

# Shoppes at Kearney

A Commercial Development

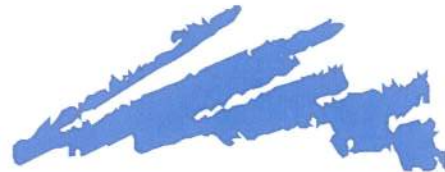
in the  
CITY OF KEARNEY  
Clay County, Missouri

## MICRO Storm Water Drainage Study

December 12, 2012

**Prepared For:**

Star Development  
244 W Mill, Suite 101  
Liberty, MO 64068



### AGC Engineers, Inc.

405 S. Leonard St. Suite D  
Liberty, Missouri 64068

[www.agcengineers.com](http://www.agcengineers.com)

816-781-4200  
Fax 792-3666





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  - North Leg (downstream of 92 Highway) 8x8 0.64%
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ARMY Corp of Engineers Permit



## **General Information**

This project is located in the south east quadrant of, and immediately adjacent to, 35 and 92 Highways. This site is in the northwest quarter of Section 34 of Township 53N, Range 31W, Kearney, Clay County, Missouri and drains to Fishing River tributary 16. This is a commercial development planned for a grocery store, retail shops, a hotel, pharmacy, convenience store and restaurants. It is understood that the use's may ultimately change with the final development of the site but in accordance with the zoning. See attached "Preliminary Plan" for "Shoppes at Kearney" in the Appendix.

The purpose of this MICRO drainage study is to review the existing runoff and identify means to limit the peak runoff from the ultimate development to existing conditions, for the one percent chance storm (100 year storm) and higher frequency storms including the 2, 10, 25 and 50 yr storms.

Portions of an existing drainage channel are to be enclosed with this development. This report will size the structures and identify any impacts.

This study shall also identify the Best Management practices proposed to protect water quality during and after construction.

Previous Reports include:

MACRO	September 14, 2012
MACRO Addendum 1,	October 16, 2012

The original MACRO attempted to use in channel detention. The subsequent use of the proposed FEMA model showed existing back water from Regency Drive which complicated the use or modeling of, in channel detention and the sizing of the in channel culvert. All designated detention has now been placed outside of the channel.

## **Methodology**

### **Field Survey Data**

The field survey was provided by the owner and supplemented additional field survey to confirm specific features and grades of the site and surrounding controls.

### **Hydrologic Data and Procedures**

Methodology outlined in the American Public Works Association (APWA) Standard Design Criteria, Division V Section 5600, Storm Drainage Systems and Facilities as adopted and modified by the City of Kansas City, Missouri, and SCS methods from Technical Release No. 55 (TR-55) "Urban Hydrology for Small Watersheds" were used to determine composite Curve Numbers (CN), Concentration Times (TC), Travel Times (TT), Peak Flows (Q), and preliminary detention volumes. Hydrologic Engineering Centers River Analysis System

(HEC- RAS) was used to run the existing proposed FEMA model and the proposed site improvements to compare water surface elevations up and down stream for both before and after development. Federal Highway Administration culvert sizing program HY8 was used to evaluate and size the proposed roadway crossing culverts.

## **Existing Condition Analysis**

The existing property consists of approximately 36.7 acres of which approximately 30 acres drains to a channel running generally west to east and south of 92 Highway. This channel develops from two outlets from under 35 Highway to 92 Highway exit ramp with a 4ft x 4ft concrete box culvert and a 42 inch concrete pipe drainage approximately 98 offsite acres. It converges with Fishing River Tributary 16 near the north east corner of the site and just upstream of Regency Drive. The Fishing River Tributary 16 enters the site on the north east corner via an eight (8) foot wide by six (6) foot tall reinforced concrete box culvert under 92 Highway. This drains south and then east in a large channel to and existing 12 foot wide by 5.5 foot tall reinforced box culvert under Regency Drive. This tributary has a drainage area of approximately 418 acres upstream of Regency Drive.

This study looks at two key locations. The first location is a point within the FEMA model at a cross section 178 feet upstream of the Regency Culvert. Note that when referring to the FEMA model here in this is in reference to the proposed model. This will be the point of comparison for before and after peak flows, and is downstream of the proposed improvements excepting any channel or culvert improvements between this section and Regency. This point is labeled as cross section 16435 Q in the FEMA report.

The second point of control is at the northwest corner of the site where the drainage from MoDOT 92 Highway drains onto this property. The storm system at this location is collected in a junction box outside the pavement at the 35 Highway north bound off ramp to east bound 92 Highway. Before recent improvements the system day lighted here at an elevation of 812.5. The recent improvements collected this storm water and extended it to the Shoppes site in a 42 inch pipe and day lighted at an elevation of 808.2. This becomes the second point of control since the new FEMA study reflects a 100 year storm elevation of 810 that is back water ponding from the Regency Drive Culvert and theoretically backs water into the MoDOT system.

The existing condition's consist of two main basins discussed above the north basin for the consisting of 418 acres and the south basin consisting of approximately 138 acres. There is a small portion of this project site that currently drains to the south and east. See Existing Drainage Basins exhibit in the appendix.

The current off site land use varies from row crop to commercial and includes some residential in the upper portion of the north basin.

The soil types in this area are from the USDA Soil Survey as shown in the Table below and on the "Soils Map" in the Appendix.

Symbol	Name	Soil Group
10081	Macksburg	B
10120	Sharpsburg	B
10122	Sharpsburg	B
30085	Grundy	C
30120	Lagonda	C
36007	Bremer	C

These soils are all a silty clay loam, described by NRCS as easily eroding, and moderately slow permeable soils. The Grundy, Lagonda and Bremer are limited and mostly on the existing offsite north tributary. Due to the location and limited amount of the Bremer soils, this review will use an average soil group of B.

The composite runoff curve number was developed from the existing land use conditions, and soil groups. The average slope and drainage path length was also identified.

Hydrographs were created to reflect the flows from the combined basins with the drainage areas, the appropriate curve numbers, basin slopes, and hydraulic lengths and using TR 55 within the Hydro Flow Hydrographs software.

The peak runoff flows for the 2, 10, 25, and 100 year storms are included in the appendix.

In the existing model the downstream point of comparison is at cross section (16435 Q). These flows are shown on attached existing and proposed development exhibits. The 100 year flow at this point for the FEMA model is 1553 cfs. The existing conditions model reflects 1555 cfs. The lower frequency storms varied from FEMA. This variation was discussed with FEMA's engineer that developed their model and it was understood that that their model was for 228 square miles and did not provide the level of detail required this area, but that they and the City's engineer agreed on a reduction factor to better reflect the flows in this area. The determination of this difference in the lower frequency storm is not as critical for comparison as this review looks upstream and at the impact on the MoDOT controls.

## Proposed Condition Analysis

The intent of storm water controls is to limit the flows to the pre developed condition and limit any back water ponding in the MoDOT system above the 812.5 elevation.

As reflected in the proposed Preliminary Development Plan (included in the appendix) the development of this site includes a grocery store, retail shops, a hotel, pharmacy, convenience store and restaurants. It is understood that the use's may ultimately change with the final development of the site but in accordance with the zoning.

The proposed drainage patterns create four sub basins on this site. Three drain to the Regency Road culvert and are identified as areas A1, A2 and A3. The fourth drains to the south property line designated as area B1.

Area A1 lies along the west and north west portion of the site. The south portion of area A1 (A1a) will drain into two basins along 35 Highway with a staged outlet structure and then into the existing channel draining from 35 Highway. All of Area A1 and the 98 offsite acres drain into a protected natural channel to a proposed culvert under the north leg of the roundabout. This culvert is sized to limit the backwater elevation at the MoDOT System, to at or below 812.5.

Area A2 includes the largest area of this site and drains approximately 23.5 acres. This area includes a portion that is currently draining off site to the south and south east but is redirected with the proposed improvements. Area A2 drains into proposed detention Pond C and is controlled with a staged outlet structure.

Area A3 is on the north east corner of the site. A proposed developed portion of the site (A3a) is to flow into a detention pond located at the south end of area A3a and is also controlled by a staged outlet structure.

Area B1 by the decrease in area from existing to the proposed, offsets the peak runoff factor to less than existing conditions and as proposed here in would not require detention. See also Proposed Detention Areas exhibit in the appendix.

Hydrographs were created to reflect the peak flows for the proposed conditions using the drainage areas, the developed curve numbers, basin slopes, and hydraulic lengths using TR 55 within the Hydro Flow Hydrographs software.

The peak runoff flows for the 2, 10, 25, and 100 year storms are included in the appendix.

Large reinforced box culverts are recommended for the roadway crossings and sized at 8' x 8' for each upstream leg and converge in a wye connection with a 12' x 8' section on the downstream portion of the culvert. The alignment of the outlet shall be placed in line with the existing downstream Regency Drive culvert allowing fill to be placed on the south side of the channel where it has severely



eroded. Large rip rap shall be placed on the outlet side slopes to help protect from future erosion. The enclosed wye connection will help mitigate the current erosion problem experienced by the open wye channel connection of the two stream legs.

The culvert noted here in as the west leg crosses an existing 18 inch diameter sanitary sewer. To avoid conflict is laid at a 0.1 percent grade until it crosses the sanitary sewer and then drops a 5% connecting with a culvert intercepting water from the north, noted here in as north leg. These two intercept to form a wye and the downstream leg. These culverts are sized here in as 8' x 8' for both the west and north leg and then 12' x 8' for the downstream leg. The downstream leg is positioned to line up with the downstream 12' wide Regency Drive Culvert. Additional large Rip Rap is proposed to line the sides of the channel between this downstream outlet and the Regency Drive Culvert.

- **Flood Control**

Fishing River Tributary 16 is not studied under current FEMA mapping upstream of 19th Street however their exist a current study, not officially adopted but understood to be through all reviews and comments with the exception of some levee revisions that could delay adoption of the maps for 3 to 5 years. In this proposed FEMA Model backwater from Regency Drive creates flooded areas effecting the two north tracts of this development building A and B. At this time there is no map to revise, however it should be understood that once the proposed FEMA mapping is adopted in the expected 3 to 5 years that Lot 4 and Lot 5 will be in a mapped flood plain and could then be subject to flood insurance, without map amendment/revision.

Note that these two north pad sites are being filled to and elevation of 820 to 822 where as the proposed flood elevation from the FEMA model will be 810, thus any concern for flooding of the buildings will only be due to the lag of the adoption of the maps with respect to the development of the site.

Each detention pond has an overflow spillway that is set at a minimum of 1/2 foot above the 100 year ponded storm and is directed to the creek either directly or after flowing through a public right of way or detention. Along 35 Highway Detention Pond A overflows into Pond B. Pond B has an emergency spillway that flows directly in into the east west channel downstream of the MoDOT 4' x 4' RCB and in the existing rip rapped area of the channel. Detention Pond C flows to service drive, down to Platte Clay Way, to a low point in Platte Clay Way and then over the shoulder to the Creek. Pond D overflows to Platte Clay Way and follows the same path from this same point as Pond C.

Each detention pond has staged structures to mitigate the higher frequency storms. These structures are detailed in the appendix.

The two 8' x 8' culverts on the east west channel and north south channel are sized more for a conservative back water from the FEMA study but each have emergency conveyance downstream to the culvert outlet. The west end would build up to elevation 817 and overflow Star Drive to the east and into detention pond D which also has emergency overflow at 817. This would then flow east over Platte Clay Way at an elevation of about 812 and then south east to the culvert outlet and then to the Regency Drive. The north culvert leg collects water from the 8' x 6' culvert under 92 Highway in an 8' x 8' culvert but if overflows would overflow to the south over Platte Clay Way at an elevation of about 812 to the culvert outlet and then to the Regency Drive Culvert.

- **Erosion Control and Best Management Practices**

Temporary erosion control measures such as silt fence, ditch checks, and inlet protection should be used during construction and on individual lot development. The existing on site soils have a potential for eroding thus grass reestablishment should occur as soon as possible after construction.

Silt fences will be installed on the pertinent perimeters of the site and around sediment or topsoil stockpiles. Sediment or soil stockpiles are defined as the storage for multiple days of soil or other sediment material to be used in the construction project.

Topsoil stripped from the immediate construction area will be stock piled in an area that will not interfere with construction phases and at least 15 feet away from areas of concentrated flows or pavement. The slopes of the stockpile will not exceed 2:1 to prevent erosion. A silt fence will be installed around the perimeter of the stockpile and/or as shown on the erosion control plans.

Detention facilities will be constructed during the initial part of the mass grading and used for temporary sediment control facilities during the construction of the upstream sites. The detention facilities will be constructed and operational prior to the construction of impervious surfaces in the development.

Soil compaction to be minimized in areas of the site where final vegetative stabilization will occur.

Permanent BMP's consist of vegetated swales. Roof drains and parking lot drains are to be day lighted wherever possible and directed to vegetated swales. Vegetated swales are designated along either side of Platte Clay Way to allow parking lots to be drained through curb cuts where practical. Additional vegetated swales are planned for the east side of Lots 1 and 2. The removal of native vegetation shall only occur as needed. Natural vegetation shall be used where practical along the stream disturbed stream banks.

## Summary

In summary the development of this site with the four detention basins, staged control structures and large channel culverts identified here in will limit the downstream peak flow runoff for the 2, 10, 25, 50 and 100 yr storms along with the 100 year downstream water surface elevation to the pre developed conditions.

Individual site developments should be encouraged to provide disconnects between roof drains, and parking lots to the storm system providing overland flow and flow through vegetated swales where practical.

The temporary storm water impacts from this development shall be mitigated by vehicle traffic control device, silt fence, ditch checks, inlet protection, re establishing ground cover, and the temporary sediment basins within the detention basins.

While these detention basins also serve as temporary sediment basins. Each lot development should also provide temporary erosion controls allowing the detention basins to serve only as a backup erosion control feature.

The conditions set forth in the Department of the Army Permit NWK 2009-01141 shall govern work on this site in the areas of the COE jurisdiction. See Appendix for a copy of this permit.

## Conclusions and Recommendations

It is determined here in that the proposed Shoppes at Kearney, located in Kearney, Clay County, Missouri, with the commercial development of 36 acres will create an increase in storm water runoff for which the peak flow will be mitigated by the development of four detention basins.

Detention ponds are proposed for all areas except for the Pharmacy site and Area B1. The Pharmacy site is offset by other on site detention. Area B1 is offset by less area draining to the south after regrading. The detention basins utilize staged outlet control structures to mitigate higher frequency storms. The detention facilities will be constructed and operational prior to the construction of impervious surfaces in the development and also be used as temporary siltation basins. The subdivision is responsible for maintaining the detention facilities. Final site grading plans shall include a 20 foot wide graded 5:1 maximum slope access into any basin. Any walls in the detention facilities with heights greater than 32" shall include hand rail or fencing. Cross access easement shall be provided to allow access to each detention facility.

Large reinforced box culverts are recommended for the roadway crossings sized at 8' x 8' for each upstream leg and converge in a wye connection with a 12' x 8' section on the downstream portion of the culvert. The alignment of the outlet shall be placed in line with the existing downstream Regency Drive culvert

allowing fill to be placed on the south side of the channel where it has severely eroded. Large rip rap shall be placed on the outlet side slopes to help protect from future erosion. The enclosed wye connection will help mitigate the current erosion problem experienced by the open wye channel connection of the two stream legs. Emergency overflows discussed herein shall be developed and maintained to direct overflows back to the existing channel.

The first of the two key locations for review was the downstream cross section on the upstream side of Regency Drive. These improvements based on the current development plan will limit to the peak flows at the upstream side of Regency Drive and for area B1 for the various frequency storms to near or below the existing as identified below:

<b>Section 16435 Q</b>	<b>50% (2yr)</b>	<b>10% (10yr)</b>	<b>4% (25 yr)</b>	<b>2% (50 yr)</b>	<b>1% (100 yr)</b>
FEMA Peak Runoff (cfs)	-	902	-	1334	1553
Existing Peak Runoff (cfs)	169	614	991	1255	1555
Proposed Peak Runoff (cfs)	168	614	987	1249	1542
<b>Area B1</b>					
Existing Peak Runoff (cfs)	5.2	17	27	34	41
Proposed Peak Runoff (cfs)	5.7	15	21	26	30

The downstream water surface elevation at Regency Drive is unchanged between the existing and proposed conditions as reflected in the table below.

<b>Water Surface Elevation</b>		<b>10% (10yr)</b>	<b>2% (50 yr)</b>	<b>1% (100 yr)</b>
Regency Drive	Before	803.68	809.03	809.90
	After	803.68	809.03	809.90

The second key location for review with this site was at the upstream portion of the site where MoDOT system drains on to site the water surface elevation is increased due to culvert backwater from the FEMA elevation of 810.0 to either 811.87 or 812.06 depending on the program used.

<b>100 yr Water Surface Elevation At MoDOT</b>	<b>Existing FEMA backwater from Regency</b>	<b>Hydro flow Hydrographs</b>	<b>HY8</b>
1% (100 yr)	810.0	812.06	811.87

The proposed on site storm system shall handle the 10 year storm, with overflow directed to detention areas or the existing channel. The large culverts are able to handle the 100 year storm without overflow.

# APENDIX

## Maps and Exhibits

Development Plan  
Existing Drainage Basins  
Proposed Drainage Basins  
Proposed Drainage Basin Runoff Values

## Soils Survey

South Basin  
North Basin  
SCS Curve Numbers

## FEMA

(from current study - not yet adopted)  
Flow Data  
Table 2 Summary of Discharges  
Floodway Data

## HEC RAS

Flood Data Existing  
Flood Data Proposed

## Supporting Calculations

For each 2, 10, 25 and 100 Year storms the following  
  
Existing Conditions Hydrograph Summary Tables  
Proposed Conditions Hydrograph Summary Tables

## Pond Reports

Pond A - South Pond along 35 Highway  
Pond B - North Pond along 35 Highway (pond A flows into B)  
Pond C - Grocery Store Pond  
Pond D - C Store Pond

## Large Culvert Sizing

Upstream Portion of West Leg  
Downstream Portion of West Leg  
North Leg (downstream of 92 Highway)  
Downstream Leg

## ARMY Corp of Engineers Permit



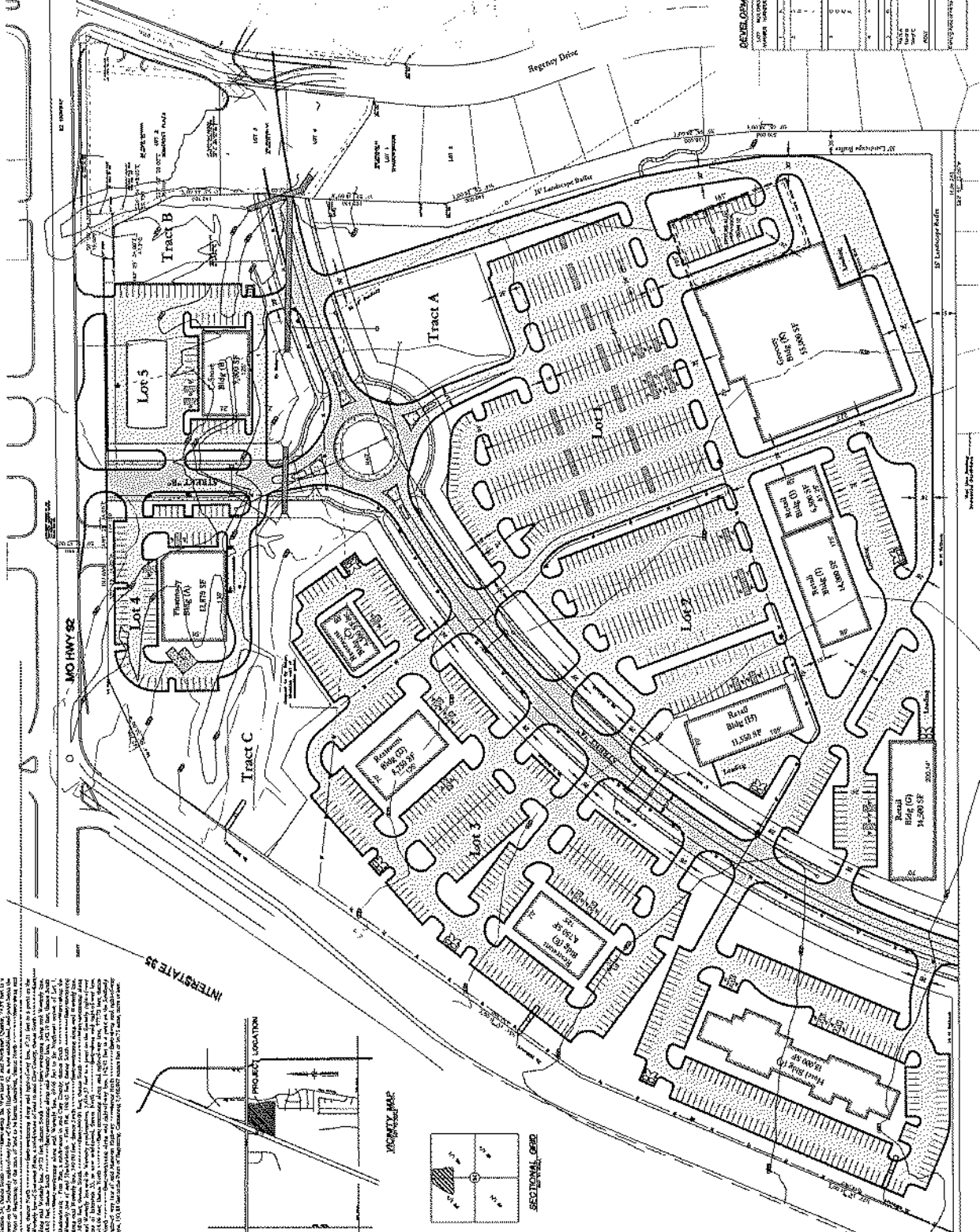
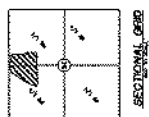
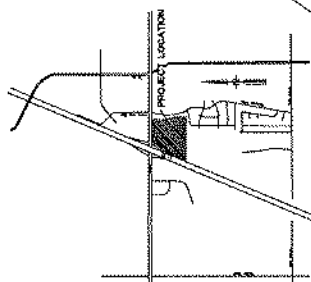
## Maps and Exhibits

# PRELIMINARY PLAN SHOPPES at Kearney

## DISTRICT C

Part of the NW 1/4 and NE 1/4 of Sec. 34, Twp. 53, Rge. 31  
Kearney, Clay County, Missouri

1. This plan is prepared for the proposed development of the property shown on the attached map. It is intended to show the location of the proposed buildings, parking areas, and other improvements, and to show the proposed layout of the property. It is not intended to show the exact location of the buildings, parking areas, and other improvements, and it is not intended to show the exact layout of the property. It is intended to show the general location of the buildings, parking areas, and other improvements, and to show the general layout of the property.



**LEGEND**

Proposed Building	Proposed Parking Area	Proposed Landscaping
Proposed Building	Proposed Parking Area	Proposed Landscaping
Proposed Building	Proposed Parking Area	Proposed Landscaping
Proposed Building	Proposed Parking Area	Proposed Landscaping
Proposed Building	Proposed Parking Area	Proposed Landscaping
Proposed Building	Proposed Parking Area	Proposed Landscaping
Proposed Building	Proposed Parking Area	Proposed Landscaping
Proposed Building	Proposed Parking Area	Proposed Landscaping
Proposed Building	Proposed Parking Area	Proposed Landscaping
Proposed Building	Proposed Parking Area	Proposed Landscaping

**GENERAL NOTES:**

1. All dimensions are in feet and inches.
2. All dimensions are to the centerline of the road.
3. All dimensions are to the centerline of the road.
4. All dimensions are to the centerline of the road.
5. All dimensions are to the centerline of the road.
6. All dimensions are to the centerline of the road.
7. All dimensions are to the centerline of the road.
8. All dimensions are to the centerline of the road.
9. All dimensions are to the centerline of the road.
10. All dimensions are to the centerline of the road.

