.7**	32.43	85.37	3.93	**337.2**	0.75	12.8	312.9	3.0	(2)-42	39	20.0	0.03	2-42" HDPE FROM DP-7 TO HEAD WALL
8	OS-1, OS-3, OS-5 - 0S-8 **(C)**,D, E, F, G, H	1.90	0.37	14.3	0.71	6.80	**4.8**	34.4	86.08	3.79	**328.0**	-	-	-	-	-	720	6.3	1.90	OPEN CHANNEL FROM HEAD WALL TO DP-8
9	B	4.94	0.66	6.4	3.27	10.30	**33.7**	-	-	-	-	-	-	-	-	-	-	-	-	
10	OS-2	-	-	-	-	-	-	33.0	67.10	4.10	[illegible] (See Filing 9 Final Drainage Study)	-	-	-	-	-	-	-	-	
11	A	2.19	0.22	11.3	0.48	7.70	**3.7**	-	-	-	[illegible] (See Filing 9 Final Drainage Study)			-	-	-	-	-	-	
12	OS-4	0.37	0.80	8.1	0.29	9.00	**2.6**	-	-	-	**2.6**	CARRYOVER TO DP-8 [illegible]								18" RCP FROM DP-12
												7	[illegible]	1.3	2.0	18	25	6.0	0.07	TO EX MANHOLE

[1]SEE FINAL DRAINAGE REPORT FOR STERLING HILLS SUBDIVISION FILING NO. 9
(CARROLL & LANGE, INC. OCTOBER 13, 1999)

[2]SEE PRELIMINARY DRAINAGE REPORT FOR STERLING HILLS SUBDIVISION FILING NO. 13. Q_{100}=70.
(CARROLL & LANGE, INC. OCTOBER, 2001)

100-yr flows from Basin H which is OS8 in the Filing No.15 Report

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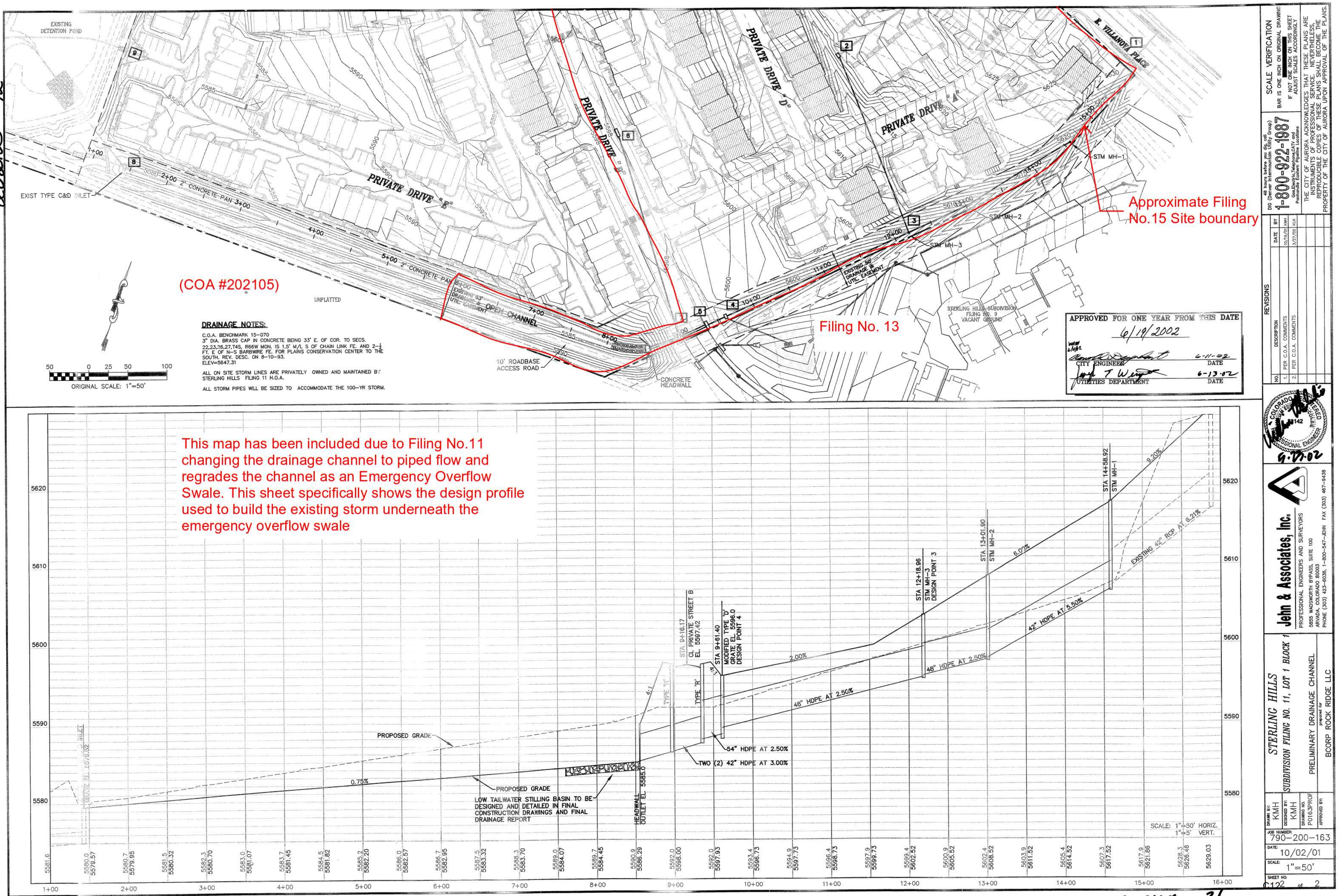