**DEVELOPMENT DATA:**

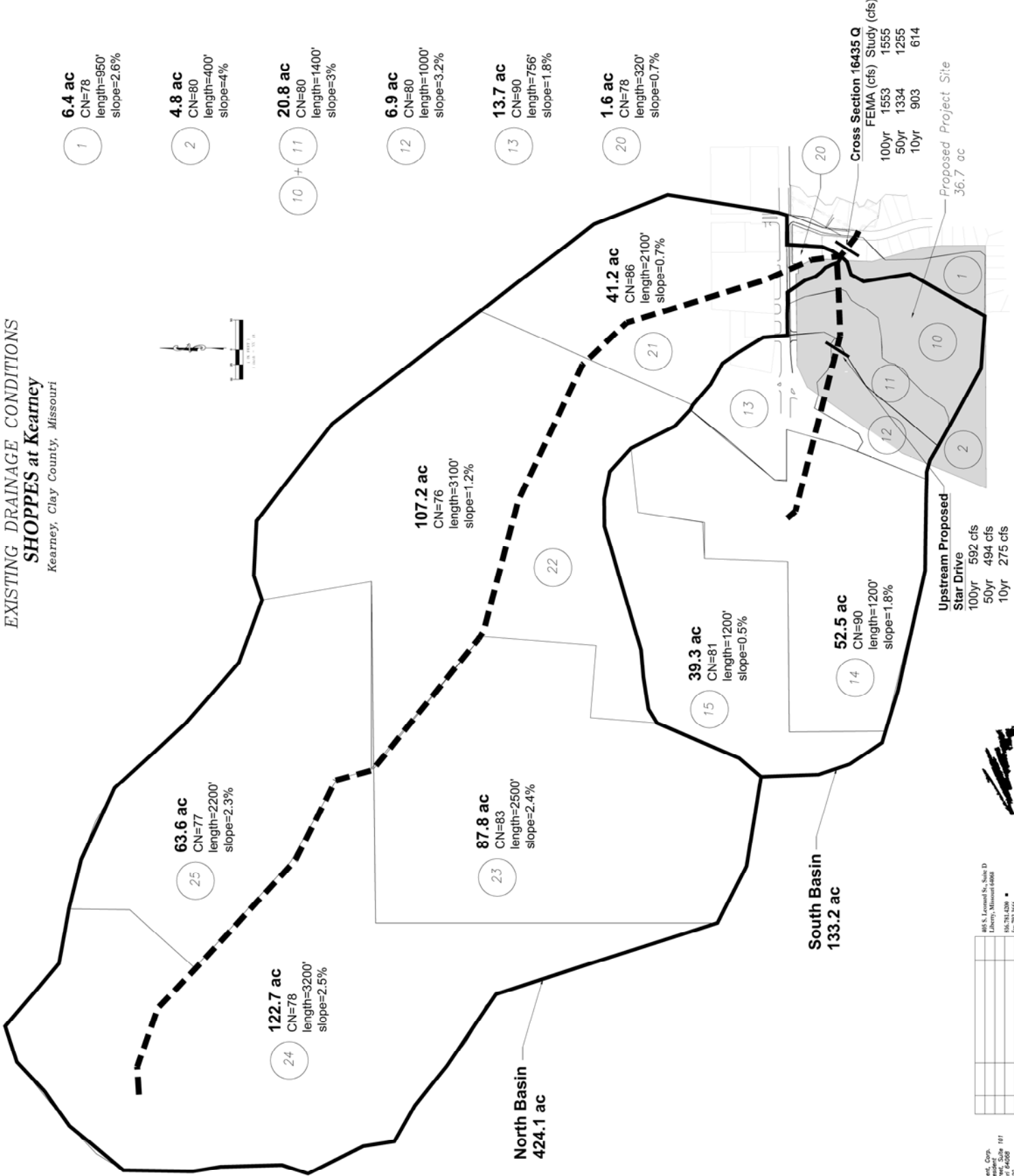
ITEM	AMOUNT	UNIT	REMARKS
1. TOTAL AREA	10.00	ACRES	
2. TOTAL AREA	10.00	ACRES	
3. TOTAL AREA	10.00	ACRES	
4. TOTAL AREA	10.00	ACRES	
5. TOTAL AREA	10.00	ACRES	
6. TOTAL AREA	10.00	ACRES	
7. TOTAL AREA	10.00	ACRES	
8. TOTAL AREA	10.00	ACRES	
9. TOTAL AREA	10.00	ACRES	
10. TOTAL AREA	10.00	ACRES	

AGC ENGINEERS, INC.  
1000 N. 10th St.  
Kearney, MO 64501  
(417) 221-1111





EXISTING DRAINAGE CONDITIONS  
**SHOPPES at Kearney**  
 Kearney, Clay County, Missouri



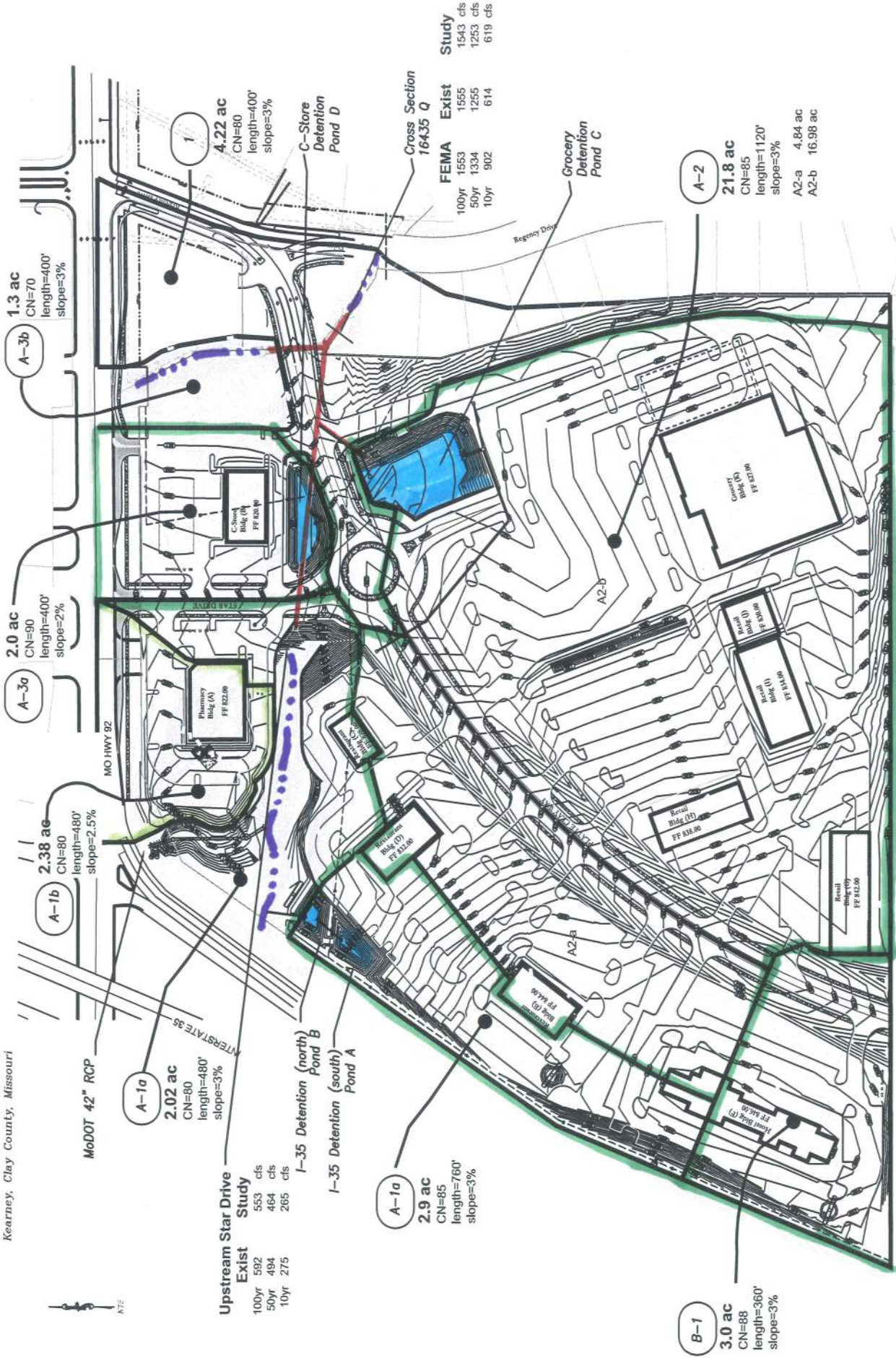
465 S. Leonard St., Suite D  
 Liberty, Missouri 64068  
 816.781.4208  
 Fax 781.3664  
 www.agcengineers.com

NO.	DATE	DESCRIPTION	BY
1	12-10-12	MACRO REPORT	A.A.

Star Development, Corp.  
 Tim Morris, President  
 244 W. Main Street, Suite 111  
 Liberty, Missouri 64068  
 (816) 781-3332  
 (816) 781-5811 FAX

# PROPOSED DRAINAGE CONDITIONS SHOPPES at Kearney

Kearney, Clay County, Missouri



**MICRO Report****Area and CN summary for Shoppes at Kearney****Proposed Site Areas**

	A1	7.28		A2	21.43		A3	3.33		B1	3.00	
										sf	ac	
Total	317238.5	<b>7.28</b>	7.3	933447.9	<b>21.4</b>	21.4	151000	<b>3.5</b>		130467.1	<b>3.0</b>	
Roadway Pavement	6047	0.1		51248	1.2		18822	0.4		6393	0.1	
Parking Pavement	101212	2.3		432153	9.9		38845	0.9		35021	0.8	
Sidewalk	2578	0.1		11726	0.3		4506	0.1		694	0.0	
Buildings	30420	0.7		114800	2.6		9000	0.2		9000	0.2	
<b>Green</b>	176981.5	4.1	<b>55.8</b>	323520.9	7.4	<b>34.7</b>	79827	1.8	<b>55.0</b>	79359.06	1.8	<b>60.8</b>
<b>Impervious</b>		3.2	<b>44.2</b>		14.0	<b>65.3</b>		1.6	<b>47.1</b>		1.2	<b>39.2</b>

**Map Measurement**

	A1			A2			A3			B1		
	<b>ac</b>	<b>cn</b>		<b>ac</b>	<b>cn</b>		<b>ac</b>	<b>cn</b>		<b>ac</b>	<b>cn</b>	
green	4.1	61	247.839	7.4	61	451.4	1.8	61	109.8	1.8	61	109.8
paved	3.2	98	313.6	14	98	1372	1.65	98	161.7	1.2	98	117.6
	7.26	<b>77.3</b>	561.439	21.4	<b>85.2</b>	1823.4	3.45	<b>78.7</b>	271.5	3	<b>75.8</b>	227.4

**Used in MICRO Model**

	A1			A2			A3			B1		
	<b>ac</b>	<b>cn</b>		<b>ac</b>	<b>cn</b>		<b>ac</b>	<b>cn</b>		<b>ac</b>	<b>cn</b>	
green	3.6	61	219.6	8	61	488	1.65	61	100.65	0.61	61	37.21
paved	4.2	98	411.6	15.5	98	1519	1.65	98	161.7	1.54	98	150.92
	7.8	<b>80.9</b>	631.2	23.5	<b>85.4</b>	2007	3.3	<b>79.5</b>	262.35	2.15	<b>87.5</b>	188.13

**Existing Areas CN**

	ac	CN
<b>N1</b>	115	81
<b>N2</b>	63	75
<b>N3</b>	88	90
<b>N4</b>	107	81
<b>N5</b>	45	90
<b>S1</b>	39	81
<b>S2</b>	59	92
<b>S3</b>	40	81
<b>B1</b>	4.8	81

Row Crops (34.7 + 5.1)  
Row Crops

**Proposed Sub Areas**

	SF	AC
A1-a	125689.5	2.89
A1-b	103775	2.38
A1-c	87774	2.02
	317238.5	<b>7.28</b>
A2-a	193664.3	4.45
A2-b	739783.5	16.98
	933447.9	<b>21.43</b>
A3-a	88319.87	2.03
A3-b	56800	1.30
	145119.9	<b>3.33</b>
A4	204968.4	<b>4.71</b>
B1	130467.1	<b>3.00</b>

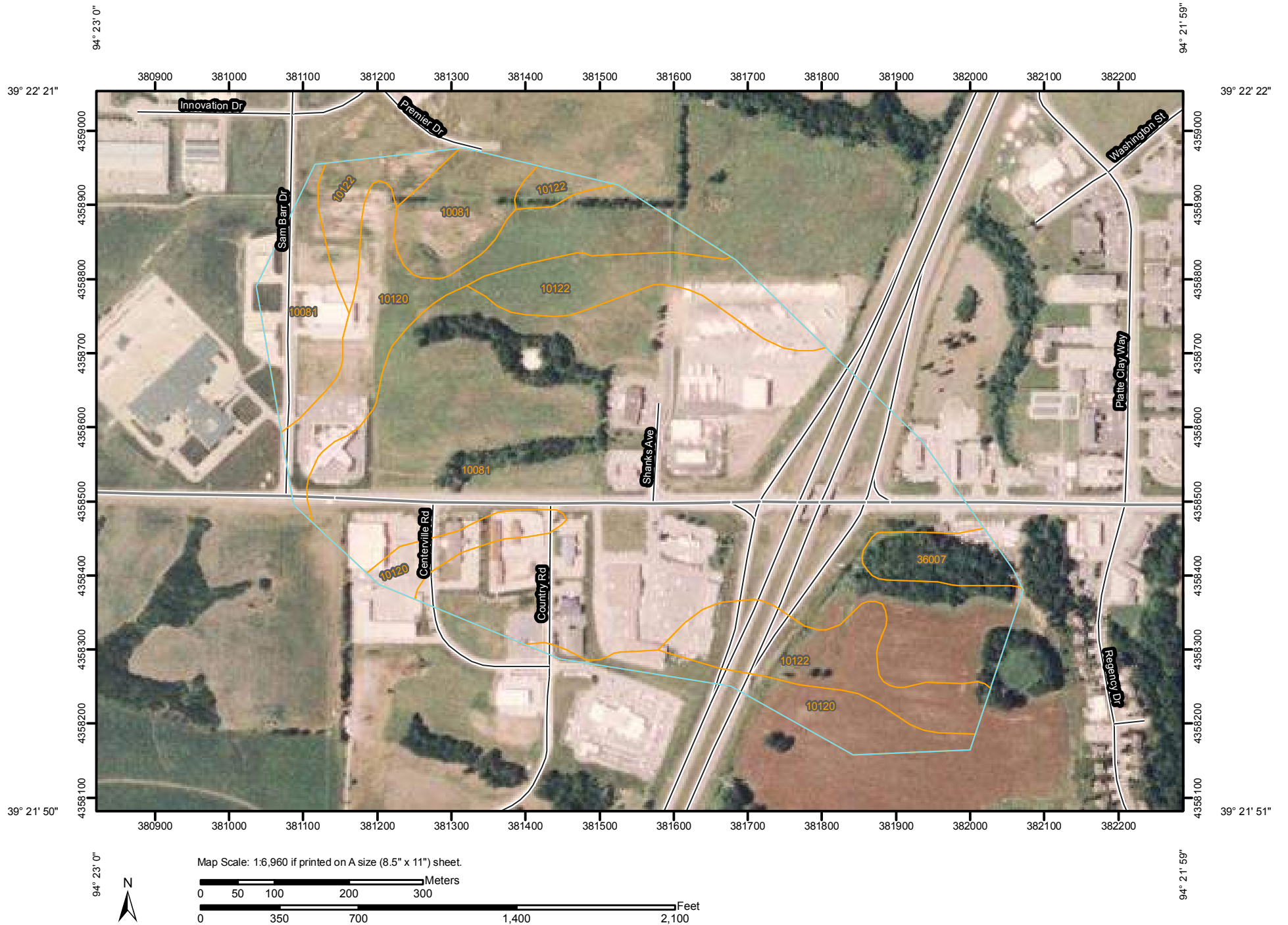


## Soils Survey





# Soil Map—Clay County, Missouri



## MAP LEGEND

### Area of Interest (AOI)

 Area of Interest (AOI)

### Soils

 Soil Map Units

### Special Point Features

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



Very Stony Spot



Wet Spot



Other

### Special Line Features



Gully



Short Steep Slope



Other

### Political Features



Cities

### Water Features



Streams and Canals

### Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

## MAP INFORMATION

Map Scale: 1:6,960 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

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 accurate map measurements.

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>

Coordinate System: UTM Zone 15N NAD83

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

Soil Survey Area: Clay County, Missouri

Survey Area Data: Version 9, Dec 23, 2011

Date(s) aerial images were photographed: 7/6/2007

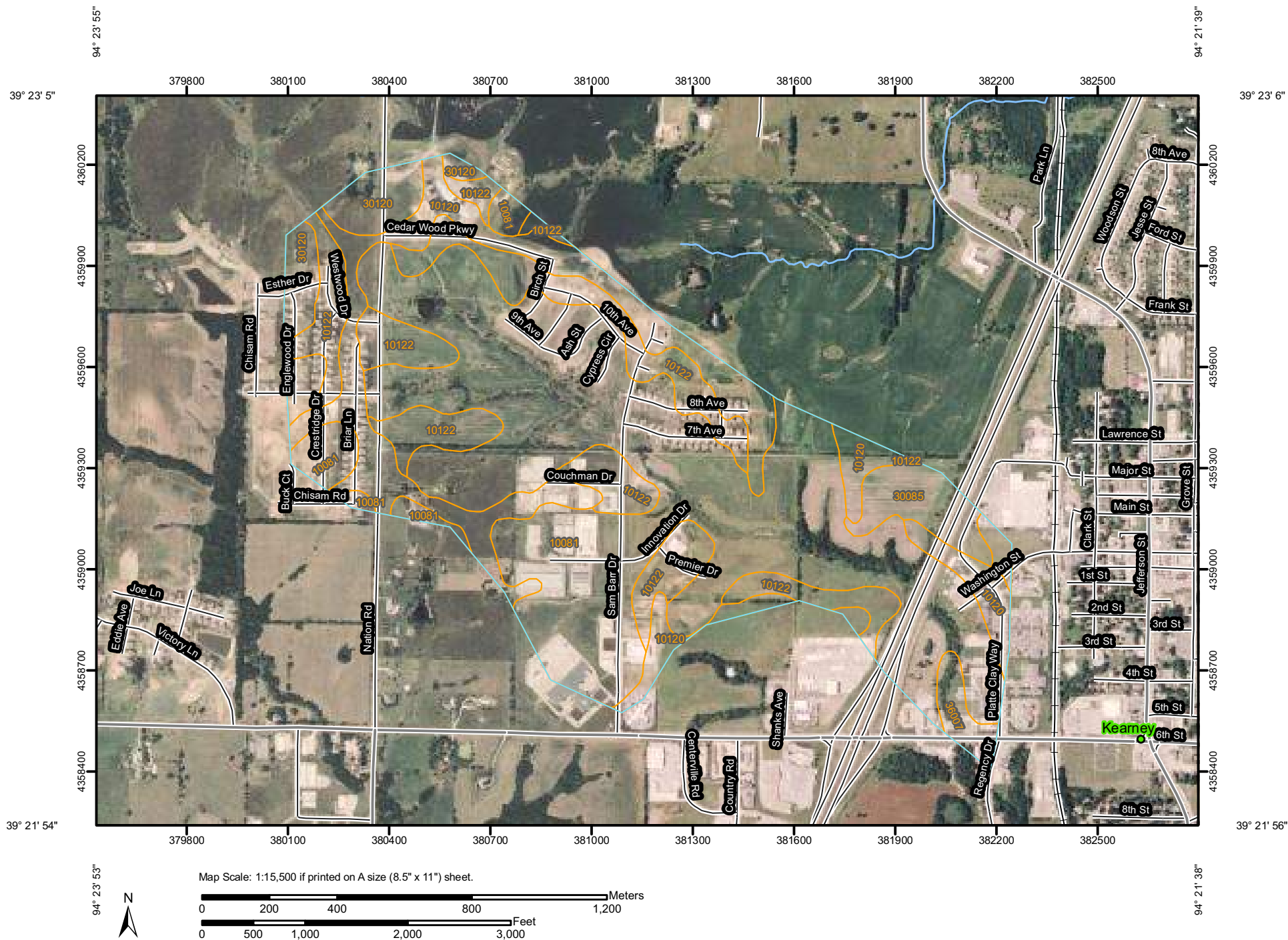
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.



## Map Unit Legend


Clay County, Missouri (MO047)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10081	Macksburg silt loam, 5 to 9 percent slopes	90.1	67.9%
10120	Sharpsburg silt loam, 2 to 5 percent slopes	20.1	15.2%
10122	Sharpsburg silt loam, 5 to 9 percent slopes, eroded	19.4	14.6%
36007	Bremer silt loam, 0 to 2 percent slopes, occasionally flooded	3.2	2.4%
<b>Totals for Area of Interest</b>		<b>132.8</b>	<b>100.0%</b>

# Soil Map—Clay County, Missouri



## MAP LEGEND






















### Area of Interest (AOI)




 Area of Interest (AOI)

### Soils




 Soil Map Units

### Special Point Features

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

-  Very Stony Spot
-  Wet Spot
-  Other

### Special Line Features

-  Gully
-  Short Steep Slope
-  Other






### Political Features

-  Cities

### Water Features

-  Streams and Canals

### Transportation

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

## MAP INFORMATION

Map Scale: 1:15,500 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

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

Source of Map: Natural Resources Conservation Service  
Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>  
Coordinate System: UTM Zone 15N NAD83

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

Soil Survey Area: Clay County, Missouri  
Survey Area Data: Version 9, Dec 23, 2011

Date(s) aerial images were photographed: 7/6/2007

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.



**FEMA**



## Map Unit Legend

Clay County, Missouri (MO047)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10081	Macksburg silt loam, 5 to 9 percent slopes	264.0	54.5%
10120	Sharpsburg silt loam, 2 to 5 percent slopes	85.6	17.7%
10122	Sharpsburg silt loam, 5 to 9 percent slopes, eroded	86.8	17.9%
30085	Grundy silt loam, 2 to 5 percent slopes	16.1	3.3%
30120	Lagonda silty clay loam, 5 to 9 percent slopes, eroded	24.4	5.0%
36007	Bremer silt loam, 0 to 2 percent slopes, occasionally flooded	7.2	1.5%
<b>Totals for Area of Interest</b>		<b>484.1</b>	<b>100.0%</b>

# Steady Flow Data - Rainfall-Runoff

File Options Help

Enter/Edit Number of Profiles (25000 max):  Reach Boundary Conditions ...

## Locations of Flow Data Changes

River:

Reach:

River Sta.:

Flow Change Location				Profile Names and Flow Rates				
	River	Reach	RS	P100yr	Floodway	P10yr	P50yr	P500yr
1	FishingTrib16	Main	17242.3	1268	1268	731	1095	1697
2	FishingTrib16	Main	16435.1	1553	1553	902	1334	2068
3	FishingTrib16	Main	15783.4	1880	1880	1100	1630	2480
4	FishingTrib16	Main	8672	3050	3050	1750	2630	4070
5	FishingTrib16	Main	5405	3620	3620	2060	3120	4860
6	FishingTrib16	Main	2357.9	4130	4130	2340	3560	5560

Edit Steady flow data for the profiles (cfs)

☒ Set boundary for all profiles

☐ Set boundary for one profile at a time

## Available External Boundary Condition Types

## Selected Boundary Condition Locations and Types

River	Reach	Profile	Upstream	Downstream
FishingTrib16	Main	all		Normal Depth $S = 0.00104$

Search Flow ...



Table 2. Summary of Discharges (Continued)

<u>FLOODING SOURCE AND LOCATION</u>	<u>DRAINAGE AREA (sq. miles)</u>	<u>PEAK DISCHARGES (CFS)</u>			
		<u>10- Percent Annual Chance</u>	<u>2- Percent- Annual- Chance</u>	<u>1- Percent- Annual- Chance</u>	<u>0.2- Percent Annual Chance</u>
<b>FISHING RIVER TRIBUTARY 1.1</b>					
Just upstream of 112th Street	1.0	990	1,530	1,780	2,410
<b>FISHING RIVER TRIBUTARY 1.2</b>					
At approximately 840 feet upstream of NE 104th Street	0.4	360	560	660	890
<b>FISHING RIVER TRIBUTARY 16</b>					
Confluence with Fishing River	3.0	2,340	3,560	5,560	5,560
Just upstream of Meadowbrook Drive	2.5	2,060	3,120	3,320	4,860
Just upstream of East 19 <sup>th</sup> Street	2.0	1,750	2,630	3,050	4,070
Approximately 400 feet downstream of Regency Drive	1.2	1,100	1,630	1,880	2,480
Just downstream of 6 <sup>th</sup> Street	0.6	731	1,095	1,268	1,697
<b>HOLMES CREEK</b>					
At 0.8 miles upstream of confluence with Fishing River	17.0	6,520	10,780	12,940	18,350
At approximately 340 feet downstream of 122nd Avenue	14.5	5,670	9,440	1,430	16,320
At approximately 1 mile upstream of Summersette Road	7.4	2,880	4,840	5,820	8,260
At approximately 2050 feet upstream of Moffitt Road	5.0	2,270	3,900	4,710	6,720
At approximately 0.44 miles downstream of State Highway 33	4.4	2,070	3,410	4,100	5,840
At approximately 1270 feet upstream of State Highway 33	4.1	1,950	3,130	3,720	5,230
At approximately 0.45 miles upstream of NE 121st Street Terrace	2.8	1,590	2,490	2,920	3,990

FLOODING SOURCE		FLOODWAY				1-PERCENT ANNUAL CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)		
CROSS SECTION	DISTANCE <sup>1</sup>	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Fishing River Tributary 16								
A	516	74	965	7.2	771.4	771.4	772.3	0.9
B	2,165	86	925	7.3	772.9	772.9	773.8	0.9
C	4,336	148	1,300	4.8	775.3	775.3	776.3	1.0
D	6,163	100	993	5.2	782.9	782.9	783.9	1.0
E	7,422	60	696	6.5	784.3	784.3	785.1	0.8
F	8,214	71	696	6.3	785.2	785.2	786.2	1.0
G	8,672	95	986	4.9	787.0	787.0	788.0	1.0
H	9,666	101	977	3.2	787.7	787.7	788.6	0.9
I	10,872	86	639	4.7	788.5	788.5	789.4	0.9
J	11,704	57	715	3.0	791.5	791.5	792.3	0.8
K	12,387	45	372	5.8	791.8	791.8	792.5	0.7
L	13,029	60	722	3.2	798.3	798.3	798.9	0.6
M	13,797	87	826	3.2	798.6	798.6	799.2	0.6
N	14,168	55	1,042	2.8	805.3	805.3	805.8	0.5
O	15,527	60	726	4.2	805.3	805.3	806.1	0.8
P	16,068	45	546	3.3	805.8	805.8	806.4	0.6
Q	16,435	69	661	2.7	810.1	810.1	810.7	0.6
R	16,771	41	432	3.2	810.3	810.3	810.9	0.6

<sup>1</sup>Feet above confluence with Fishing River

<sup>2</sup>Elevations computed without consideration of backwater effects from Fishing River

FEDERAL EMERGENCY MANAGEMENT AGENCY

TABLE 3

CLAY COUNTY, MO  
AND INCORPORATED AREAS

FLOODWAY DATA

FISHING RIVER TRIBUTARY 16

## SCS Curve Numbers (CN)

Land Use Description	Hydrologic Soil Group			
	A	B	C	D
<b>Residential</b>				
<b>Average lot size:</b>				
1/8 acre or smaller	77	85	90	92
1/4 acre	61	75	83	87
1/3 acre	57	72	81	86
1/2 acre	54	70	80	85
1 acre	51	68	79	84
2 acre	46	65	77	82
1/8 acre or smaller	77	85	90	92
<b>Paved parking lots and roofs</b>	98	98	98	98
<b>Streets and roads:</b>				
Paved with curbs	98	98	98	98
Gravel	76	85	89	91
Dirt	72	82	87	89
<b>Commercial and business areas</b>	89	92	94	95
<b>Industrial districts</b>	81	88	91	93
<b>Open spaces, lawns, and parks:</b>				
Good condition	39	61	74	80
Fair condition	49	69	79	84
<b>Fallow</b>	77	86	91	94
<b>Row crops</b>	72	81	88	91

\*Average Runoff Condition. Ia = 0.2S

Source: Soil Conservation Service TR-55



**HEC RAS**





HEC-RAS Plan: MultiProfile

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	17242.3 R	P100yr	1268.00	804.34	817.93		818.21	0.001865	5.44	471.49	74.29	0.27
Main	17242.3 R	P10yr	731.00	804.34	816.92		817.04	0.000866	3.52	402.05	64.20	0.18
Main	17242.3 R	P50yr	1095.00	804.34	817.72		817.94	0.001486	4.81	456.47	71.96	0.24
Main	17111.4	P100yr	1268.00	802.18	817.85	809.89	817.99	0.000750	3.55	636.77	350.56	0.17
Main	17111.4	P10yr	731.00	802.18	816.88	808.18	816.94	0.000342	2.28	496.24	157.80	0.11
Main	17111.4	P50yr	1095.00	802.18	817.66	809.39	817.77	0.000607	3.16	603.95	342.05	0.15
Main	16882.41		Culvert									
Main	16770.9	P100yr	1268.00	796.58	812.65	802.89	812.73	0.000318	2.48	757.15	261.57	0.12
Main	16770.9	P10yr	731.00	796.58	808.77	801.45	808.84	0.000393	2.18	394.22	106.35	0.13
Main	16770.9	P50yr	1095.00	796.58	812.52	802.47	812.59	0.000247	2.17	738.76	254.63	0.11
Main	16655.6	P100yr	1268.00	794.68	812.54	801.24	812.68	0.000405	3.06	559.21	392.42	0.14
Main	16655.6	P10yr	731.00	794.68	808.71	799.67	808.79	0.000356	2.37	358.61	140.10	0.12
Main	16655.6	P50yr	1095.00	794.68	812.45	800.79	812.55	0.000304	2.64	549.77	373.30	0.12
Main	16555	P100yr	1268.00	794.38	812.54	800.94	812.59	0.000191	2.13	1515.95	450.33	0.09
Main	16555	P10yr	731.00	794.38	808.64	799.37	808.72	0.000333	2.33	367.86	145.05	0.12
Main	16555	P50yr	1095.00	794.38	812.38	800.49	812.48	0.000293	2.62	576.94	431.43	0.12
Main	16554		Culvert									
Main	16455	P100yr	1268.00	794.08	812.03	800.64	812.16	0.000399	3.05	569.51	418.05	0.14
Main	16455	P10yr	731.00	794.08	805.60	799.08	805.74	0.000821	3.07	263.65	76.88	0.18
Main	16455	P50yr	1095.00	794.08	811.60	800.19	811.71	0.000320	2.68	530.47	311.34	0.12
Main South	16435.1 Q	P100yr	1553.00	794.05	812.02	800.93	812.07	0.000221	2.08	1064.22	274.96	0.10
Main South	16435.1 Q	P10yr	902.00	794.05	805.39	799.31	805.53	0.001080	2.97	307.93	52.48	0.20
Main South	16435.1 Q	P50yr	1334.00	794.05	811.59	800.44	811.63	0.000193	1.90	975.41	249.36	0.09
Main South	16430	P100yr	1553.00	793.90	811.85	800.55	812.01	0.000513	3.45	875.52	246.89	0.15
Main South	16430	P10yr	902.00	793.90	805.14	798.84	805.37	0.001294	3.88	253.01	41.98	0.22
Main South	16430	P50yr	1334.00	793.90	811.45	800.00	811.58	0.000423	3.09	780.33	214.71	0.14
Main South	16428		Culvert									
Main South	16321.8	P100yr	1553.00	793.10	809.90	799.75	810.11	0.000721	3.90	645.16	151.36	0.18
Main South	16321.8	P10yr	902.00	793.10	803.68	798.04	803.95	0.001644	4.18	232.57	39.99	0.24
Main South	16321.8	P50yr	1334.00	793.10	809.03	799.18	809.21	0.000661	3.59	536.51	97.44	0.17
Main South	16257.05		Culvert									
Main South	16194.7	P100yr	1553.00	792.02	805.81	798.14	805.99	0.000684	3.72	678.39	91.08	0.18
Main South	16194.7	P10yr	902.00	792.02	800.21	796.62	800.50	0.002229	4.54	240.36	57.31	0.30
Main South	16194.7	P50yr	1334.00	792.02	802.83	797.66	803.11	0.001459	4.54	431.23	73.74	0.26
Main South	16068.3 P	P100yr	1553.00	790.96	805.75	797.19	805.90	0.000527	3.21	673.40	102.81	0.16
Main South	16068.3 P	P10yr	902.00	790.96	800.01	795.81	800.23	0.001608	3.73	266.46	51.82	0.25
Main South	16068.3 P	P50yr	1334.00	790.96	802.71	796.76	802.92	0.001078	3.82	423.08	64.33	0.22
Main South	15783.4	P100yr	1880.00	788.96	805.54		805.72	0.000666	3.98	865.99	118.54	0.18
Main South	15783.4	P10yr	1100.00	788.96	799.28		799.66	0.002250	5.11	281.75	62.06	0.30
Main South	15783.4	P50yr	1630.00	788.96	802.21		802.54	0.001496	5.05	518.60	92.53	0.26
Main South	15527.3 O	P100yr	1880.00	787.96	805.34	795.83	805.55	0.000734	4.22	785.40	93.67	0.19
Main South	15527.3 O	P10yr	1100.00	787.96	798.68	793.86	799.08	0.002343	5.26	282.35	60.10	0.30
Main South	15527.3 O	P50yr	1630.00	787.96	801.81	795.24	802.16	0.001554	5.20	494.86	74.38	0.26
Main South	14966.8	P100yr	1880.00	786.22	805.38		805.40	0.000087	1.62	2606.33	269.80	0.07
Main South	14966.8	P10yr	1100.00	786.22	798.56		798.61	0.000325	2.27	1058.58	207.33	0.12
Main South	14966.8	P50yr	1630.00	786.22	801.82		801.86	0.000188	2.05	1752.24	217.89	0.10
Main South	14389.8	P100yr	1880.00	786.71	805.23	794.55	805.32	0.000349	3.17	1480.08	204.46	0.13
Main South	14389.8	P10yr	1100.00	786.71	797.97	792.39	798.27	0.001623	4.83	379.55	78.69	0.26
Main South	14389.8	P50yr	1630.00	786.71	801.45	793.87	801.66	0.000952	4.47	808.00	155.13	0.21
Main South	14167.9 N	P100yr	1880.00	784.22	805.25	790.28	805.27	0.000065	1.56	2867.70	263.78	0.06
Main South	14167.9 N	P10yr	1100.00	784.22	798.08	789.05	798.11	0.000153	1.78	1290.29	176.34	0.09
Main South	14167.9 N	P50yr	1630.00	784.22	801.52	789.94	801.55	0.000127	1.89	1951.20	223.21	0.08
Main South	14040.5	P100yr	1880.00	784.72	804.96	791.81	805.19	0.000415	4.16	589.47	457.92	0.17
Main South	14040.5	P10yr	1100.00	784.72	797.81	789.96	798.02	0.000681	3.95	360.62	214.02	0.20
Main South	14040.5	P50yr	1630.00	784.72	801.18	791.29	801.45	0.000653	4.53	468.27	277.87	0.20
Main South	13980.21		Culvert									
Main South	13931.4	P100yr	1880.00	785.10	798.41	792.54	799.07	0.002086	6.73	333.35	395.76	0.34
Main South	13931.4	P10yr	1100.00	785.10	793.88	790.70	794.37	0.004103	6.77	182.08	185.79	0.44
Main South	13931.4	P50yr	1630.00	785.10	796.35	791.99	797.10	0.003022	7.15	267.48	312.93	0.40



HEC-RAS Plan: MultiProfile River: FishingTrib16 Reach: Main

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	17242.3 R	P100yr	1268.00	804.34	817.87		818.16	0.001900	5.48	467.18	73.63	0.27
Main	17242.3 R	P10yr	731.00	804.34	816.61		816.75	0.000967	3.65	382.73	61.98	0.19
Main	17242.3 R	P50yr	1095.00	804.34	817.61		817.84	0.001537	4.86	448.85	70.74	0.24
Main	17111.4	P100yr	1268.00	802.18	817.79	809.89	817.94	0.000771	3.58	626.13	348.30	0.17
Main	17111.4	P10yr	731.00	802.18	816.57	808.18	816.64	0.000383	2.37	468.72	90.19	0.12
Main	17111.4	P50yr	1095.00	802.18	817.54	809.39	817.67	0.000638	3.22	585.42	338.97	0.16
Main	16882.41	Culvert										
Main	16770.9	P100yr	1268.00	796.58	810.31	802.89	810.46	0.000662	3.14	510.80	143.29	0.17
Main	16770.9	P10yr	731.00	796.58	804.64	801.45	804.90	0.003168	4.14	178.06	38.28	0.33
Main	16770.9	P50yr	1095.00	796.58	809.39	802.47	809.53	0.000692	3.02	439.23	131.27	0.17
Main	16655.6	P100yr	1268.00	794.68	810.17	801.24	810.36	0.000710	3.63	420.89	184.39	0.18
Main	16655.6	P10yr	731.00	794.68	804.39	799.67	804.62	0.001747	3.87	200.90	45.84	0.25
Main	16655.6	P50yr	1095.00	794.68	809.27	800.79	809.44	0.000679	3.38	381.74	153.45	0.17
Main	16435.1 Q	P100yr	1553.00	794.05	810.10	800.93	810.21	0.000480	2.77	721.64	170.37	0.14
Main	16435.1 Q	P10yr	902.00	794.05	803.96	799.31	804.18	0.002201	3.71	243.26	41.67	0.27
Main	16435.1 Q	P50yr	1334.00	794.05	809.19	800.44	809.29	0.000508	2.70	581.77	136.34	0.14
Main	16321.8	P100yr	1553.00	793.10	809.90	799.75	810.11	0.000721	3.90	645.16	151.36	0.18
Main	16321.8	P10yr	902.00	793.10	803.68	798.04	803.95	0.001644	4.18	232.57	39.99	0.24
Main	16321.8	P50yr	1334.00	793.10	809.03	799.18	809.21	0.000661	3.59	536.51	97.44	0.17
Main	16257.05	Culvert										
Main	16194.7	P100yr	1553.00	792.02	805.81	798.14	805.99	0.000684	3.72	678.39	91.08	0.18
Main	16194.7	P10yr	902.00	792.02	800.21	796.62	800.50	0.002229	4.54	240.36	57.31	0.30
Main	16194.7	P50yr	1334.00	792.02	802.83	797.66	803.11	0.001459	4.54	431.23	73.74	0.26
Main	16068.3 P	P100yr	1553.00	790.96	805.75	797.19	805.90	0.000527	3.21	673.40	102.81	0.16
Main	16068.3 P	P10yr	902.00	790.96	800.01	795.81	800.23	0.001608	3.73	266.46	51.82	0.25
Main	16068.3 P	P50yr	1334.00	790.96	802.71	796.76	802.92	0.001078	3.82	423.08	64.33	0.22
Main	15783.4	P100yr	1880.00	788.96	805.54		805.72	0.000666	3.98	865.99	118.54	0.18
Main	15783.4	P10yr	1100.00	788.96	799.28		799.66	0.002250	5.11	281.75	62.06	0.30
Main	15783.4	P50yr	1630.00	788.96	802.21		802.54	0.001496	5.05	518.60	92.53	0.26
Main	15527.3 O	P100yr	1880.00	787.96	805.34	795.83	805.55	0.000734	4.22	785.40	93.67	0.19
Main	15527.3 O	P10yr	1100.00	787.96	798.68	793.86	799.08	0.002343	5.26	282.35	60.10	0.30
Main	15527.3 O	P50yr	1630.00	787.96	801.81	795.24	802.16	0.001554	5.20	494.86	74.38	0.26
Main	14966.8	P100yr	1880.00	786.22	805.38		805.40	0.000087	1.62	2606.33	269.80	0.07
Main	14966.8	P10yr	1100.00	786.22	798.56		798.61	0.000325	2.27	1058.58	207.33	0.12
Main	14966.8	P50yr	1630.00	786.22	801.82		801.86	0.000188	2.05	1752.24	217.89	0.10
Main	14389.8	P100yr	1880.00	786.71	805.23	794.55	805.32	0.000349	3.17	1480.08	204.46	0.13
Main	14389.8	P10yr	1100.00	786.71	797.97	792.39	798.27	0.001623	4.83	379.55	78.69	0.26
Main	14389.8	P50yr	1630.00	786.71	801.45	793.87	801.66	0.000952	4.47	808.00	155.13	0.21
Main	14167.9 N	P100yr	1880.00	784.22	805.25	790.28	805.27	0.000065	1.56	2867.70	263.78	0.06
Main	14167.9 N	P10yr	1100.00	784.22	798.08	789.05	798.11	0.000153	1.78	1290.29	176.34	0.09
Main	14167.9 N	P50yr	1630.00	784.22	801.52	789.94	801.55	0.000127	1.89	1951.20	223.21	0.08
Main	14040.5	P100yr	1880.00	784.72	804.96	791.81	805.19	0.000415	4.16	589.47	457.92	0.17
Main	14040.5	P10yr	1100.00	784.72	797.81	789.96	798.02	0.000681	3.95	360.62	214.02	0.20
Main	14040.5	P50yr	1630.00	784.72	801.18	791.29	801.45	0.000653	4.53	468.27	277.87	0.20
Main	13980.21	Culvert										
Main	13931.4	P100yr	1880.00	785.10	798.41	792.54	799.07	0.002086	6.73	333.35	395.76	0.34
Main	13931.4	P10yr	1100.00	785.10	793.68	790.70	794.37	0.004103	6.77	182.08	185.79	0.44
Main	13931.4	P50yr	1630.00	785.10	796.35	791.99	797.10	0.003022	7.15	267.48	312.93	0.40
Main	13797.2 M	P100yr	1880.00	784.47	798.59	791.94	798.68	0.000405	2.75	1190.43	244.87	0.15
Main	13797.2 M	P10yr	1100.00	784.47	793.61	790.08	793.79	0.001661	3.72	450.39	167.19	0.27
Main	13797.2 M	P50yr	1630.00	784.47	796.50	791.45	796.61	0.000714	3.17	867.22	204.36	0.19
Main	13532.1	P100yr	1880.00	784.22	798.44	791.62	798.56	0.000520	3.14	951.64	189.50	0.17
Main	13532.1	P10yr	1100.00	784.22	792.99	789.83	793.26	0.002473	4.35	329.97	98.09	0.32
Main	13532.1	P50yr	1630.00	784.22	796.23	791.02	796.40	0.000928	3.61	678.01	147.60	0.21
Main	13028.9 L	P100yr	1880.00	783.75	798.31	789.68	798.39	0.000231	2.65	1229.43	253.19	0.13
Main	13028.9 L	P10yr	1100.00	783.75	792.24	788.24	792.45	0.001130	3.79	360.07	96.96	0.26
Main	13028.9 L	P50yr	1630.00	783.75	795.99	789.25	796.11	0.000411	3.08	830.06	153.90	0.17
Main	12929.7	P100yr	1880.00	783.05	798.17	788.94	798.34	0.000364	3.33	596.39	101.30	0.16



## Existing Conditions Hydrograph Summary Tables



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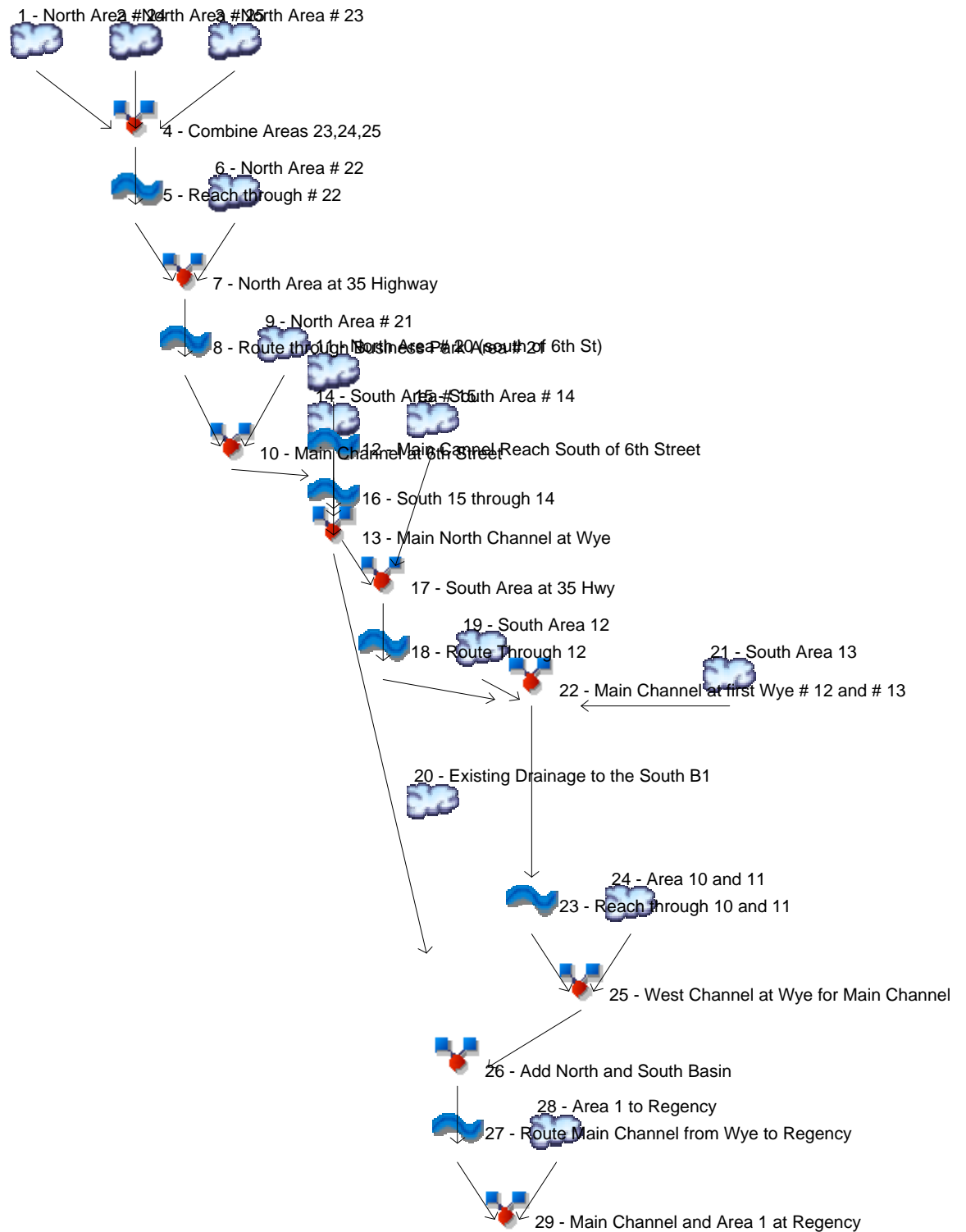
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# Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8



# Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	37.59	-----	-----	148.44	242.53	308.45	383.40	North Area # 24
2	SCS Runoff	-----	-----	21.64	-----	-----	89.70	148.04	189.20	236.02	North Area # 25
3	SCS Runoff	-----	-----	52.71	-----	-----	164.68	254.44	316.00	384.87	North Area # 23
4	Combine	1, 2, 3	-----	106.31	-----	-----	386.11	619.86	782.73	966.47	Combine Areas 23,24,25
5	Reach	4	-----	99.22	-----	-----	370.50	598.82	759.07	939.89	Reach through # 22
6	SCS Runoff	-----	-----	20.78	-----	-----	92.21	155.01	199.51	250.17	North Area # 22
7	Combine	5, 6	-----	116.92	-----	-----	448.36	729.11	926.69	1149.99	North Area at 35 Highway
8	Reach	7	-----	113.42	-----	-----	441.49	721.23	916.80	1139.74	Route through Business Park Area #
9	SCS Runoff	-----	-----	23.75	-----	-----	66.88	100.37	123.14	148.51	North Area # 21
10	Combine	8, 9	-----	134.11	-----	-----	503.65	815.74	1034.88	1282.04	Main Channel at 6th Street
11	SCS Runoff	-----	-----	1.127	-----	-----	4.211	6.812	8.624	10.67	North Area # 20 (south of 6th St)
12	Reach	10	-----	134.15	-----	-----	503.99	816.67	1035.37	1282.49	Main Cannel Reach South of 6th Stre
13	Combine	11, 12	-----	134.29	-----	-----	504.51	817.50	1036.40	1283.81	Main North Channel at Wye
14	SCS Runoff	-----	-----	17.21	-----	-----	58.67	92.58	116.13	142.58	South Area # 15
15	SCS Runoff	-----	-----	77.19	-----	-----	188.07	270.37	325.74	387.20	South Area # 14
16	Reach	14	-----	16.48	-----	-----	57.47	91.09	114.52	140.88	South 15 through 14
17	Combine	15, 16	-----	82.36	-----	-----	213.01	312.99	380.99	456.89	South Area at 35 Hwy
18	Reach	17	-----	81.82	-----	-----	212.06	311.98	380.29	456.56	Route Through 12
19	SCS Runoff	-----	-----	5.203	-----	-----	18.01	28.57	35.88	44.09	South Area 12
20	SCS Runoff	-----	-----	5.163	-----	-----	17.13	26.98	33.77	41.39	Existing Drainage to the South B1
21	SCS Runoff	-----	-----	25.39	-----	-----	61.44	88.15	106.11	126.04	South Area 13
22	Combine	18, 19, 21	-----	104.98	-----	-----	274.37	404.61	493.56	592.88	Main Channel at first Wye # 12 and #
23	Reach	22	-----	103.94	-----	-----	274.08	404.01	492.82	592.66	Reach through 10 and 11
24	SCS Runoff	-----	-----	13.01	-----	-----	45.48	72.35	90.97	111.90	Area 10 and 11
25	Combine	23, 24	-----	116.79	-----	-----	319.55	476.36	583.22	702.56	West Channel at Wye for Main Chann
26	Combine	13, 25	-----	167.83	-----	-----	610.84	985.03	1246.98	1544.57	Add North and South Basin
27	Reach	26	-----	168.06	-----	-----	611.40	985.68	1248.54	1545.71	Route Main Channel from Wye to Re
28	SCS Runoff	-----	-----	3.725	-----	-----	14.21	23.13	29.36	36.39	Area 1 to Regency
29	Combine	27, 28	-----	168.82	-----	-----	614.11	990.83	1255.21	1554.79	Main Channel and Area 1 at Regency
Proj. file: Shoppes Existing Conditions MACRO 10-14-12.gpw										Sunday, Dec 9, 2012	

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	37.59	2	750	265,504	-----	-----	-----	North Area # 24
2	SCS Runoff	21.64	2	742	130,435	-----	-----	-----	North Area # 25
3	SCS Runoff	52.71	2	738	266,143	-----	-----	-----	North Area # 23
4	Combine	106.31	2	742	662,081	1, 2, 3	-----	-----	Combine Areas 23,24,25
5	Reach	99.22	2	752	662,077	4	-----	-----	Reach through # 22
6	SCS Runoff	20.78	2	764	202,536	-----	-----	-----	North Area # 22
7	Combine	116.92	2	754	864,613	5, 6	-----	-----	North Area at 35 Highway
8	Reach	113.42	2	762	864,609	7	-----	-----	Route through Business Park Area #
9	SCS Runoff	23.75	2	748	148,928	-----	-----	-----	North Area # 21
10	Combine	134.11	2	760	1,013,537	8, 9	-----	-----	Main Channel at 6th Street
11	SCS Runoff	1.127	2	724	3,401	-----	-----	-----	North Area # 20 (south of 6th St)
12	Reach	134.15	2	762	1,013,537	10	-----	-----	Main Cannel Reach South of 6th Stre
13	Combine	134.29	2	762	1,016,938	11, 12	-----	-----	Main North Channel at Wye
14	SCS Runoff	17.21	2	744	104,842	-----	-----	-----	South Area # 15
15	SCS Runoff	77.19	2	724	241,334	-----	-----	-----	South Area # 14
16	Reach	16.48	2	752	104,838	14	-----	-----	South 15 through 14
17	Combine	82.36	2	724	346,172	15, 16	-----	-----	South Area at 35 Hwy
18	Reach	81.82	2	728	346,171	17	-----	-----	Route Through 12
19	SCS Runoff	5.203	2	726	17,235	-----	-----	-----	South Area 12
20	SCS Runoff	5.163	2	720	11,989	-----	-----	-----	Existing Drainage to the South B1
21	SCS Runoff	25.39	2	720	65,893	-----	-----	-----	South Area 13
22	Combine	104.98	2	726	429,299	18, 19, 21	-----	-----	Main Channel at first Wye # 12 and #
23	Reach	103.94	2	728	429,298	22	-----	-----	Reach through 10 and 11
24	SCS Runoff	13.01	2	730	51,142	-----	-----	-----	Area 10 and 11
25	Combine	116.79	2	728	480,440	23, 24	-----	-----	West Channel at Wye for Main Chann
26	Combine	167.83	2	758	1,497,378	13, 25	-----	-----	Add North and South Basin
27	Reach	168.06	2	760	1,497,984	26	-----	-----	Route Main Channel from Wye to Re
28	SCS Runoff	3.725	2	728	14,200	-----	-----	-----	Area 1 to Regency
29	Combine	168.82	2	760	1,512,184	27, 28	-----	-----	Main Channel and Area 1 at Regency
Shoppes Existing Conditions MACRO 10-14-11					Report Period: 2 Year			Sunday, Dec 9, 2012	

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	148.44	2	748	923,190	-----	-----	-----	North Area # 24
2	SCS Runoff	89.70	2	740	468,361	-----	-----	-----	North Area # 25
3	SCS Runoff	164.68	2	736	798,246	-----	-----	-----	North Area # 23
4	Combine	386.11	2	740	2,189,797	1, 2, 3	-----	-----	Combine Areas 23,24,25
5	Reach	370.50	2	748	2,189,792	4	-----	-----	Reach through # 22
6	SCS Runoff	92.21	2	762	751,874	-----	-----	-----	North Area # 22
7	Combine	448.36	2	750	2,941,668	5, 6	-----	-----	North Area at 35 Highway
8	Reach	441.49	2	756	2,941,667	7	-----	-----	Route through Business Park Area #
9	SCS Runoff	66.88	2	746	411,789	-----	-----	-----	North Area # 21
10	Combine	503.65	2	754	3,353,457	8, 9	-----	-----	Main Channel at 6th Street
11	SCS Runoff	4.211	2	722	11,824	-----	-----	-----	North Area # 20 (south of 6th St)
12	Reach	503.99	2	756	3,353,453	10	-----	-----	Main Cannel Reach South of 6th Stre
13	Combine	504.51	2	756	3,365,276	11, 12	-----	-----	Main North Channel at Wye
14	SCS Runoff	58.67	2	744	332,863	-----	-----	-----	South Area # 15
15	SCS Runoff	188.07	2	724	601,627	-----	-----	-----	South Area # 14
16	Reach	57.47	2	748	332,861	14	-----	-----	South 15 through 14
17	Combine	213.01	2	724	934,488	15, 16	-----	-----	South Area at 35 Hwy
18	Reach	212.06	2	728	934,489	17	-----	-----	Route Through 12
19	SCS Runoff	18.01	2	724	56,356	-----	-----	-----	South Area 12
20	SCS Runoff	17.13	2	718	39,204	-----	-----	-----	Existing Drainage to the South B1
21	SCS Runoff	61.44	2	720	164,266	-----	-----	-----	South Area 13
22	Combine	274.37	2	726	1,155,110	18, 19, 21	-----	-----	Main Channel at first Wye # 12 and #
23	Reach	274.08	2	728	1,155,111	22	-----	-----	Reach through 10 and 11
24	SCS Runoff	45.48	2	728	167,230	-----	-----	-----	Area 10 and 11
25	Combine	319.55	2	728	1,322,340	23, 24	-----	-----	West Channel at Wye for Main Chann
26	Combine	610.84	2	752	4,687,614	13, 25	-----	-----	Add North and South Basin
27	Reach	611.40	2	754	4,689,435	26	-----	-----	Route Main Channel from Wye to Re
28	SCS Runoff	14.21	2	726	49,376	-----	-----	-----	Area 1 to Regency
29	Combine	614.11	2	754	4,738,812	27, 28	-----	-----	Main Channel and Area 1 at Regency
Shoppes Existing Conditions MACRO 10-14-11					Report Period: 10 Year			Sunday, Dec 9, 2012	

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	242.53	2	748	1,492,850	-----	-----	-----	North Area # 24
2	SCS Runoff	148.04	2	740	764,306	-----	-----	-----	North Area # 25
3	SCS Runoff	254.44	2	736	1,236,106	-----	-----	-----	North Area # 23
4	Combine	619.86	2	740	3,493,261	1, 2, 3	-----	-----	Combine Areas 23,24,25
5	Reach	598.82	2	746	3,493,261	4	-----	-----	Reach through # 22
6	SCS Runoff	155.01	2	762	1,238,441	-----	-----	-----	North Area # 22
7	Combine	729.11	2	748	4,731,704	5, 6	-----	-----	North Area at 35 Highway
8	Reach	721.23	2	754	4,731,703	7	-----	-----	Route through Business Park Area #
9	SCS Runoff	100.37	2	746	622,214	-----	-----	-----	North Area # 21
10	Combine	815.74	2	752	5,353,907	8, 9	-----	-----	Main Channel at 6th Street
11	SCS Runoff	6.812	2	722	19,121	-----	-----	-----	North Area # 20 (south of 6th St)
12	Reach	816.67	2	754	5,353,914	10	-----	-----	Main Cannel Reach South of 6th Stre
13	Combine	817.50	2	754	5,373,036	11, 12	-----	-----	Main North Channel at Wye
14	SCS Runoff	92.58	2	742	524,236	-----	-----	-----	South Area # 15
15	SCS Runoff	270.37	2	724	880,850	-----	-----	-----	South Area # 14
16	Reach	91.09	2	748	524,235	14	-----	-----	South 15 through 14
17	Combine	312.99	2	724	1,405,085	15, 16	-----	-----	South Area at 35 Hwy
18	Reach	311.98	2	726	1,405,086	17	-----	-----	Route Through 12
19	SCS Runoff	28.57	2	724	89,527	-----	-----	-----	South Area 12
20	SCS Runoff	26.98	2	718	62,280	-----	-----	-----	Existing Drainage to the South B1
21	SCS Runoff	88.15	2	720	240,504	-----	-----	-----	South Area 13
22	Combine	404.61	2	724	1,735,116	18, 19, 21	-----	-----	Main Channel at first Wye # 12 and #
23	Reach	404.01	2	728	1,735,115	22	-----	-----	Reach through 10 and 11
24	SCS Runoff	72.35	2	728	265,663	-----	-----	-----	Area 10 and 11
25	Combine	476.36	2	728	2,000,779	23, 24	-----	-----	West Channel at Wye for Main Chann
26	Combine	985.03	2	750	7,373,815	13, 25	-----	-----	Add North and South Basin
27	Reach	985.68	2	752	7,376,629	26	-----	-----	Route Main Channel from Wye to Re
28	SCS Runoff	23.13	2	726	79,844	-----	-----	-----	Area 1 to Regency
29	Combine	990.83	2	750	7,456,468	27, 28	-----	-----	Main Channel and Area 1 at Regency
Shoppes Existing Conditions MACRO 10-14-11					Report Period: 25 Year			Sunday, Dec 9, 2012	



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	308.45	2	748	1,898,401	-----	-----	-----	North Area # 24
2	SCS Runoff	189.20	2	738	975,821	-----	-----	-----	North Area # 25
3	SCS Runoff	316.00	2	736	1,542,354	-----	-----	-----	North Area # 23
4	Combine	782.73	2	740	4,416,578	1, 2, 3	-----	-----	Combine Areas 23,24,25
5	Reach	759.07	2	746	4,416,570	4	-----	-----	Reach through # 22
6	SCS Runoff	199.51	2	762	1,587,593	-----	-----	-----	North Area # 22
7	Combine	926.69	2	748	6,004,162	5, 6	-----	-----	North Area at 35 Highway
8	Reach	916.80	2	754	6,004,157	7	-----	-----	Route through Business Park Area #
9	SCS Runoff	123.14	2	746	768,052	-----	-----	-----	North Area # 21
10	Combine	1034.88	2	752	6,772,214	8, 9	-----	-----	Main Channel at 6th Street
11	SCS Runoff	8.624	2	722	24,315	-----	-----	-----	North Area # 20 (south of 6th St)
12	Reach	1035.37	2	754	6,772,218	10	-----	-----	Main Cannel Reach South of 6th Stre
13	Combine	1036.40	2	754	6,796,531	11, 12	-----	-----	Main North Channel at Wye
14	SCS Runoff	116.13	2	742	658,990	-----	-----	-----	South Area # 15
15	SCS Runoff	325.74	2	724	1,072,411	-----	-----	-----	South Area # 14
16	Reach	114.52	2	746	658,988	14	-----	-----	South 15 through 14
17	Combine	380.99	2	724	1,731,397	15, 16	-----	-----	South Area at 35 Hwy
18	Reach	380.29	2	726	1,731,398	17	-----	-----	Route Through 12
19	SCS Runoff	35.88	2	724	112,968	-----	-----	-----	South Area 12
20	SCS Runoff	33.77	2	718	78,586	-----	-----	-----	Existing Drainage to the South B1
21	SCS Runoff	106.11	2	720	292,806	-----	-----	-----	South Area 13
22	Combine	493.56	2	724	2,137,173	18, 19, 21	-----	-----	Main Channel at first Wye # 12 and #
23	Reach	492.82	2	726	2,137,170	22	-----	-----	Reach through 10 and 11
24	SCS Runoff	90.97	2	728	335,219	-----	-----	-----	Area 10 and 11
25	Combine	583.22	2	728	2,472,392	23, 24	-----	-----	West Channel at Wye for Main Chann
26	Combine	1246.98	2	748	9,268,924	13, 25	-----	-----	Add North and South Basin
27	Reach	1248.54	2	750	9,272,439	26	-----	-----	Route Main Channel from Wye to Re
28	SCS Runoff	29.36	2	726	101,535	-----	-----	-----	Area 1 to Regency
29	Combine	1255.21	2	750	9,373,967	27, 28	-----	-----	Main Channel and Area 1 at Regency
Shoppes Existing Conditions MACRO 10-14-11					Return Period: 50 Year			Sunday, Dec 9, 2012	

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	383.40	2	746	2,363,087	-----	-----	-----	North Area # 24
2	SCS Runoff	236.02	2	738	1,218,700	-----	-----	-----	North Area # 25
3	SCS Runoff	384.87	2	736	1,889,872	-----	-----	-----	North Area # 23
4	Combine	966.47	2	740	5,471,661	1, 2, 3	-----	-----	Combine Areas 23,24,25
5	Reach	939.89	2	746	5,471,653	4	-----	-----	Reach through # 22
6	SCS Runoff	250.17	2	762	1,989,424	-----	-----	-----	North Area # 22
7	Combine	1149.99	2	748	7,461,082	5, 6	-----	-----	North Area at 35 Highway
8	Reach	1139.74	2	752	7,461,075	7	-----	-----	Route through Business Park Area #
9	SCS Runoff	148.51	2	746	932,743	-----	-----	-----	North Area # 21
10	Combine	1282.04	2	752	8,393,818	8, 9	-----	-----	Main Channel at 6th Street
11	SCS Runoff	10.67	2	722	30,267	-----	-----	-----	North Area # 20 (south of 6th St)
12	Reach	1282.49	2	752	8,393,820	10	-----	-----	Main Cannel Reach South of 6th Stre
13	Combine	1283.81	2	752	8,424,087	11, 12	-----	-----	Main North Channel at Wye
14	SCS Runoff	142.58	2	742	812,460	-----	-----	-----	South Area # 15
15	SCS Runoff	387.20	2	724	1,287,589	-----	-----	-----	South Area # 14
16	Reach	140.88	2	746	812,458	14	-----	-----	South 15 through 14
17	Combine	456.89	2	724	2,100,049	15, 16	-----	-----	South Area at 35 Hwy
18	Reach	456.56	2	726	2,100,049	17	-----	-----	Route Through 12
19	SCS Runoff	44.09	2	724	139,716	-----	-----	-----	South Area 12
20	SCS Runoff	41.39	2	718	97,193	-----	-----	-----	Existing Drainage to the South B1
21	SCS Runoff	126.04	2	720	351,558	-----	-----	-----	South Area 13
22	Combine	592.88	2	724	2,591,322	18, 19, 21	-----	-----	Main Channel at first Wye # 12 and #
23	Reach	592.66	2	726	2,591,322	22	-----	-----	Reach through 10 and 11
24	SCS Runoff	111.90	2	728	414,591	-----	-----	-----	Area 10 and 11
25	Combine	702.56	2	728	3,005,913	23, 24	-----	-----	West Channel at Wye for Main Chann
26	Combine	1544.57	2	748	11,430,000	13, 25	-----	-----	Add North and South Basin
27	Reach	1545.71	2	750	11,434,300	26	-----	-----	Route Main Channel from Wye to Re
28	SCS Runoff	36.39	2	726	126,388	-----	-----	-----	Area 1 to Regency
29	Combine	1554.79	2	748	11,560,700	27, 28	-----	-----	Main Channel and Area 1 at Regency
Shoppes Existing Conditions MACRO 10-14-11					Return Period: 100 Year			Sunday, Dec 9, 2012	

# Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Sunday, Dec 9, 2012

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	-----
2	119.0000	17.0000	1.0000	-----
3	0.0000	0.0000	0.0000	-----
5	154.0000	18.8000	1.0000	-----
10	175.0000	18.8000	1.0000	-----
25	203.0000	18.8000	1.0000	-----
50	233.0000	19.8000	1.0000	-----
100	256.0000	19.8000	1.0000	-----

File name: KCMO IDF curve data.IDF

$$\text{Intensity} = B / (T_c + D)^E$$

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	5.41	4.41	3.72	3.22	2.83	2.53	2.29	2.09	1.92	1.78	1.65	1.55
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.47	5.35	4.56	3.97	3.52	3.16	2.86	2.62	2.41	2.24	2.09	1.95
10	7.35	6.08	5.18	4.51	4.00	3.59	3.25	2.98	2.74	2.54	2.37	2.22
25	8.53	7.05	6.01	5.23	4.63	4.16	3.77	3.45	3.18	2.95	2.75	2.58
50	9.40	7.82	6.70	5.85	5.20	4.68	4.25	3.90	3.60	3.34	3.11	2.92
100	10.32	8.59	7.36	6.43	5.71	5.14	4.67	4.28	3.95	3.67	3.42	3.21

Tc = time in minutes. Values may exceed 60.

Precip. file name: Sample.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	0.00	2.20	0.00	3.30	4.25	5.77	6.80	7.95
SCS 6-Hr	0.00	1.80	0.00	0.00	2.60	0.00	0.00	4.00
Huff-1st	0.00	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Custom	0.00	1.75	0.00	2.80	3.90	5.25	6.00	7.10



## **Proposed Conditions Hydrograph Summary Tables**



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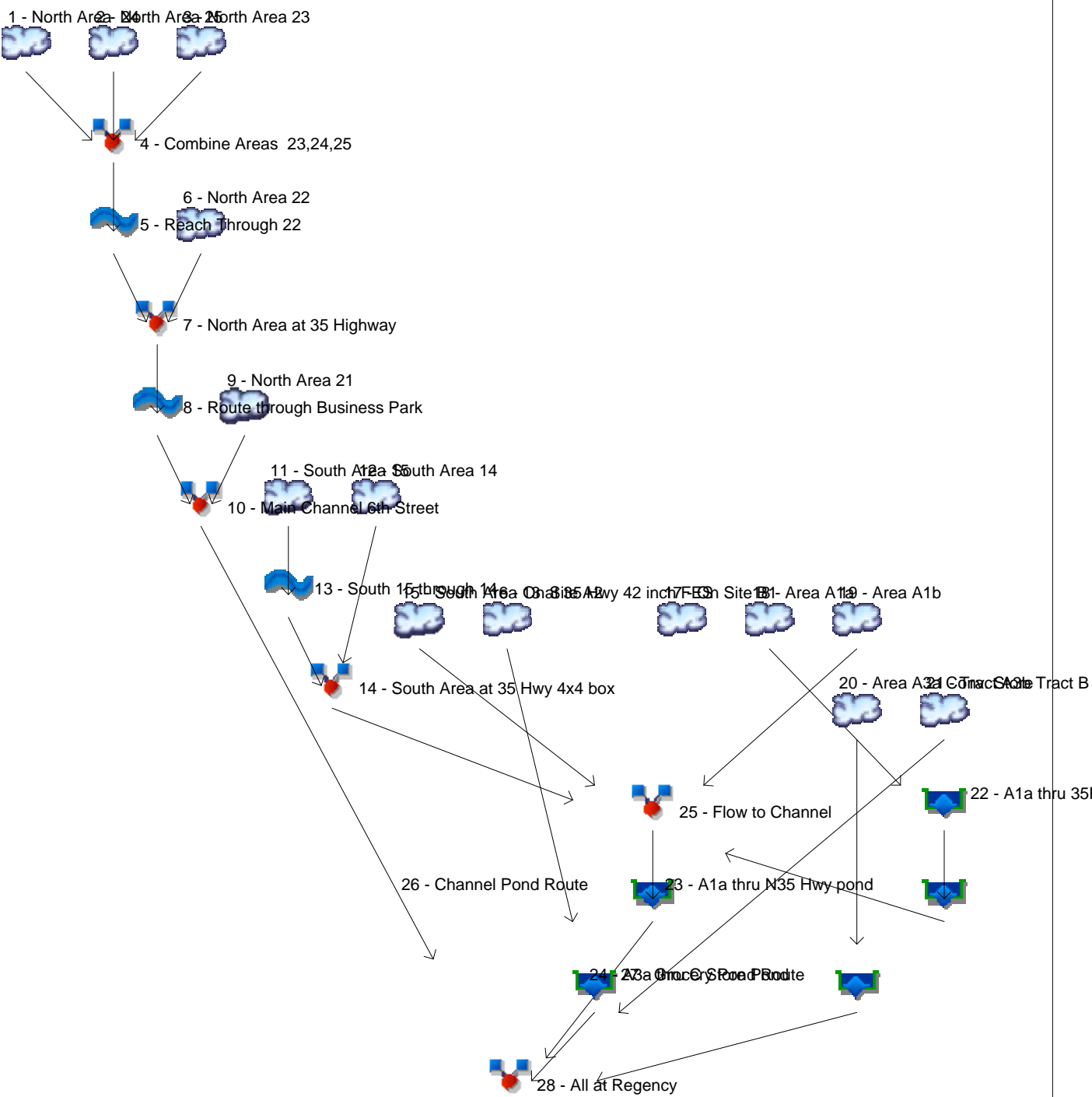
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