202105 2/2

Pages from the Wright Water Engineers Pond Redesign Report

STERLING HILLS FILING NO. 11 WATER QUALITY DETENTION POND

FINAL DRAINAGE REPORT

A. INTRODUCTION

The purpose of this report is to explain the original basis of design for the Sterling Hills Filing No. 11 Detention Pond ("Pond") and to justify the proposed improvements planned for the Pond.

The Pond was designed by Carrol & Lange (C&L) and was constructed in 2000 to 2001. The Pond was designed to capture flows from Filing Nos. 9 and 10. Filing Nos. 11, 12, and 13, and now the proposed Filing No. 15 exist within the original bounds of Filings Nos. 9 and 10 and are served by the Pond. The Pond itself is located within Filing No. 11, and was originally located within Filing No. 9. The Pond was designed as an extended dry detention basin to provide the water quality capture volume (WQCV) with a 40-hour drain time and detention for the 10- and 100-year events. The Pond was not large enough to provide the full 10- and 100-year detention volumes for the tributary area to the Pond, and inlets to the Pond from the southeast and north split flow and divert high flows around the Pond. Based on the Final Drainage Report for Filing No. 13 and the 2001 as-built certification for the Pond by C&L the following storage volumes were required and provided by the Pond:

Table 1. Pond Storage Volumes from C&L Design and As-built Certification

Volume	Required Volume (ac-ft)	As-built Volume (ac-ft)
WQCV	4.67	4.59
10-year	4.67 + 2.21 = 6.88	6.56
100-year	4.67 + 3.88 = 8.55	9.17

Since it was constructed, the Pond has had significant maintenance needs and has been difficult to maintain. The original Pond design did not include forebays or a micropool, measures that are important for preventing plugging of the outlet works, and as a result, there has been significant sediment accumulation in the Pond and ponding of water that creates nuisance conditions for residents living nearby. The Pond was constructed with very little separation from underlying

The Buick Series is a sandy clay loam having an AASHTO rating of A-6 or A-7 and a moderate to high shrink swell potential. The Buick Series consists of deep, gently sloping to sloping soils that occur on uplands. Surface runoff is moderate to rapid and the hazard of water erosion is high."

The NRCS soils report is attached in Appendix 3.

b) Type of development: Use, proposed density, composite percent of impervious area

The Pond was originally designed to provide water quality and some detention to Sterling Hills Filings Nos. 9 and 10. The total drainage area originally planned for the Pond was 234 acres (112 acres from Filing No. 10 and 122 acres from Filing No. 9). Following the development of Filing Nos. 9 and 10, additional filings were developed within the 234 acres that comprised Filing Nos. 9 and 10. Filing Nos. 11, 12, and 13 have been developed within the designed drainage area of the Pond and Filing No. 15 is proposed to be developed within the drainage area. With the addition of the more recent filings, the total acreage of the drainage area has not increased to the Pond, but the composite percentage of impervious area has changed. Table 2 shows the area and percent impervious area of each of the filings, including the proposed Filing No. 15, that comprise the drainage are to the Pond.

Table 2. Drainage Basin Size and Impervious Area

Filing No.	Area (acres)	% Imperviousness
9	78.12	45
10	111.8	45
11	8.3	46.5
12	10.2	57.9
13	16.5	58
15	9.08	50.4
Total	**234**	**46.7**

The total drainage area to the Pond is 234 acres with a composite percent of impervious area of 46.8% percent.