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# Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8





# Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	37.59	-----	-----	148.44	242.53	308.45	383.40	North Area 24
2	SCS Runoff	-----	-----	21.43	-----	-----	88.86	146.65	187.42	233.79	North Area 25
3	SCS Runoff	-----	-----	52.83	-----	-----	165.06	255.02	316.72	385.74	North Area 23
4	Combine	1, 2, 3	-----	106.22	-----	-----	385.63	619.03	781.65	965.09	Combine Areas 23,24,25
5	Reach	4	-----	99.13	-----	-----	370.04	598.01	758.01	938.56	Reach Through 22
6	SCS Runoff	-----	-----	20.74	-----	-----	92.04	154.72	199.13	249.70	North Area 22
7	Combine	5, 6	-----	116.80	-----	-----	447.75	728.07	925.33	1148.28	North Area at 35 Highway
8	Reach	7	-----	113.31	-----	-----	440.89	720.19	915.45	1138.03	Route through Business Park
9	SCS Runoff	-----	-----	23.75	-----	-----	66.88	100.37	123.14	148.51	North Area 21
10	Combine	8, 9	-----	133.99	-----	-----	503.05	814.70	1033.53	1280.33	Main Channel 6th Street
11	SCS Runoff	-----	-----	17.07	-----	-----	58.22	91.88	115.24	141.49	South Area 15
12	SCS Runoff	-----	-----	77.19	-----	-----	188.07	270.37	325.74	387.20	South Area 14
13	Reach	11	-----	16.02	-----	-----	56.27	89.62	112.68	138.56	South 15 through 14
14	Combine	12, 13	-----	81.83	-----	-----	211.29	310.41	377.85	453.15	South Area at 35 Hwy 4x4 box
15	SCS Runoff	-----	-----	18.69	-----	-----	45.31	65.04	78.31	93.04	South Area 13 at 35 Hwy 42 inch FES
16	SCS Runoff	-----	-----	23.54	-----	-----	67.68	101.90	125.16	151.06	On Site A2
17	SCS Runoff	-----	-----	5.702	-----	-----	14.49	21.06	25.49	30.40	On Site B1
18	SCS Runoff	-----	-----	3.920	-----	-----	11.16	16.75	20.54	24.77	Area A1a
19	SCS Runoff	-----	-----	1.247	-----	-----	4.224	6.675	8.367	10.27	Area A1b
20	SCS Runoff	-----	-----	4.005	-----	-----	9.640	13.81	16.61	19.72	Area A3a Conv. Store
21	SCS Runoff	-----	-----	0.436	-----	-----	2.755	4.901	6.479	8.297	Tract A3b Tract B
22	Reservoir	18	-----	3.898	-----	-----	9.818	13.18	15.11	16.87	A1a thru 35Hwy Pond
23	Reservoir	22	-----	3.814	-----	-----	8.040	10.40	11.48	12.00	A1a thru N35 Hwy pond
24	Reservoir	20	-----	1.569	-----	-----	2.369	2.821	3.685	4.528	A3a thru C Store Pond
25	Combine	14, 15, 19, 23, 25	-----	105.10	-----	-----	266.56	387.89	470.56	562.55	Flow to Channel
26	Reservoir	25	-----	141.87	-----	-----	265.28	383.68	464.15	552.53	Channel Pond Route
27	Reservoir	16	-----	1.462	-----	-----	21.69	31.57	35.97	39.95	Grocery Pond Route
28	Combine	10, 21, 24, 26, 27	-----	163.23	-----	-----	614.02	987.55	1248.52	1541.74	All at Regency
Proj. file: Shoppes Proposed Conditions MICRO.gpw										Sunday, Dec 9, 2012	

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

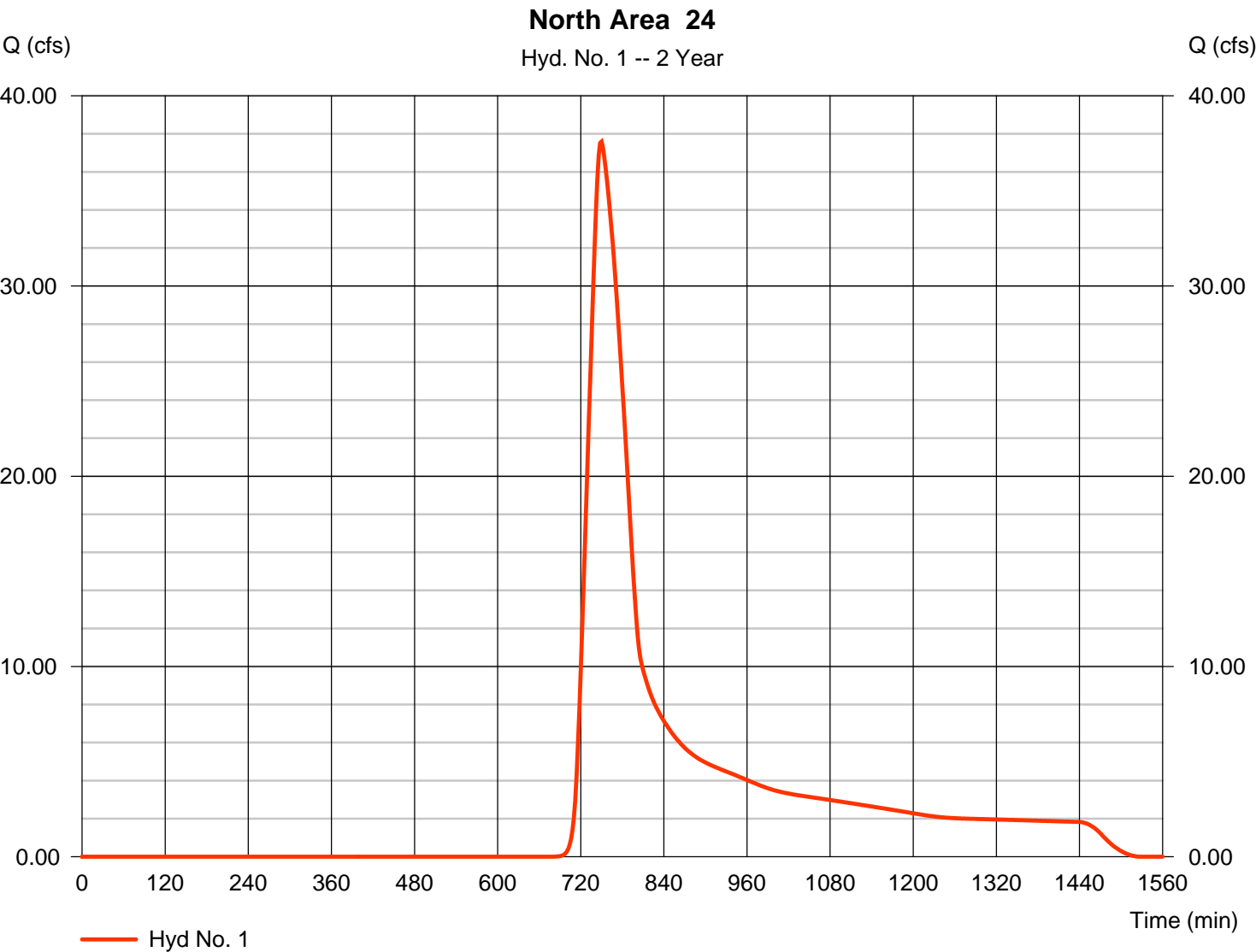
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	37.59	2	750	265,504	-----	-----	-----	North Area 24
2	SCS Runoff	21.43	2	742	129,204	-----	-----	-----	North Area 25
3	SCS Runoff	52.83	2	738	266,749	-----	-----	-----	North Area 23
4	Combine	106.22	2	742	661,457	1, 2, 3	-----	-----	Combine Areas 23,24,25
5	Reach	99.13	2	752	661,453	4	-----	-----	Reach Through 22
6	SCS Runoff	20.74	2	764	202,158	-----	-----	-----	North Area 22
7	Combine	116.80	2	754	863,611	5, 6	-----	-----	North Area at 35 Highway
8	Reach	113.31	2	762	863,607	7	-----	-----	Route through Business Park
9	SCS Runoff	23.75	2	748	148,928	-----	-----	-----	North Area 21
10	Combine	133.99	2	760	1,012,535	8, 9	-----	-----	Main Channel 6th Street
11	SCS Runoff	17.07	2	744	104,041	-----	-----	-----	South Area 15
12	SCS Runoff	77.19	2	724	241,334	-----	-----	-----	South Area 14
13	Reach	16.02	2	752	104,037	11	-----	-----	South 15 through 14
14	Combine	81.83	2	724	345,371	12, 13	-----	-----	South Area at 35 Hwy 4x4 box
15	SCS Runoff	18.69	2	722	52,438	-----	-----	-----	South Area 13 at 35 Hwy 42 inch FES
16	SCS Runoff	23.54	2	724	74,749	-----	-----	-----	On Site A2
17	SCS Runoff	5.702	2	716	11,523	-----	-----	-----	On Site B1
18	SCS Runoff	3.920	2	722	10,254	-----	-----	-----	Area A1a
19	SCS Runoff	1.247	2	722	3,349	-----	-----	-----	Area A1b
20	SCS Runoff	4.005	2	718	9,194	-----	-----	-----	Area A3a Conv. Store
21	SCS Runoff	0.436	2	722	1,559	-----	-----	-----	Tract A3b Tract B
22	Reservoir	3.898	2	722	9,644	18	821.19	807	A1a thru 35Hwy Pond
23	Reservoir	3.814	2	724	9,644	22	819.05	122	A1a thru N35 Hwy pond
24	Reservoir	1.569	2	726	9,189	20	813.21	2,659	A3a thru C Store Pond
25	Combine	105.10	2	724	410,802	14, 15, 19, 23, 25	-----	-----	Flow to Channel
26	Reservoir	141.87	2	720	347,436	25	810.31	64,938	Channel Pond Route
27	Reservoir	1.462	2	834	27,041	16	810.04	48,488	Grocery Pond Route
28	Combine	163.23	2	758	1,397,760	10, 21, 24, 26, 27	-----	-----	All at Regency
Shoppes Proposed Conditions MICRO.gpw					Return Period: 2 Year			Sunday, Dec 9, 2012	

# Hydrograph Report

## Hyd. No. 1

North Area 24

Hydrograph type	= SCS Runoff	Peak discharge	= 37.59 cfs
Storm frequency	= 2 yrs	Time to peak	= 750 min
Time interval	= 2 min	Hyd. volume	= 265,504 cuft
Drainage area	= 122.700 ac	Curve number	= 78
Basin Slope	= 2.5 %	Hydraulic length	= 3200 ft
Tc method	= LAG	Time of conc. (Tc)	= 54.29 min
Total precip.	= 2.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	148.44	2	748	923,190	-----	-----	-----	North Area 24
2	SCS Runoff	88.86	2	740	463,942	-----	-----	-----	North Area 25
3	SCS Runoff	165.06	2	736	800,063	-----	-----	-----	North Area 23
4	Combine	385.63	2	740	2,187,196	1, 2, 3	-----	-----	Combine Areas 23,24,25
5	Reach	370.04	2	748	2,187,193	4	-----	-----	Reach Through 22
6	SCS Runoff	92.04	2	762	750,473	-----	-----	-----	North Area 22
7	Combine	447.75	2	750	2,937,665	5, 6	-----	-----	North Area at 35 Highway
8	Reach	440.89	2	756	2,937,665	7	-----	-----	Route through Business Park
9	SCS Runoff	66.88	2	746	411,789	-----	-----	-----	North Area 21
10	Combine	503.05	2	754	3,349,451	8, 9	-----	-----	Main Channel 6th Street
11	SCS Runoff	58.22	2	744	330,322	-----	-----	-----	South Area 15
12	SCS Runoff	188.07	2	724	601,627	-----	-----	-----	South Area 14
13	Reach	56.27	2	748	330,320	11	-----	-----	South 15 through 14
14	Combine	211.29	2	724	931,948	12, 13	-----	-----	South Area at 35 Hwy 4x4 box
15	SCS Runoff	45.31	2	722	130,725	-----	-----	-----	South Area 13 at 35 Hwy 42 inch FES
16	SCS Runoff	67.68	2	724	212,268	-----	-----	-----	On Site A2
17	SCS Runoff	14.49	2	716	30,238	-----	-----	-----	On Site B1
18	SCS Runoff	11.16	2	720	29,120	-----	-----	-----	Area A1a
19	SCS Runoff	4.224	2	720	10,950	-----	-----	-----	Area A1b
20	SCS Runoff	9.640	2	718	22,919	-----	-----	-----	Area A3a Conv. Store
21	SCS Runoff	2.755	2	722	7,296	-----	-----	-----	Tract A3b Tract B
22	Reservoir	9.818	2	724	28,510	18	822.33	2,183	A1a thru 35Hwy Pond
23	Reservoir	8.040	2	730	28,510	22	821.33	1,886	A1a thru N35 Hwy pond
24	Reservoir	2.369	2	730	22,914	20	814.33	7,657	A3a thru C Store Pond
25	Combine	266.56	2	724	1,102,130	14, 15, 19, 23, 25	-----	-----	Flow to Channel
26	Reservoir	265.28	2	724	1,038,765	25	810.36	68,469	Channel Pond Route
27	Reservoir	21.69	2	742	164,561	16	812.68	96,812	Grocery Pond Route
28	Combine	614.02	2	752	4,582,986	10, 21, 24, 26, 27	-----	-----	All at Regency
Shoppes Proposed Conditions MICRO.gpw					Return Period: 10 Year			Sunday, Dec 9, 2012	

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

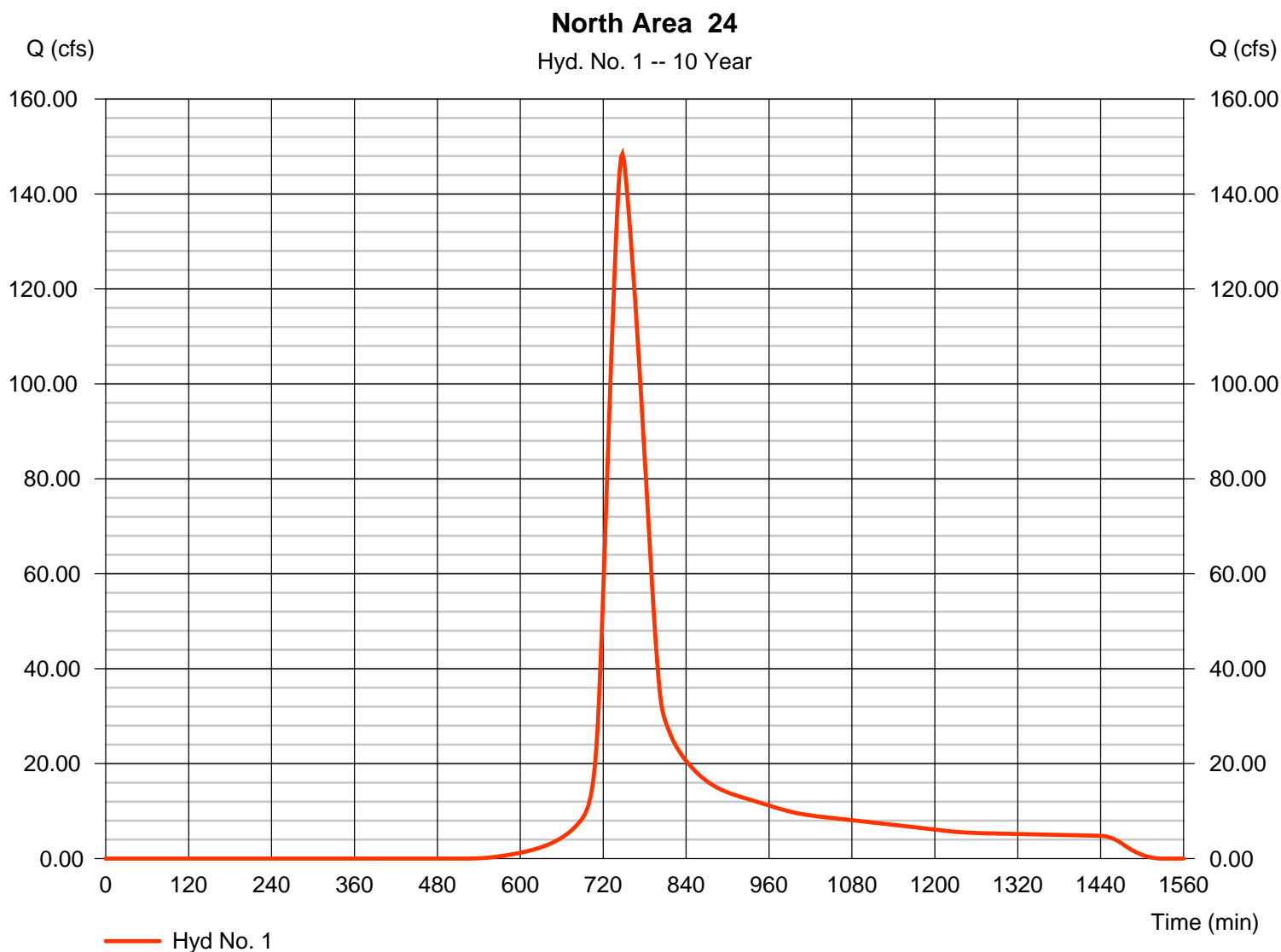
Sunday, Dec 9, 2012

## Hyd. No. 1

North Area 24

Hydrograph type = SCS Runoff  
 Storm frequency = 10 yrs  
 Time interval = 2 min  
 Drainage area = 122.700 ac  
 Basin Slope = 2.5 %  
 Tc method = LAG  
 Total precip. = 4.25 in  
 Storm duration = 24 hrs

Peak discharge = 148.44 cfs  
 Time to peak = 748 min  
 Hyd. volume = 923,190 cuft  
 Curve number = 78  
 Hydraulic length = 3200 ft  
 Time of conc. (Tc) = 54.29 min  
 Distribution = Type II  
 Shape factor = 484



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	242.53	2	748	1,492,850	-----	-----	-----	North Area 24
2	SCS Runoff	146.65	2	740	757,096	-----	-----	-----	North Area 25
3	SCS Runoff	255.02	2	736	1,238,923	-----	-----	-----	North Area 23
4	Combine	619.03	2	740	3,488,869	1, 2, 3	-----	-----	Combine Areas 23,24,25
5	Reach	598.01	2	746	3,488,865	4	-----	-----	Reach Through 22
6	SCS Runoff	154.72	2	762	1,236,132	-----	-----	-----	North Area 22
7	Combine	728.07	2	748	4,724,994	5, 6	-----	-----	North Area at 35 Highway
8	Reach	720.19	2	754	4,724,996	7	-----	-----	Route through Business Park
9	SCS Runoff	100.37	2	746	622,214	-----	-----	-----	North Area 21
10	Combine	814.70	2	752	5,347,209	8, 9	-----	-----	Main Channel 6th Street
11	SCS Runoff	91.88	2	742	520,235	-----	-----	-----	South Area 15
12	SCS Runoff	270.37	2	724	880,850	-----	-----	-----	South Area 14
13	Reach	89.62	2	748	520,232	11	-----	-----	South 15 through 14
14	Combine	310.41	2	724	1,401,084	12, 13	-----	-----	South Area at 35 Hwy 4x4 box
15	SCS Runoff	65.04	2	722	191,396	-----	-----	-----	South Area 13 at 35 Hwy 42 inch FES
16	SCS Runoff	101.90	2	724	323,340	-----	-----	-----	On Site A2
17	SCS Runoff	21.06	2	716	44,969	-----	-----	-----	On Site B1
18	SCS Runoff	16.75	2	720	44,357	-----	-----	-----	Area A1a
19	SCS Runoff	6.675	2	720	17,395	-----	-----	-----	Area A1b
20	SCS Runoff	13.81	2	718	33,556	-----	-----	-----	Area A3a Conv. Store
21	SCS Runoff	4.901	2	720	12,769	-----	-----	-----	Tract A3b Tract B
22	Reservoir	13.18	2	726	43,747	18	823.42	4,108	A1a thru 35Hwy Pond
23	Reservoir	10.40	2	734	43,747	22	822.83	4,189	A1a thru N35 Hwy pond
24	Reservoir	2.821	2	730	33,551	20	815.09	11,783	A3a thru C Store Pond
25	Combine	387.89	2	724	1,653,622	14, 15, 19, 23, 25	-----	-----	Flow to Channel
26	Reservoir	383.68	2	726	1,590,255	25	811.01	77,751	Channel Pond Route
27	Reservoir	31.57	2	742	275,632	16	815.05	146,075	Grocery Pond Route
28	Combine	987.55	2	750	7,259,411	10, 21, 24, 26, 27	-----	-----	All at Regency
Shoppes Proposed Conditions MICRO.gpw					Return Period: 25 Year			Sunday, Dec 9, 2012	

# Hydrograph Report

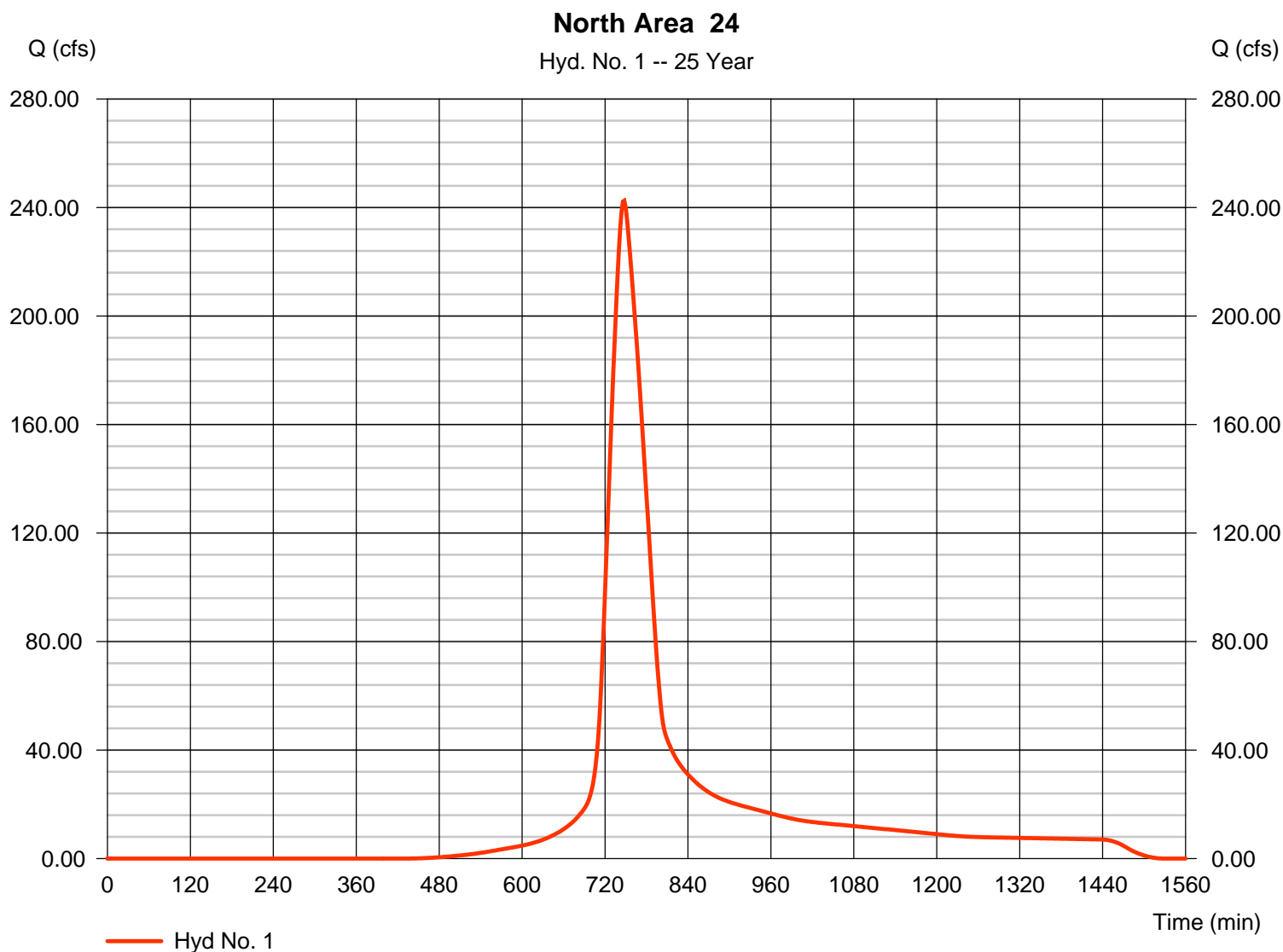
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Sunday, Dec 9, 2012