- UD-Detention Orifice Plate Sizing Calculations
- Outlet Rating Curve Spreadsheet

C.2 Hydrologic Criteria

a) Rainfall source and P1 identified

Rainfall data is from the Filing No. 9 Drainage Report (Carroll & Lange, 2000).

b) Calculation method

The calculation method to determine the WQCV and size the outlet orifice plate was the UD-BMP spreadsheet tool developed by MHFD (Appendix 1). The 10 and 100-year volumes were the same as used in the Final Drainage Report for Filing No. 13 and is described in detail on Page 8 of the Final Drainage Report (Carroll & Lange, 2004).

c) Detention volume computation method

Pond volumes for the WQCV and 10- and 100-year storage will be restored to original design capacity as a part of the rehabilitation project. The volumes provided will be the same as the design volumes listed in Table 1, and the Pond will be excavated and regraded to closely match the stage-storage curve from the required volumes in Table 1, which is shown in Figure 2. Table 2 summarizes the design volumes for the Pond rehabilitation. WWE verified the WQCV using the UD-BMP workbook (Appendix 1) based on the impervious area of each filing, including Filing No. 15, which has not yet been constructed. For an overall area of 234 acres with an imperviousness of 46.8 percent, the required WQCV is approximately 3.86 acre-feet. A rehabilitated pond will provide approximately 4.7 acre-feet for the WQCV. Therefore, the WQCV will be adequate for all of the filings draining to the pond, including Filing No. 15. The WQCV drain time is 40-hours, in conformance with MHFD criteria, and the 10- and 100-year release rates and elevations are the same as in the original C&L design.

the WQCV using the UD-BMP workbook (Appendix 1) based on the impervious area of each filing, including Filing No. 15, which has not yet been constructed. For an overall area of 234 acres with an imperviousness of 46.8 percent, the required WQCV is approximately 3.86 acre-feet. As shown in Table 2, the rehabilitated pond will provide approximately 4.7 acre-feet for the WQCV. Therefore, the WQCV will be adequate for all of the filings draining to the pond, including Filing No. 15.

WWE evaluated the WQCV that needs to be provided by the Pond based on the imperviousness of the area draining to the Pond. For Filing No. 15, WWE used a proposed imperviousness of 51.5 percent for the 9.1-acre drainage area, consistent with the Preliminary Drainage Report for Filing No. 15 from Dewberry (Appendix 3) WWE calculated the design volume for the WQCV including this area and other developed areas in the watershed using the UD-BMP workbook from the Mile High Flood District (MHFD). WQCV calculations are provided in Appendix 1.

The outlet structure for the Pond will be redesigned to incorporate a micropool and will include a new orifice plate for releasing the WQCV and the 10-year peak discharge and the existing overflow weir/grate for the 100-year discharge.

d) Major drainageways

Runoff from Filing No. 10 is conveyed in an open channel on the south side of the proposed Filing No. 15 to the Pond' south east inlet.

A spillway provides the emergency overflow on the west side of the Pond. The Pond and the spillway both discharge to an unnamed tributary to West Tollgate Creek.

D. DRAINAGE PLAN

D.1 General Concept

The Drainage Plan for the Pond is described on Pages 10 and 11 of the Final Drainage Report for Sterling Hills Subdivision Filing No. 13 (Carroll & Lange, 2004).

Sterling Hills Imperviousness Calculation

	Area (acres)	% Imperviousness	References
Filing 9	78.12	45	Final Drainage Report For Sterling Hills Subdivision Filing No. 13, UDFCD Chapter 6 Runoff
Filing 10	111.8	45	Final Drainage Report For Sterling Hills Subdivision Filing No. 13, UDFCD Chapter 6 Runoff
Filing 11	8.3	46.5	Final Drainage Report For Sterling Hills Subdivision Filing No. 13
Filing 12	10.2	57.9	Final Drainage Report For Sterling Hills Subdivision Filing No. 13
Filing 13	16.5	58	Final Drainage Report For Sterling Hills Subdivision Filing No. 13
Filing 15	9.08	51.5	Preliminary Drainage Report Filing No. 15 (Dewberry)
Total	234	46.8	

The Site included

Meeting Notes

Meeting Name:	Drainage Discussion with Aurora Water	
Location:	Virtual (Microsoft Teams)	
Date:	12/18/2023	
Re:	**Sterling Hills – Calamar 55+**	
Attendees:	☒	Richard Ommert, Aurora Water
	☒	Colin Haggerty, Mile High Flood District
	☒	Derek Clark, Mile High Flood District
	☒	Scott Brown, Galloway
	☒	Casey Visscher, Galloway
	☒	Lauren Lansford, Galloway

Notes:

- Project Introduction
  - (See meeting invite for agenda)
  - There is an existing pond providing detention offsite – but only 50% imp was assumed in the PDR for the site – so additional water detention will be needed for the new site plan.
  - There is an existing channel to the east but flows are now piped, swale now conveys emergency overflows.

- Site Discussion
  - We need to accurately calculate the head (checking clogging) at the 50-ft inlets to ensure they can capture all 100-yr flows
    - Otherwise, we will need to capture our own flows and the overflow from the existing swale.
    - Soil riprap (whatever was called out in the PD) is fine to line the channel.
    - Once we know if we are exceeding inlet capacity we can check the abilities of the offsite pond (if it provides WQ or just detention) and seek a variance. Otherwise, an on-site pond is needed.
  - Per airport zone overlay, drain time in this area is 48 hours.
  - The site will need a full-spectrum detention pond if one is needed on-site.

Note Taker: Lauren Lansford