## Hyd. No. 1

North Area 24

Hydrograph type	= SCS Runoff	Peak discharge	= 242.53 cfs
Storm frequency	= 25 yrs	Time to peak	= 748 min
Time interval	= 2 min	Hyd. volume	= 1,492,850 cuft
Drainage area	= 122.700 ac	Curve number	= 78
Basin Slope	= 2.5 %	Hydraulic length	= 3200 ft
Tc method	= LAG	Time of conc. (Tc)	= 54.29 min
Total precip.	= 5.77 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	308.45	2	748	1,898,401	-----	-----	-----	North Area 24
2	SCS Runoff	187.42	2	738	966,614	-----	-----	-----	North Area 25
3	SCS Runoff	316.72	2	736	1,545,867	-----	-----	-----	North Area 23
4	Combine	781.65	2	740	4,410,883	1, 2, 3	-----	-----	Combine Areas 23,24,25
5	Reach	758.01	2	746	4,410,880	4	-----	-----	Reach Through 22
6	SCS Runoff	199.13	2	762	1,584,632	-----	-----	-----	North Area 22
7	Combine	925.33	2	748	5,995,510	5, 6	-----	-----	North Area at 35 Highway
8	Reach	915.45	2	754	5,995,510	7	-----	-----	Route through Business Park
9	SCS Runoff	123.14	2	746	768,052	-----	-----	-----	North Area 21
10	Combine	1033.53	2	752	6,763,559	8, 9	-----	-----	Main Channel 6th Street
11	SCS Runoff	115.24	2	742	653,959	-----	-----	-----	South Area 15
12	SCS Runoff	325.74	2	724	1,072,411	-----	-----	-----	South Area 14
13	Reach	112.68	2	748	653,957	11	-----	-----	South 15 through 14
14	Combine	377.85	2	724	1,726,366	12, 13	-----	-----	South Area at 35 Hwy 4x4 box
15	SCS Runoff	78.31	2	722	233,019	-----	-----	-----	South Area 13 at 35 Hwy 42 inch FES
16	SCS Runoff	125.16	2	724	400,544	-----	-----	-----	On Site A2
17	SCS Runoff	25.49	2	716	55,123	-----	-----	-----	On Site B1
18	SCS Runoff	20.54	2	720	54,948	-----	-----	-----	Area A1a
19	SCS Runoff	8.367	2	720	21,949	-----	-----	-----	Area A1b
20	SCS Runoff	16.61	2	718	40,854	-----	-----	-----	Area A3a Conv. Store
21	SCS Runoff	6.479	2	720	16,803	-----	-----	-----	Tract A3b Tract B
22	Reservoir	15.11	2	726	54,338	18	824.15	5,852	A1a thru 35Hwy Pond
23	Reservoir	11.48	2	736	54,338	22	823.55	5,794	A1a thru N35 Hwy pond
24	Reservoir	3.685	2	730	40,849	20	815.51	14,438	A3a thru C Store Pond
25	Combine	470.56	2	724	2,035,674	14, 15, 19, 23, 25	-----	-----	Flow to Channel
26	Reservoir	464.15	2	726	1,972,307	25	811.47	84,874	Channel Pond Route
27	Reservoir	35.97	2	742	352,836	16	816.55	180,302	Grocery Pond Route
28	Combine	1248.52	2	750	9,146,347	10, 21, 24, 26, 27	-----	-----	All at Regency
Shoppes Proposed Conditions MICRO.gpw					Return Period: 50 Year			Sunday, Dec 9, 2012	



# Hydrograph Report

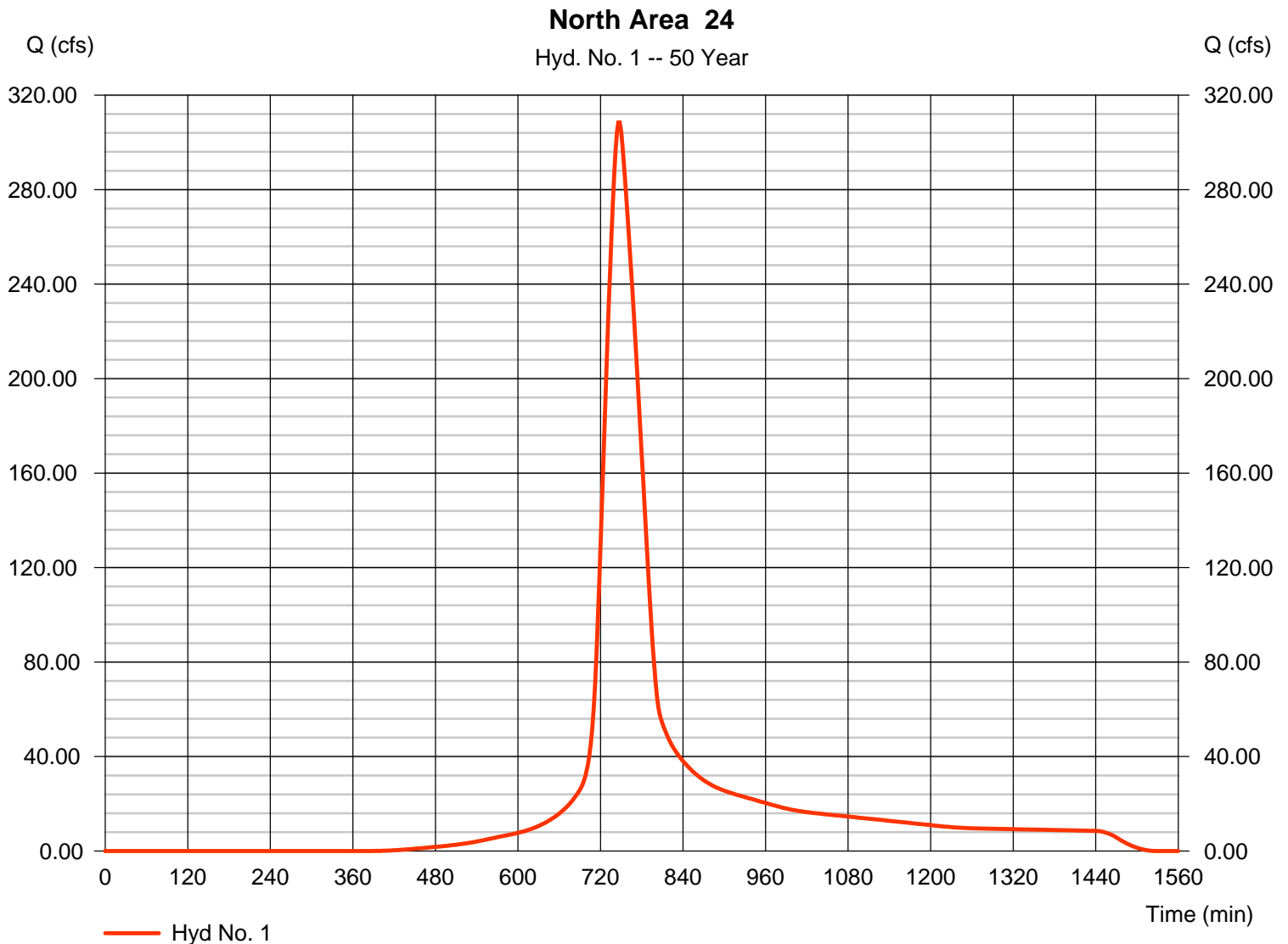
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Sunday, Dec 9, 2012

## Hyd. No. 1

North Area 24

Hydrograph type	= SCS Runoff	Peak discharge	= 308.45 cfs
Storm frequency	= 50 yrs	Time to peak	= 748 min
Time interval	= 2 min	Hyd. volume	= 1,898,401 cuft
Drainage area	= 122.700 ac	Curve number	= 78
Basin Slope	= 2.5 %	Hydraulic length	= 3200 ft
Tc method	= LAG	Time of conc. (Tc)	= 54.29 min
Total precip.	= 6.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	383.40	2	746	2,363,087	-----	-----	-----	North Area 24
2	SCS Runoff	233.79	2	738	1,207,203	-----	-----	-----	North Area 25
3	SCS Runoff	385.74	2	736	1,894,175	-----	-----	-----	North Area 23
4	Combine	965.09	2	740	5,464,465	1, 2, 3	-----	-----	Combine Areas 23,24,25
5	Reach	938.56	2	746	5,464,468	4	-----	-----	Reach Through 22
6	SCS Runoff	249.70	2	762	1,985,715	-----	-----	-----	North Area 22
7	Combine	1148.28	2	748	7,450,176	5, 6	-----	-----	North Area at 35 Highway
8	Reach	1138.03	2	752	7,450,177	7	-----	-----	Route through Business Park
9	SCS Runoff	148.51	2	746	932,743	-----	-----	-----	North Area 21
10	Combine	1280.33	2	752	8,382,916	8, 9	-----	-----	Main Channel 6th Street
11	SCS Runoff	141.49	2	742	806,258	-----	-----	-----	South Area 15
12	SCS Runoff	387.20	2	724	1,287,589	-----	-----	-----	South Area 14
13	Reach	138.56	2	748	806,256	11	-----	-----	South 15 through 14
14	Combine	453.15	2	724	2,093,845	12, 13	-----	-----	South Area at 35 Hwy 4x4 box
15	SCS Runoff	93.04	2	722	279,775	-----	-----	-----	South Area 13 at 35 Hwy 42 inch FES
16	SCS Runoff	151.06	2	724	487,861	-----	-----	-----	On Site A2
17	SCS Runoff	30.40	2	716	66,558	-----	-----	-----	On Site B1
18	SCS Runoff	24.77	2	720	66,927	-----	-----	-----	Area A1a
19	SCS Runoff	10.27	2	720	27,146	-----	-----	-----	Area A1b
20	SCS Runoff	19.72	2	718	49,051	-----	-----	-----	Area A3a Conv. Store
21	SCS Runoff	8.297	2	720	21,516	-----	-----	-----	Tract A3b Tract B
22	Reservoir	16.87	2	726	66,317	18	824.96	8,091	A1a thru 35Hwy Pond
23	Reservoir	12.00	2	738	66,317	22	824.36	7,919	A1a thru N35 Hwy pond
24	Reservoir	4.528	2	730	49,046	20	815.96	17,319	A3a thru C Store Pond
25	Combine	562.55	2	724	2,467,082	14, 15, 19, 23, 25	-----	-----	Flow to Channel
26	Reservoir	552.53	2	726	2,403,714	25	812.06	94,312	Channel Pond Route
27	Reservoir	39.95	2	742	440,154	16	818.08	217,180	Grocery Pond Route
28	Combine	1541.74	2	750	11,297,340	10, 21, 24, 26, 27	-----	-----	All at Regency
Shoppes Proposed Conditions MICRO.gpw					Return Period: 100 Year			Sunday, Dec 9, 2012	

# Hydrograph Report

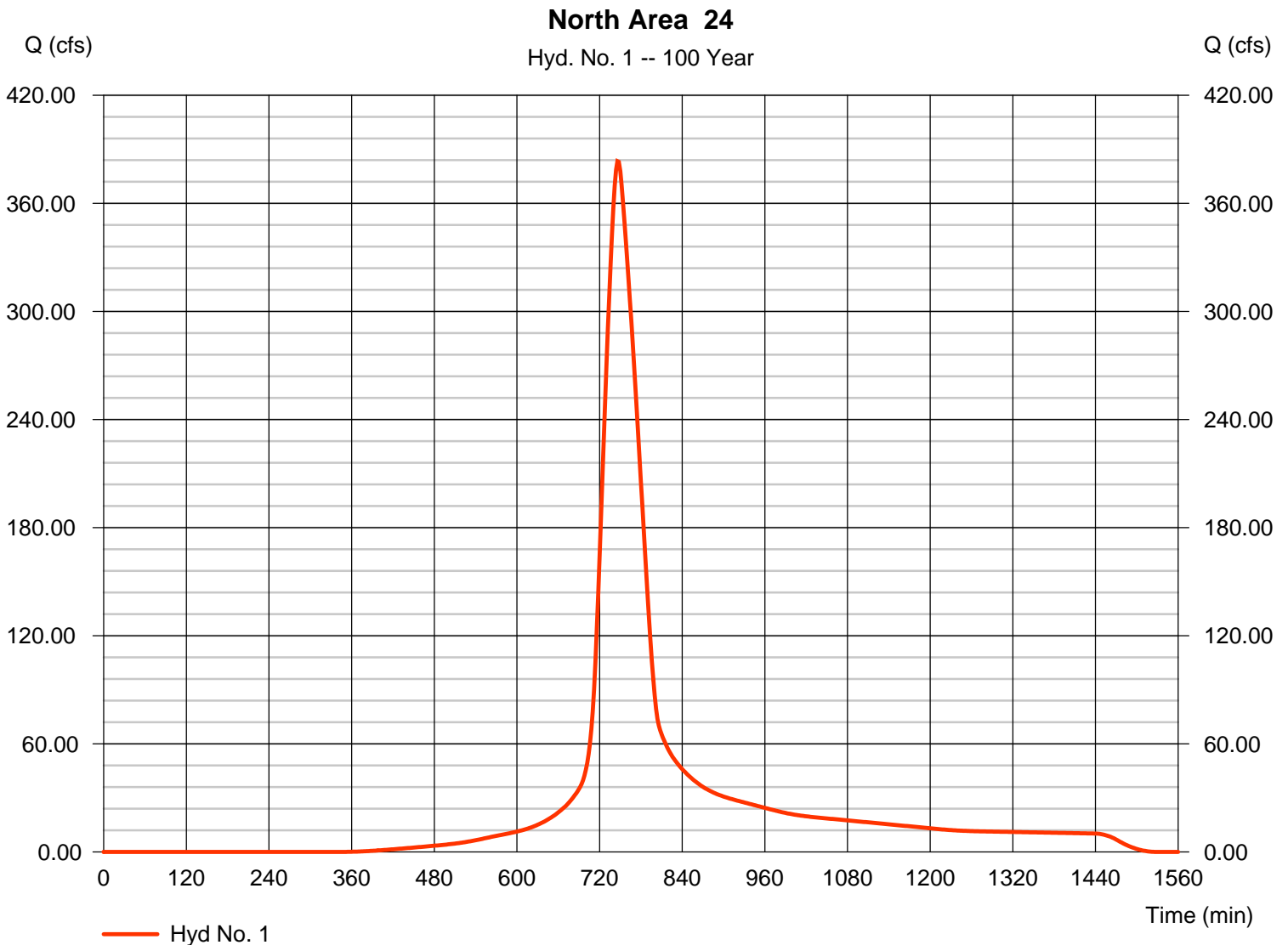
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Sunday, Dec 9, 2012

## Hyd. No. 1

North Area 24

Hydrograph type	= SCS Runoff	Peak discharge	= 383.40 cfs
Storm frequency	= 100 yrs	Time to peak	= 746 min
Time interval	= 2 min	Hyd. volume	= 2,363,087 cuft
Drainage area	= 122.700 ac	Curve number	= 78
Basin Slope	= 2.5 %	Hydraulic length	= 3200 ft
Tc method	= LAG	Time of conc. (Tc)	= 54.29 min
Total precip.	= 7.95 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



# Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Sunday, Dec 9, 2012

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	-----
2	119.0000	17.0000	1.0000	-----
3	0.0000	0.0000	0.0000	-----
5	154.0000	18.8000	1.0000	-----
10	175.0000	18.8000	1.0000	-----
25	203.0000	18.8000	1.0000	-----
50	233.0000	19.8000	1.0000	-----
100	256.0000	19.8000	1.0000	-----

File name: KCMO IDF curve data.IDF

$$\text{Intensity} = B / (T_c + D)^E$$

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	5.41	4.41	3.72	3.22	2.83	2.53	2.29	2.09	1.92	1.78	1.65	1.55
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.47	5.35	4.56	3.97	3.52	3.16	2.86	2.62	2.41	2.24	2.09	1.95
10	7.35	6.08	5.18	4.51	4.00	3.59	3.25	2.98	2.74	2.54	2.37	2.22
25	8.53	7.05	6.01	5.23	4.63	4.16	3.77	3.45	3.18	2.95	2.75	2.58
50	9.40	7.82	6.70	5.85	5.20	4.68	4.25	3.90	3.60	3.34	3.11	2.92
100	10.32	8.59	7.36	6.43	5.71	5.14	4.67	4.28	3.95	3.67	3.42	3.21

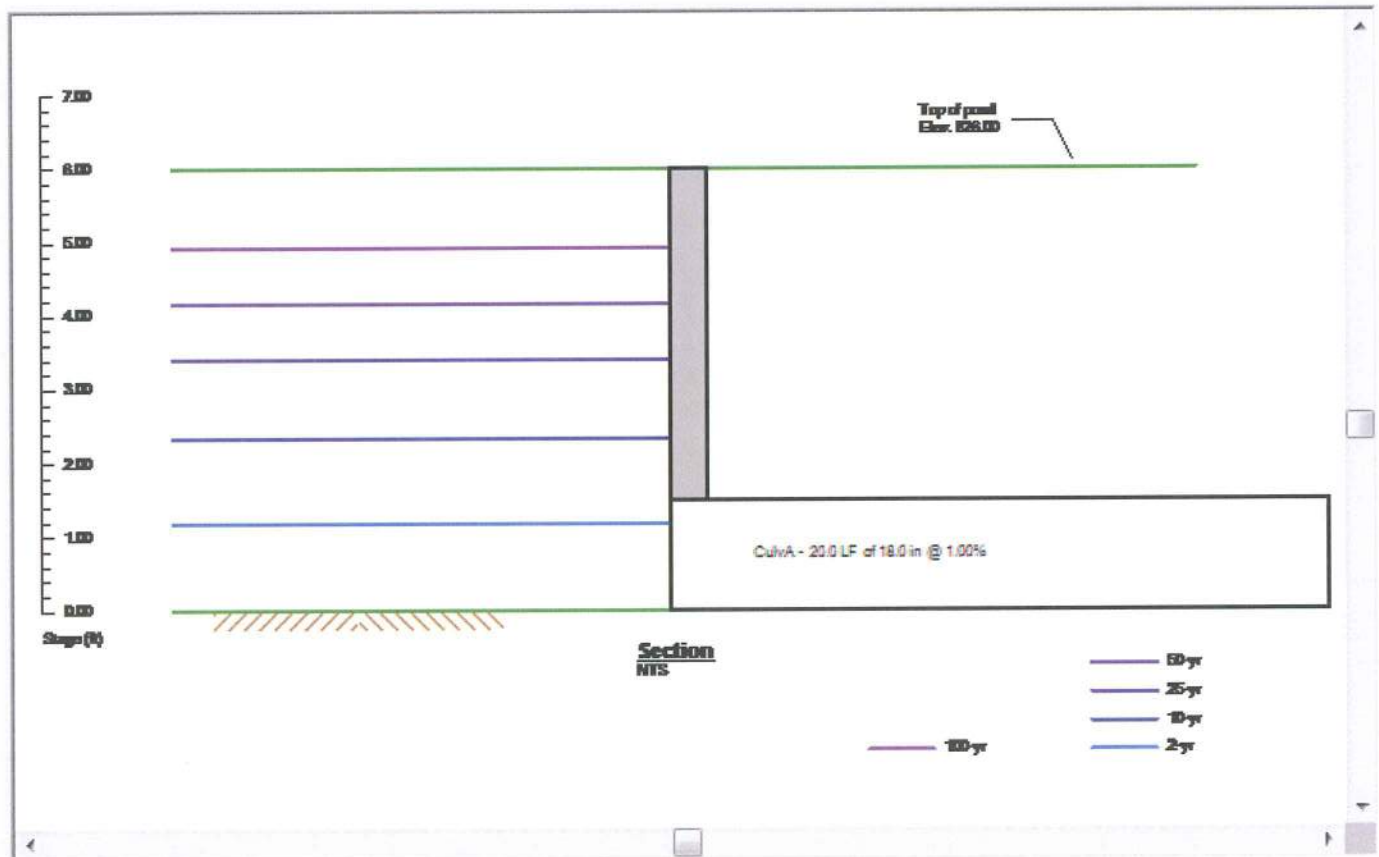
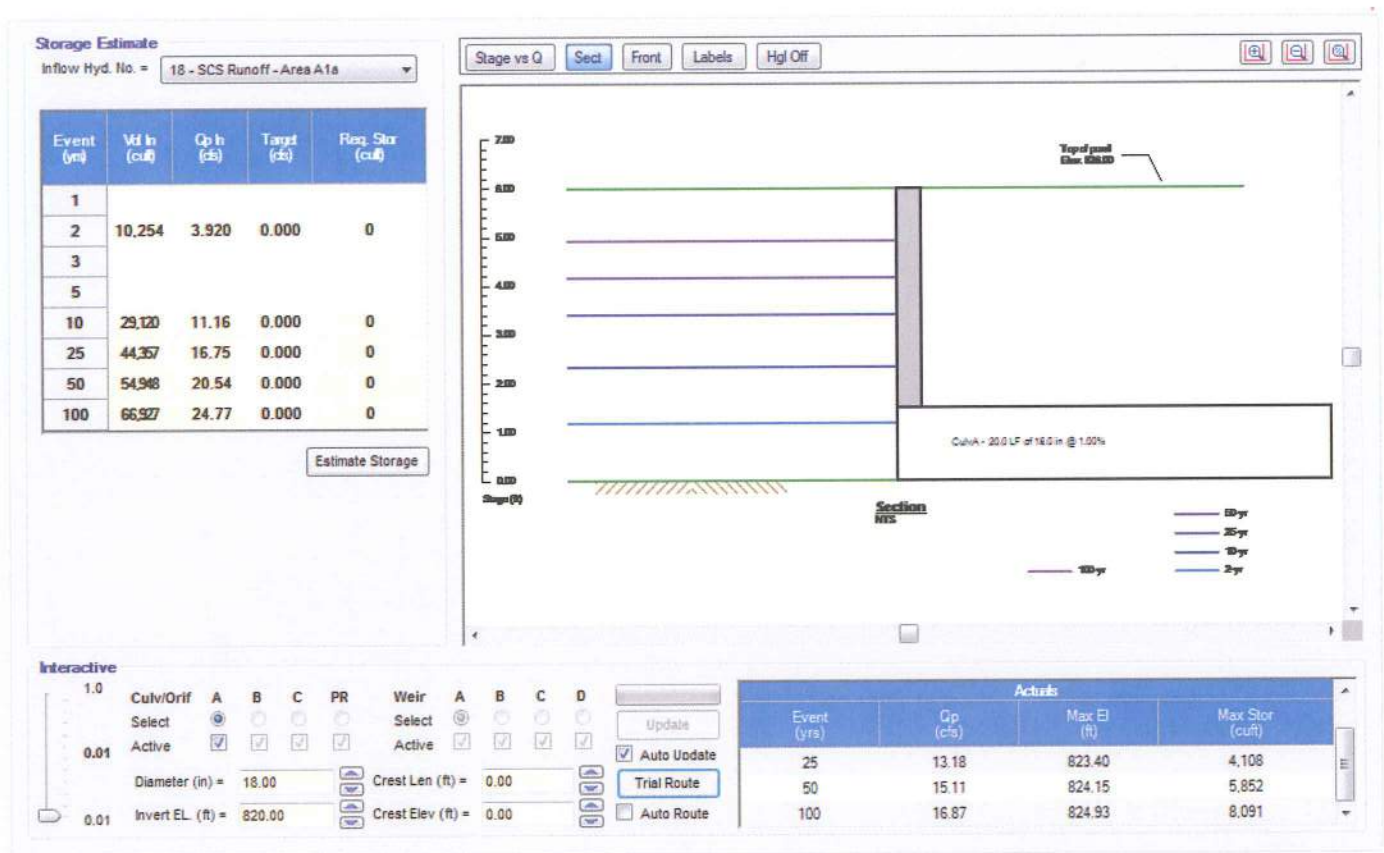
Tc = time in minutes. Values may exceed 60.

Precip. file name: Sample.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	0.00	2.20	0.00	3.30	4.25	5.77	6.80	7.95
SCS 6-Hr	0.00	1.80	0.00	0.00	2.60	0.00	0.00	4.00
Huff-1st	0.00	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Custom	0.00	1.75	0.00	2.80	3.90	5.25	6.00	7.10

## Pond Reports





Pond A - (South Pond along I-35 Highway)





# Hydrograph Report

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Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

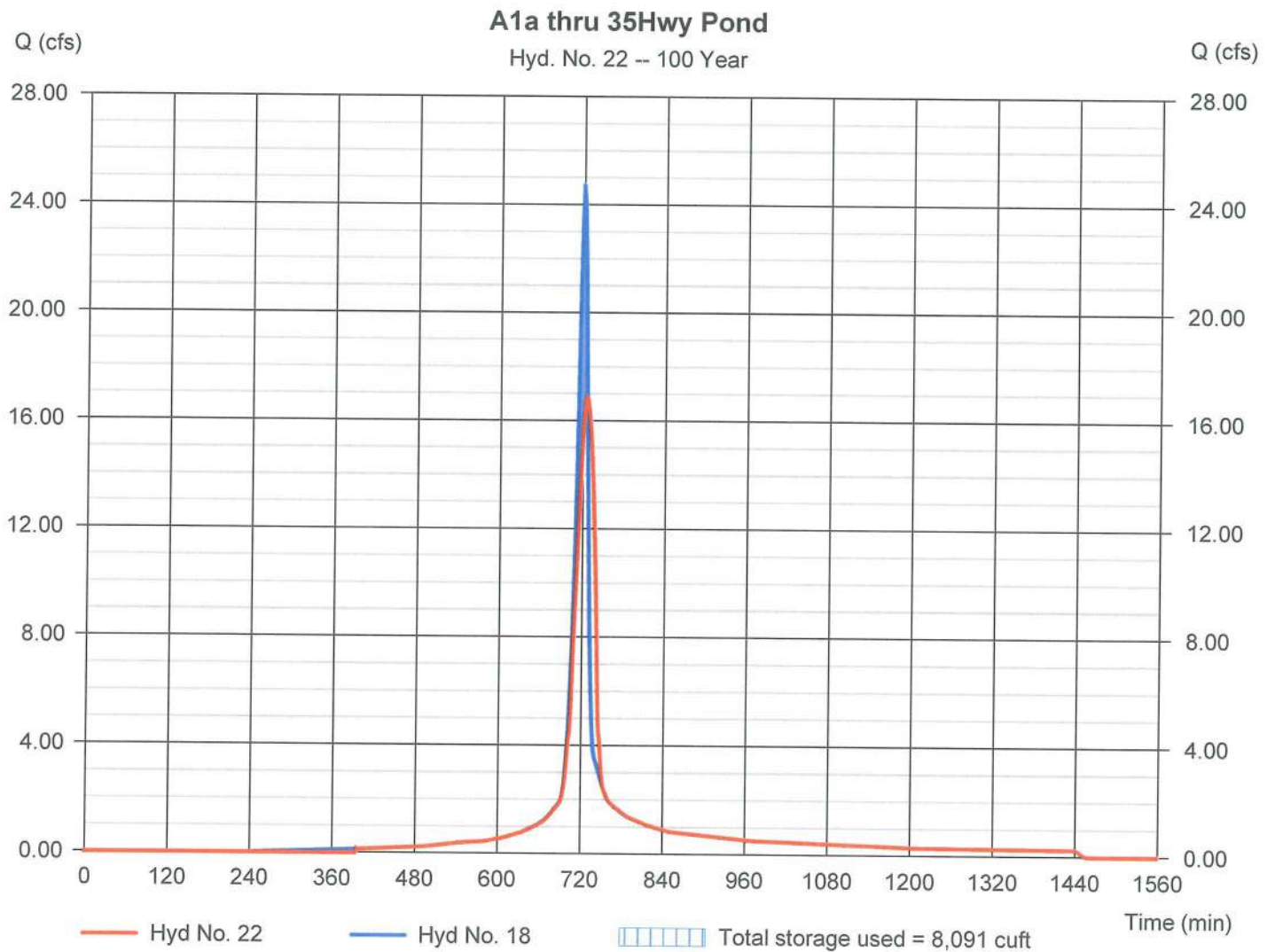
Sunday, Dec 9, 2012

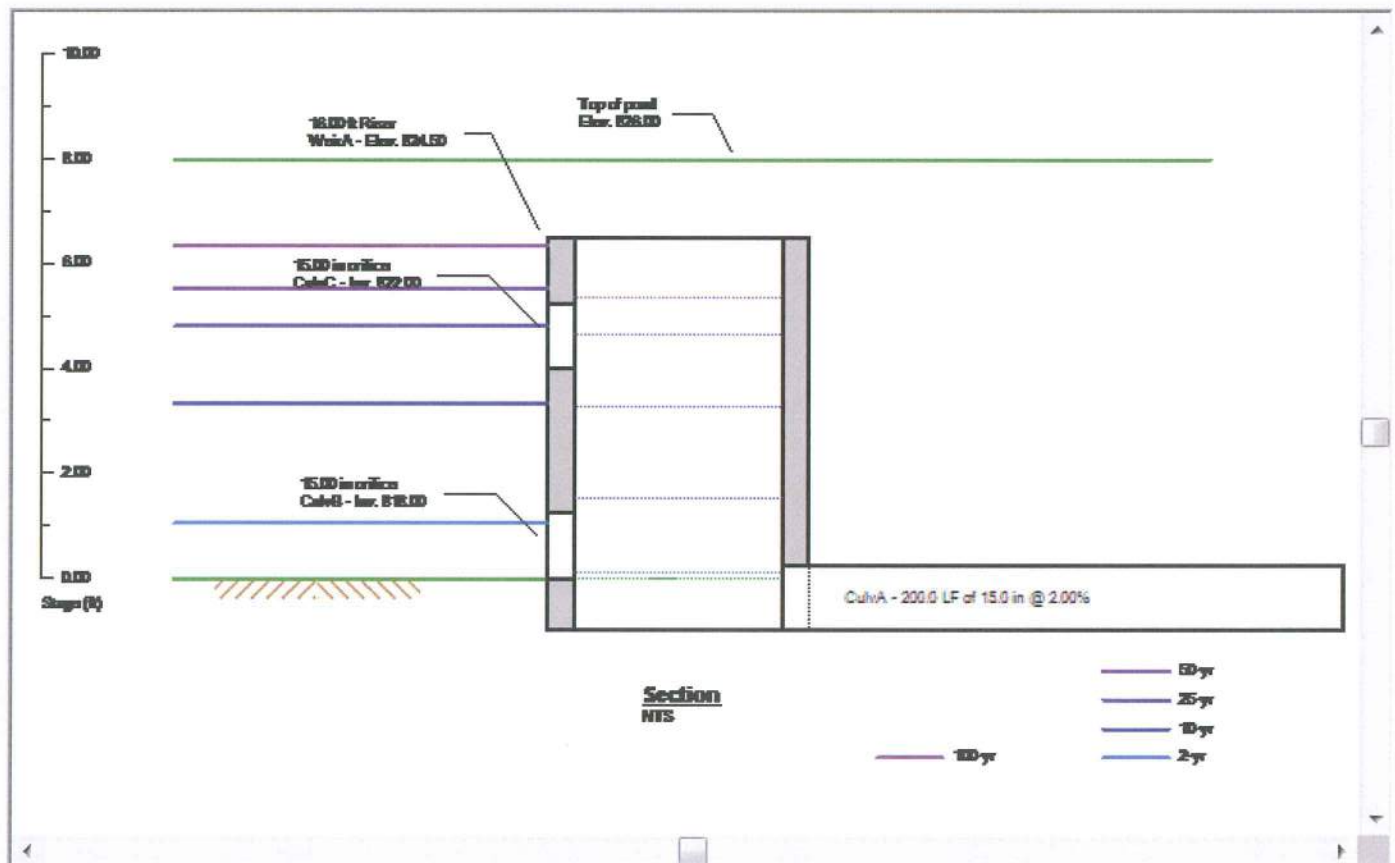
## Hyd. No. 22

A1a thru 35Hwy Pond

Hydrograph type	= Reservoir	Peak discharge	= 16.87 cfs
Storm frequency	= 100 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 66,317 cuft
Inflow hyd. No.	= 18 - Area A1a	Max. Elevation	= 824.96 ft
Reservoir name	= 35 Hwy Pond	Max. Storage	= 8,091 cuft

Storage Indication method used.





North B - (North Pond along I-35 Highway)

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

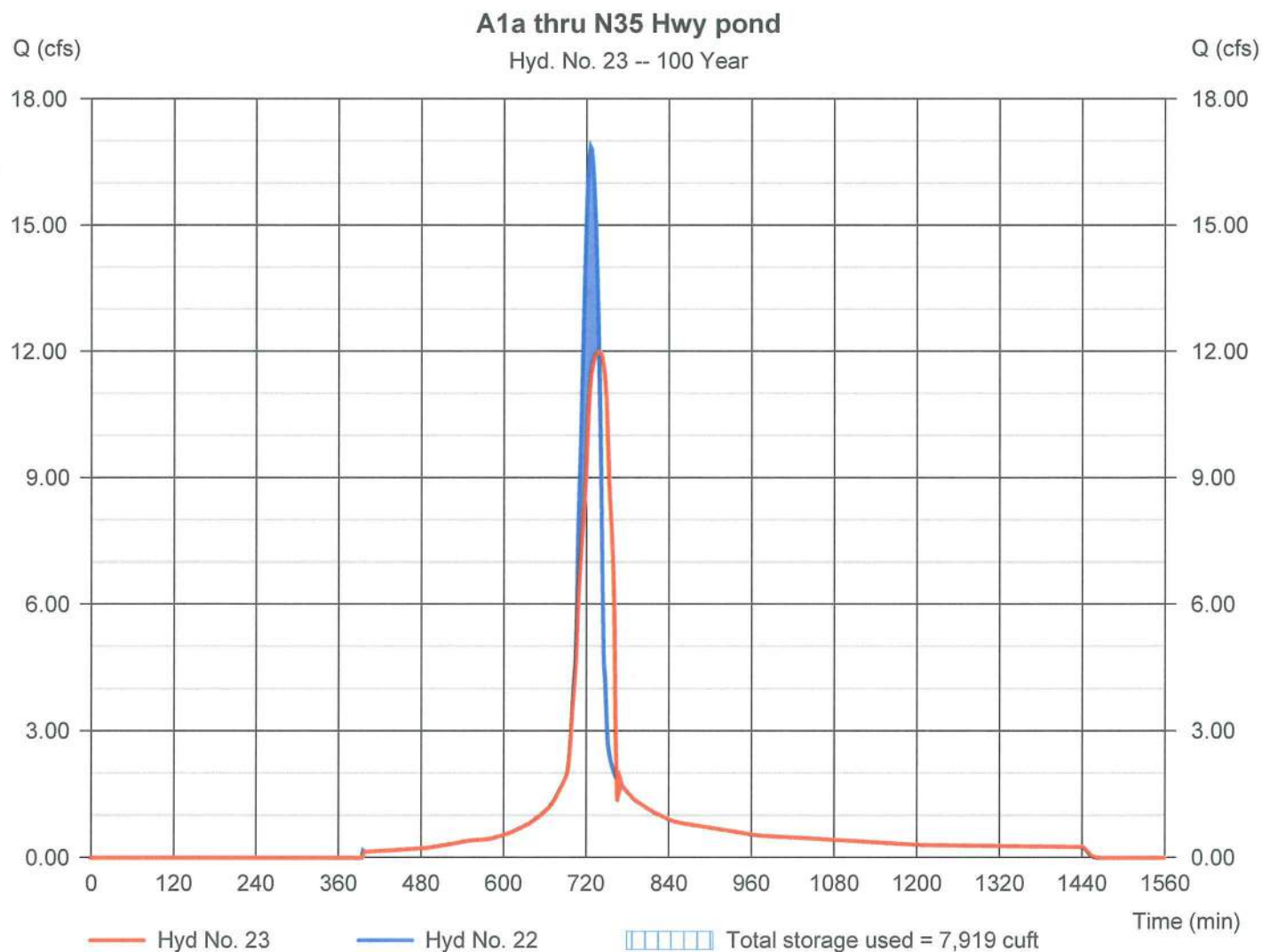
Sunday, Dec 9, 2012

## Hyd. No. 23

A1a thru N35 Hwy pond

Hydrograph type	= Reservoir	Peak discharge	= 12.00 cfs
Storm frequency	= 100 yrs	Time to peak	= 738 min
Time interval	= 2 min	Hyd. volume	= 66,317 cuft
Inflow hyd. No.	= 22 - A1a thru 35Hwy Pond	Max. Elevation	= 824.36 ft
Reservoir name	= Hwy 35 Pond North	Max. Storage	= 7,919 cuft

Storage Indication method used.



# Pond Report

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Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Sunday, Dec 9, 2012

## Pond No. 1 - Hwy 35 Pond North

### Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 818.00 ft

### Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	818.00	00	0	0
1.00	819.00	300	100	100
2.00	820.00	696	484	584
3.00	821.00	1,072	877	1,461
4.00	822.00	1,524	1,291	2,753
5.00	823.00	2,053	1,782	4,534
6.00	824.00	2,657	2,348	6,883
7.00	825.00	3,338	2,991	9,873
8.00	826.00	4,900	4,094	13,967

### Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 15.00	15.00	15.00	0.00
Span (in)	= 15.00	15.00	15.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 817.00	818.00	822.00	0.00
Length (ft)	= 200.00	5.00	5.00	0.00
Slope (%)	= 2.00	2.00	2.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	Yes	No

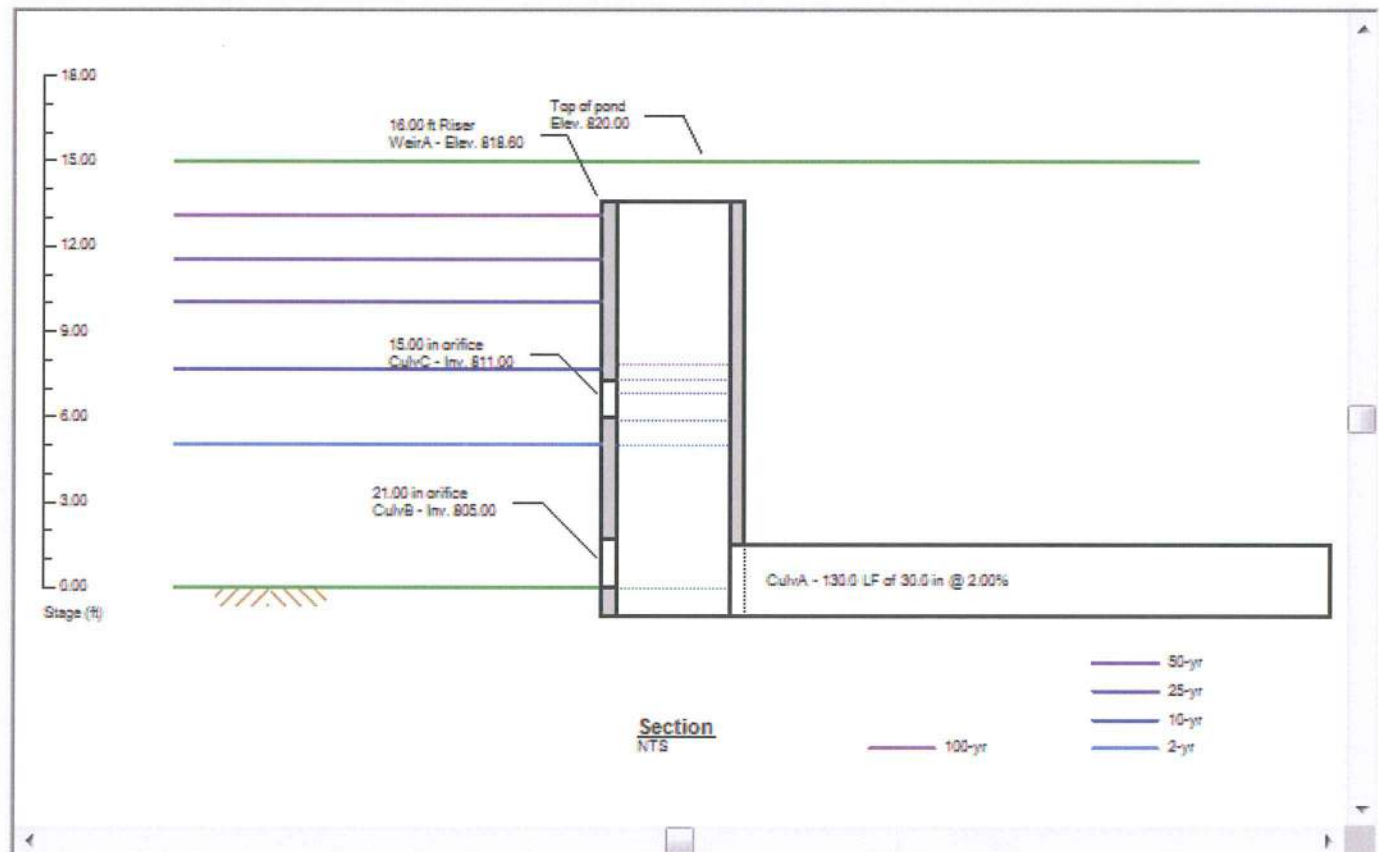
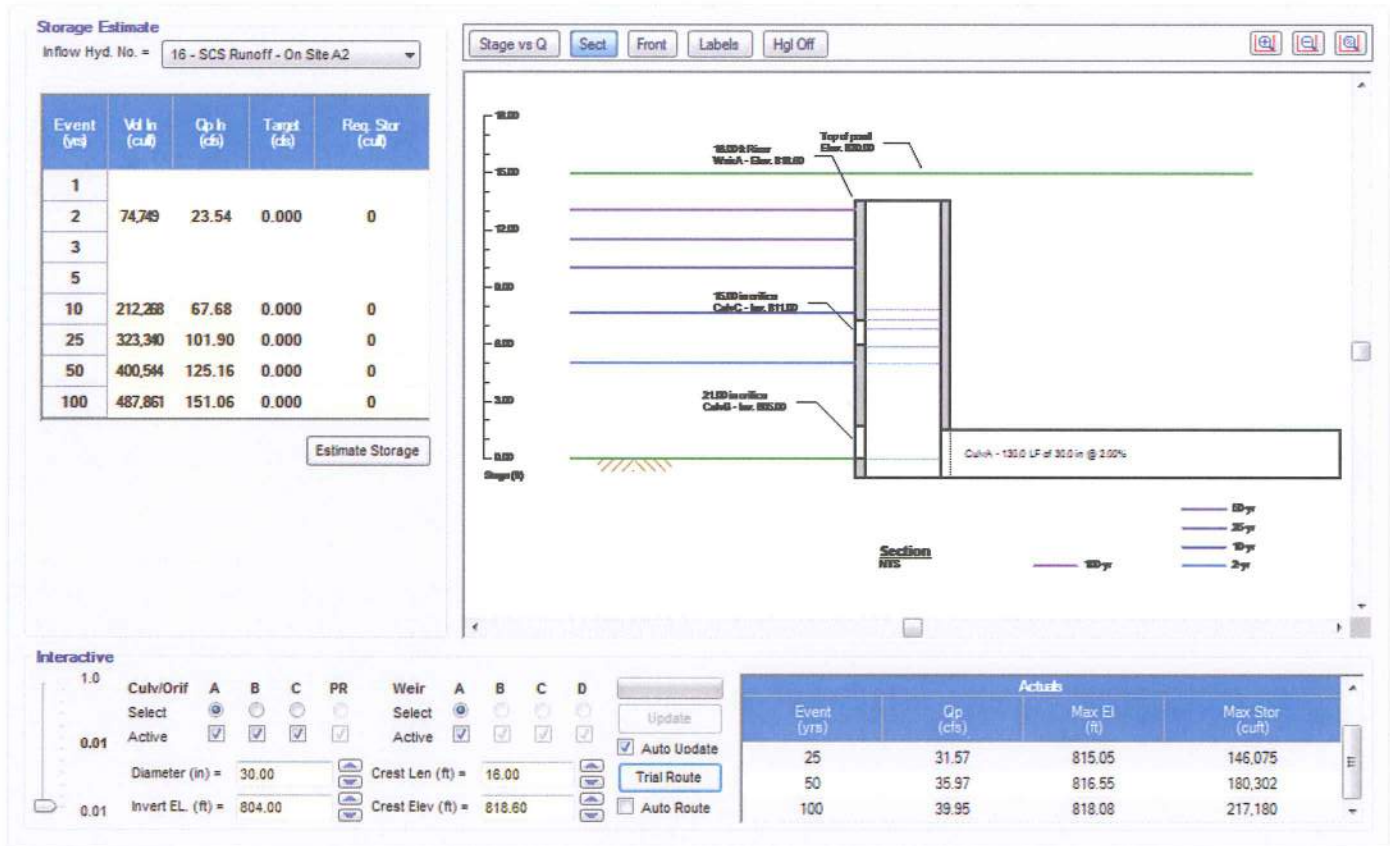
### Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 16.00	0.00	0.00	0.00
Crest El. (ft)	= 824.50	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No
Exfil.(in/hr)	= 0.000 (by Contour)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	818.00	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
1.00	100	819.00	3.58 ic	3.58 ic	0.00	---	0.00	---	---	---	---	---	3.584
2.00	584	820.00	6.44 ic	6.44 ic	0.00	---	0.00	---	---	---	---	---	6.438
3.00	1,461	821.00	7.67 ic	7.67 ic	0.00	---	0.00	---	---	---	---	---	7.675
4.00	2,753	822.00	8.74 ic	8.74 ic	0.00	---	0.00	---	---	---	---	---	8.738
5.00	4,534	823.00	10.75 oc	7.17 ic	3.58 ic	---	0.00	---	---	---	---	---	10.75
6.00	6,883	824.00	11.79 oc	5.90 ic	5.90 ic	---	0.00	---	---	---	---	---	11.79
7.00	9,873	825.00	13.03 oc	1.52 ic	1.52 ic	---	9.98 s	---	---	---	---	---	13.02
8.00	13,967	826.00	13.66 oc	0.42 ic	0.42 ic	---	12.78 s	---	---	---	---	---	13.62



Pond C - (Grocery Store Pond)

# Pond Report

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Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Sunday, Dec 9, 2012

## Pond No. 2 - Grocery Detention

### Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Beginning Elevation = 805.00 ft

### Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	805.00	00	0	0
1.00	806.00	2,428	809	809
2.00	807.00	7,480	4,723	5,532
3.00	808.00	13,914	10,531	16,063
4.00	809.00	16,161	15,022	31,085
5.00	810.00	17,091	16,622	47,707
6.00	811.00	18,032	17,558	65,265
7.00	812.00	18,984	18,504	83,769
8.00	813.00	19,946	19,461	103,230
9.00	814.00	20,919	20,429	123,658
10.00	815.00	21,903	21,407	145,065
11.00	816.00	22,898	22,397	167,462
12.00	817.00	23,903	23,396	190,858
13.00	818.00	24,919	24,407	215,265
14.00	819.00	25,946	25,428	240,693
15.00	820.00	26,983	26,460	267,153

### Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 30.00	21.00	15.00	0.00
Span (in)	= 30.00	21.00	15.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 804.00	805.00	811.00	0.00
Length (ft)	= 130.00	1.00	1.00	0.00
Slope (%)	= 2.00	1.00	1.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	Yes	No

### Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 16.00	0.00	0.00	0.00
Crest El. (ft)	= 818.60	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Rect	---	---
Multi-Stage	= Yes	No	No	No
Exfil.(in/hr)	= 0.000 (by Contour)			
TW Elev. (ft)	= 810.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	805.00	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
1.00	809	806.00	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
2.00	5,532	807.00	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
3.00	16,063	808.00	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
4.00	31,085	809.00	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
5.00	47,707	810.00	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
6.00	65,265	811.00	10.40 ic	10.40 ic	0.00	---	0.00	---	---	---	---	---	10.40
7.00	83,769	812.00	17.53 ic	13.94 ic	3.58 ic	---	0.00	---	---	---	---	---	17.53
8.00	103,230	813.00	23.39 ic	16.46 ic	6.93 ic	---	0.00	---	---	---	---	---	23.39
9.00	123,658	814.00	27.83 ic	18.72 ic	9.11 ic	---	0.00	---	---	---	---	---	27.83
10.00	145,065	815.00	31.43 ic	20.81 ic	10.62 ic	---	0.00	---	---	---	---	---	31.43
11.00	167,462	816.00	34.43 ic	22.80 ic	11.63 ic	---	0.00	---	---	---	---	---	34.43
12.00	190,858	817.00	37.19 ic	24.63 ic	12.57 ic	---	0.00	---	---	---	---	---	37.19
13.00	215,265	818.00	39.76 ic	26.33 ic	13.43 ic	---	0.00	---	---	---	---	---	39.76
14.00	240,693	819.00	50.39 ic	24.44 ic	12.47 ic	---	13.48	---	---	---	---	---	50.39
15.00	267,153	820.00	73.20 ic	7.37 ic	3.76 ic	---	62.07 s	---	---	---	---	---	73.20



# Hydrograph Report

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Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

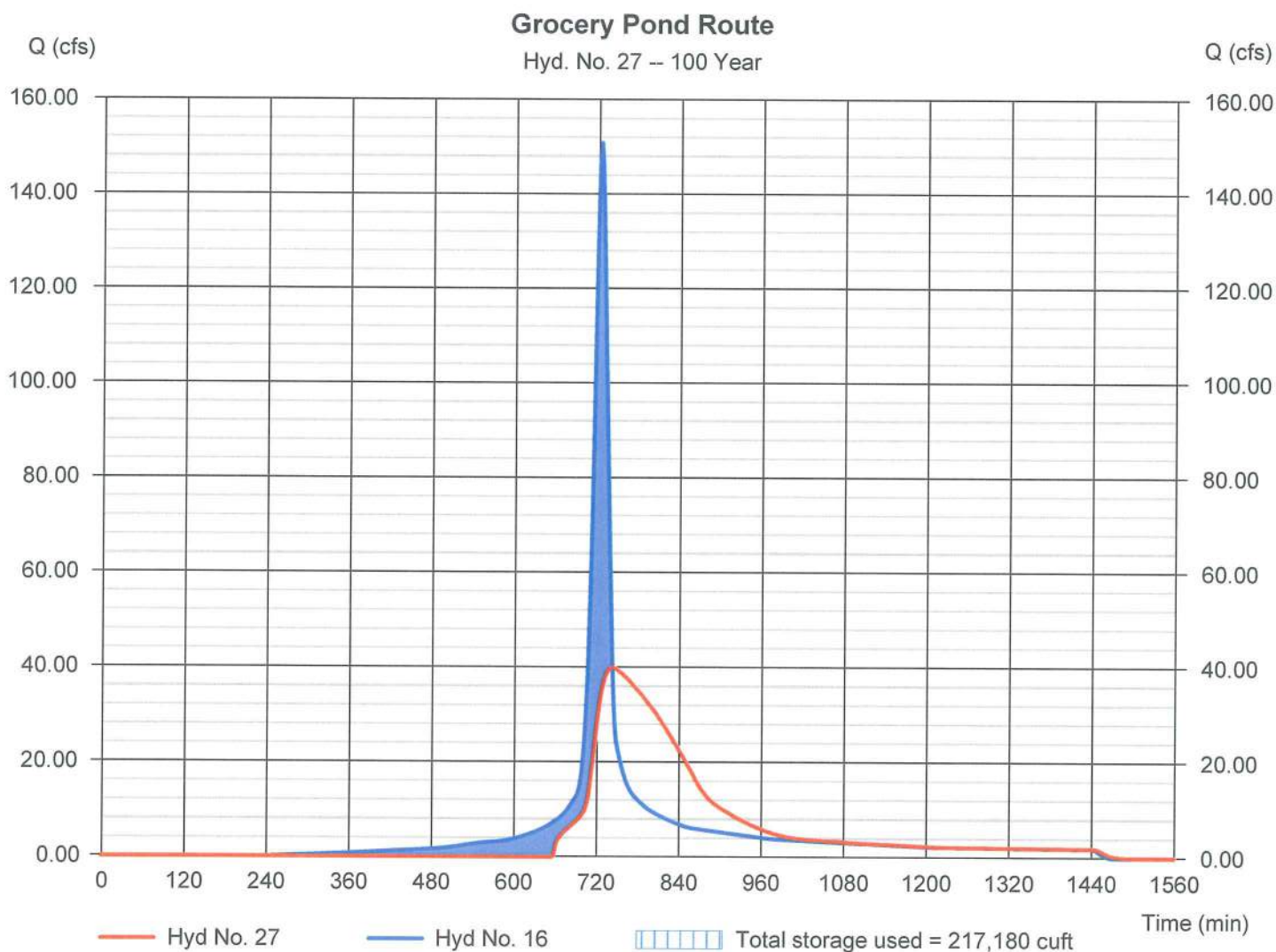
Sunday, Dec 9, 2012

## Hyd. No. 27

### Grocery Pond Route

Hydrograph type	= Reservoir	Peak discharge	= 39.95 cfs
Storm frequency	= 100 yrs	Time to peak	= 742 min
Time interval	= 2 min	Hyd. volume	= 440,154 cuft
Inflow hyd. No.	= 16 - On Site A2	Max. Elevation	= 818.08 ft
Reservoir name	= Grocery Detention	Max. Storage	= 217,180 cuft

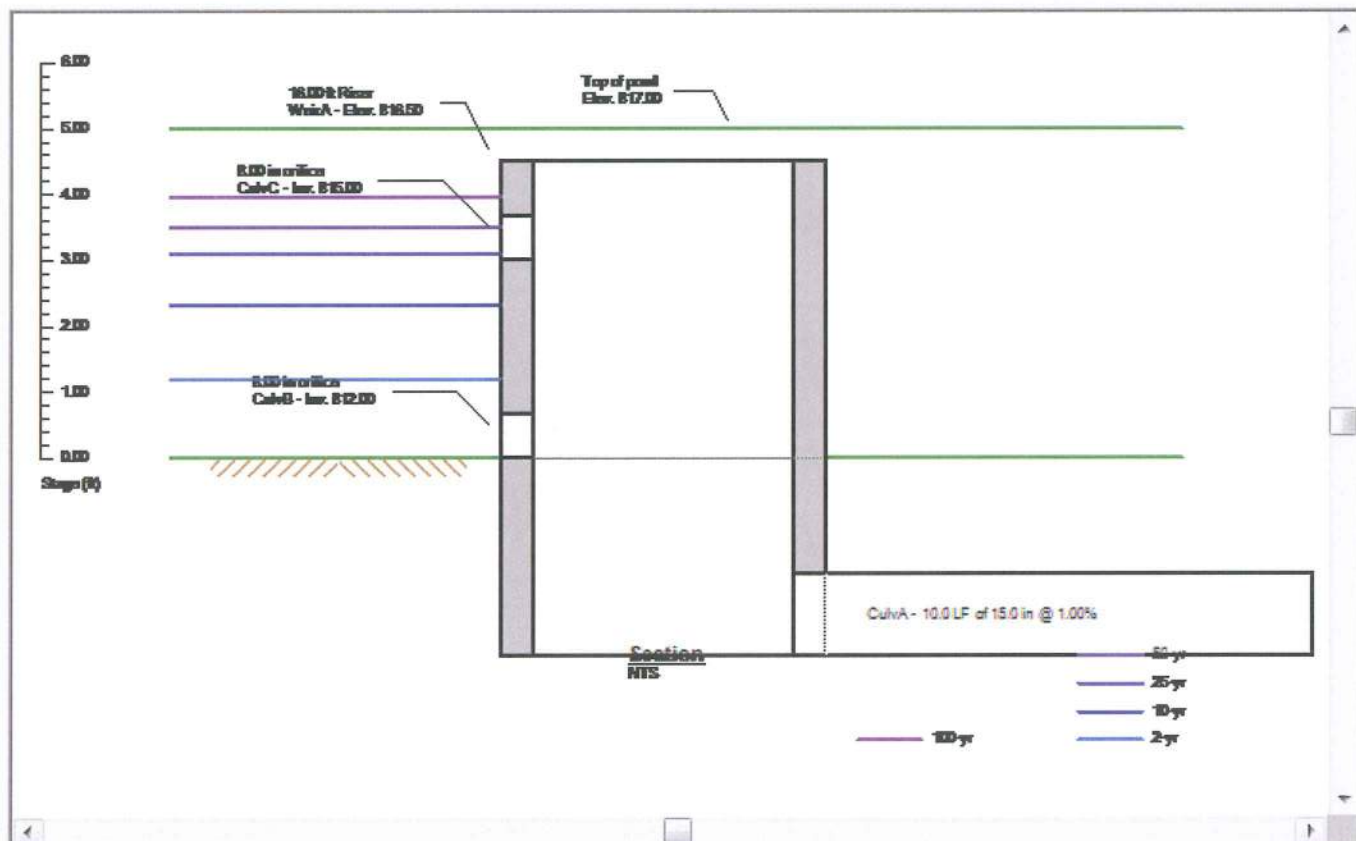
Storage Indication method used.



## Inflow Hyd. No. = 20 - SCS Runoff - Area A3a Conv. SI ▼

Estimate Storage

Actuals			
Event (yrs)	Qp (cfs)	Max El (ft)	Max Stor (cuft)
25	2,821	815.09	11,783
50	3,685	815.51	14,438
100	4,528	815.96	17,319



### Pond D - (C-Store Pond)



# Pond Report

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Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Sunday, Dec 9, 2012

## Pond No. 5 - C Store

### Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Beginning Elevation = 812.00 ft

### Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	812.00	451	0	0
1.00	813.00	3,670	1,802	1,802
2.00	814.00	4,705	4,176	5,979
3.00	815.00	5,797	5,241	11,220
4.00	816.00	6,945	6,362	17,581
5.00	817.00	8,134	7,531	25,112

### Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 15.00	8.00	8.00	0.00
Span (in)	= 15.00	8.00	8.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 809.00	812.00	815.00	0.00
Length (ft)	= 10.00	5.00	5.00	0.00
Slope (%)	= 1.00	1.00	1.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	Yes	No

### Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 16.00	0.00	0.00	0.00
Crest El. (ft)	= 816.50	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No
Exfil.(in/hr)	= 0.000 (by Wet area)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Civ A cfs	Civ B cfs	Civ C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	812.00	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
1.00	1,802	813.00	9.11 ic	1.37 ic	0.00	---	0.00	---	---	---	---	---	1.372
2.00	5,979	814.00	9.11 ic	2.17 ic	0.00	---	0.00	---	---	---	---	---	2.170
3.00	11,220	815.00	9.11 ic	2.74 ic	0.00	---	0.00	---	---	---	---	---	2.744
4.00	17,581	816.00	9.11 ic	3.22 ic	1.37 ic	---	0.00	---	---	---	---	---	4.590
5.00	25,112	817.00	15.84 ic	0.72 ic	0.72 ic	---	14.40 s	---	---	---	---	---	15.84

# Hydrograph Report

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Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

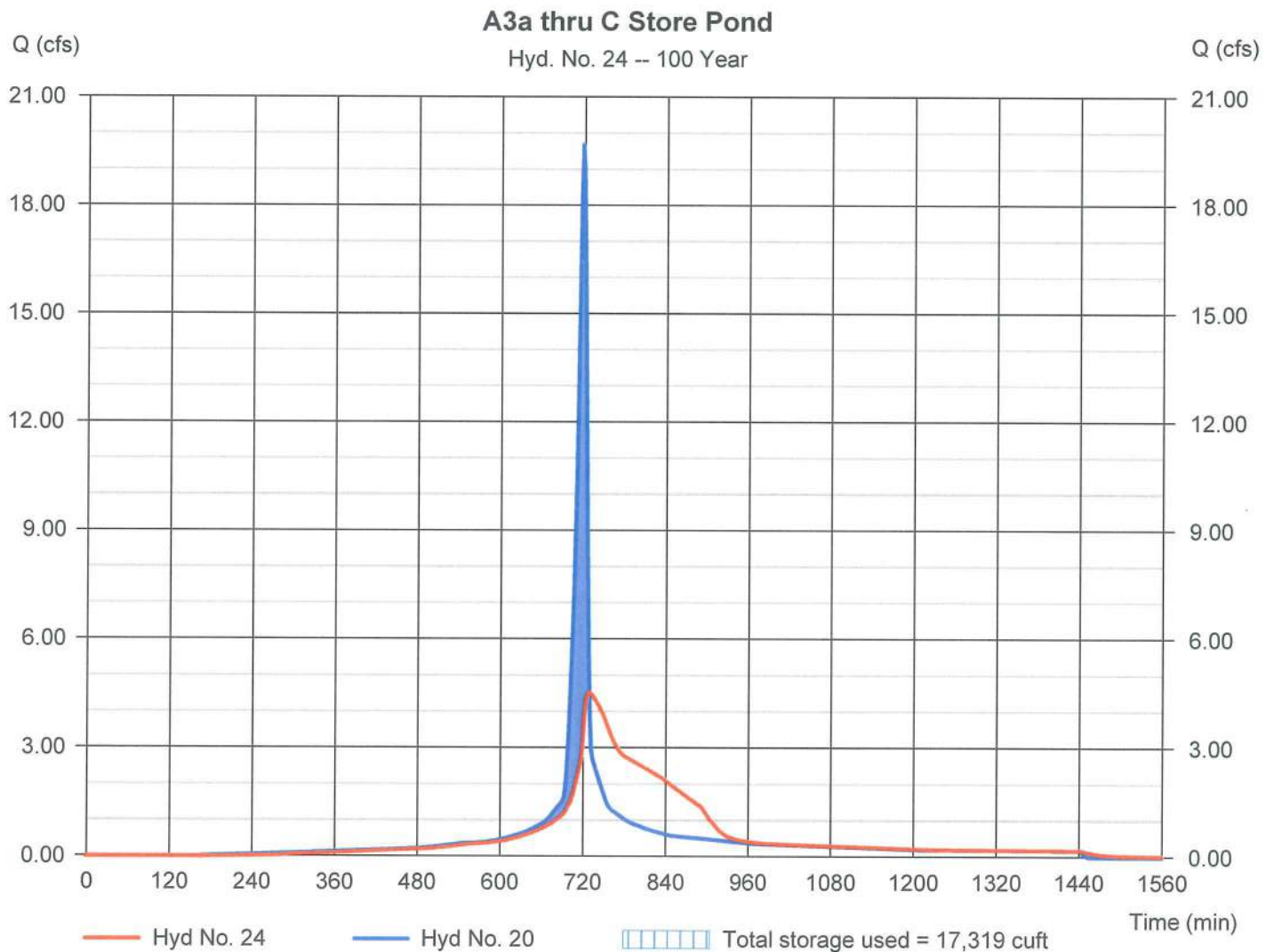
Sunday, Dec 9, 2012

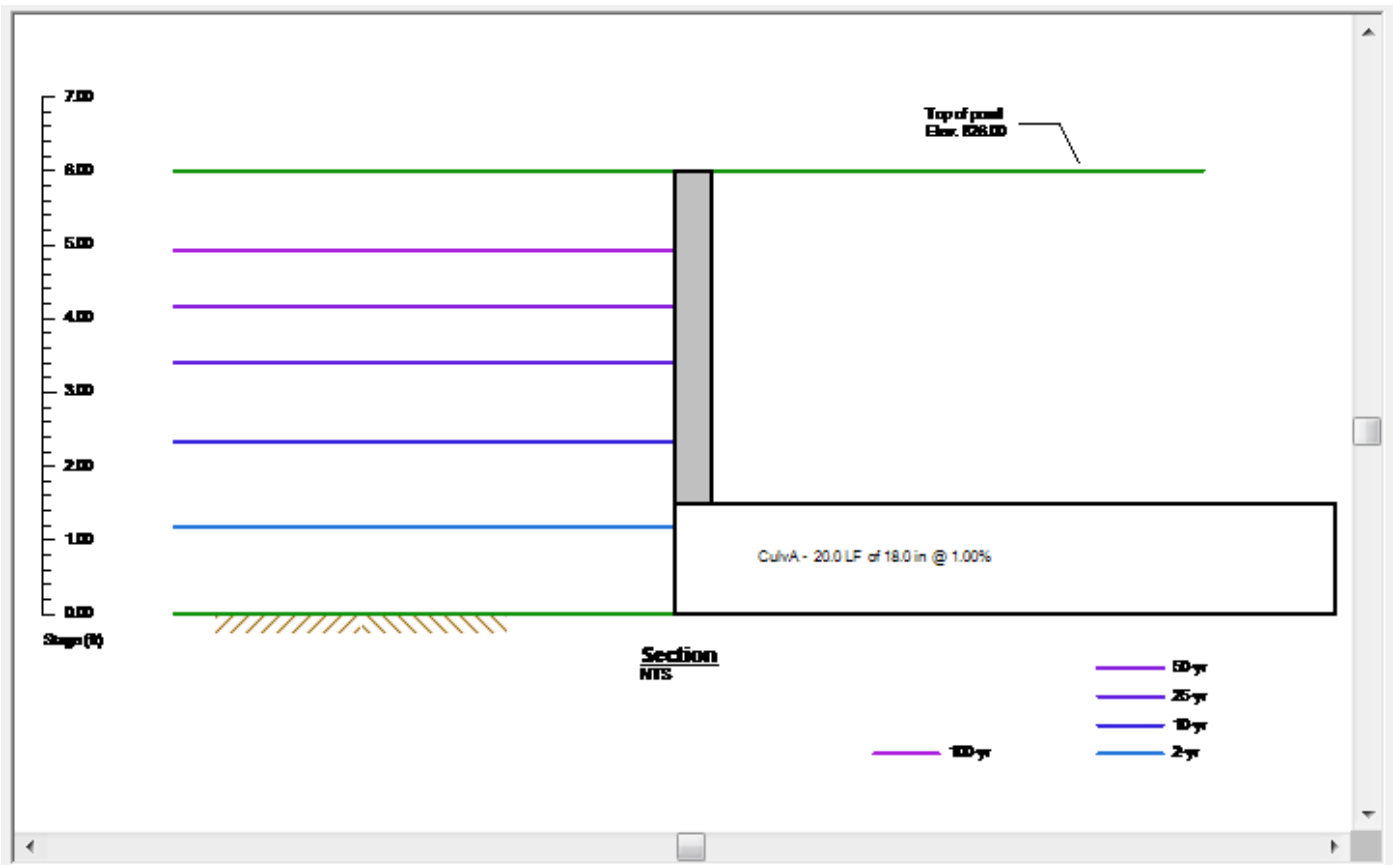
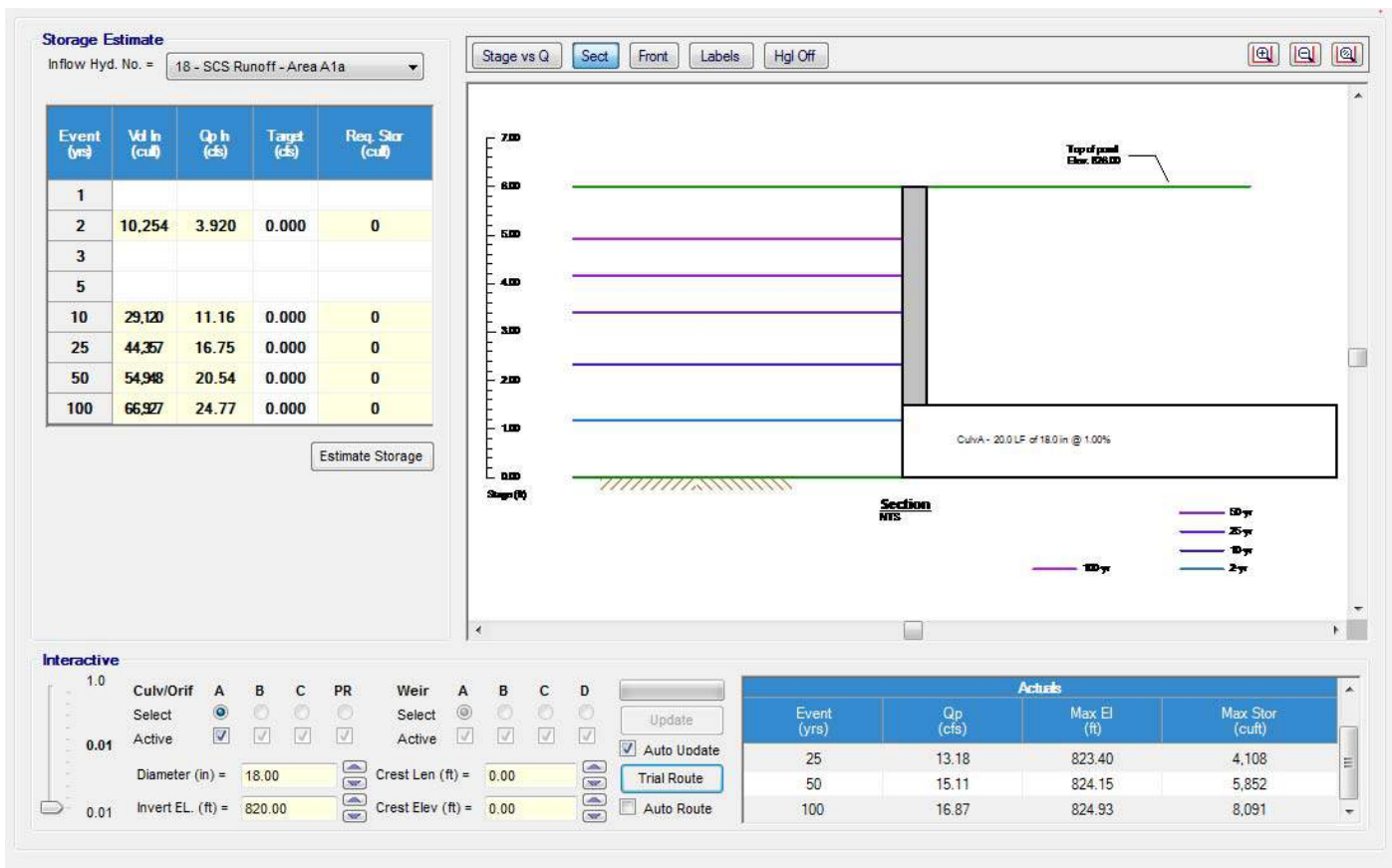
## Hyd. No. 24

A3a thru C Store Pond

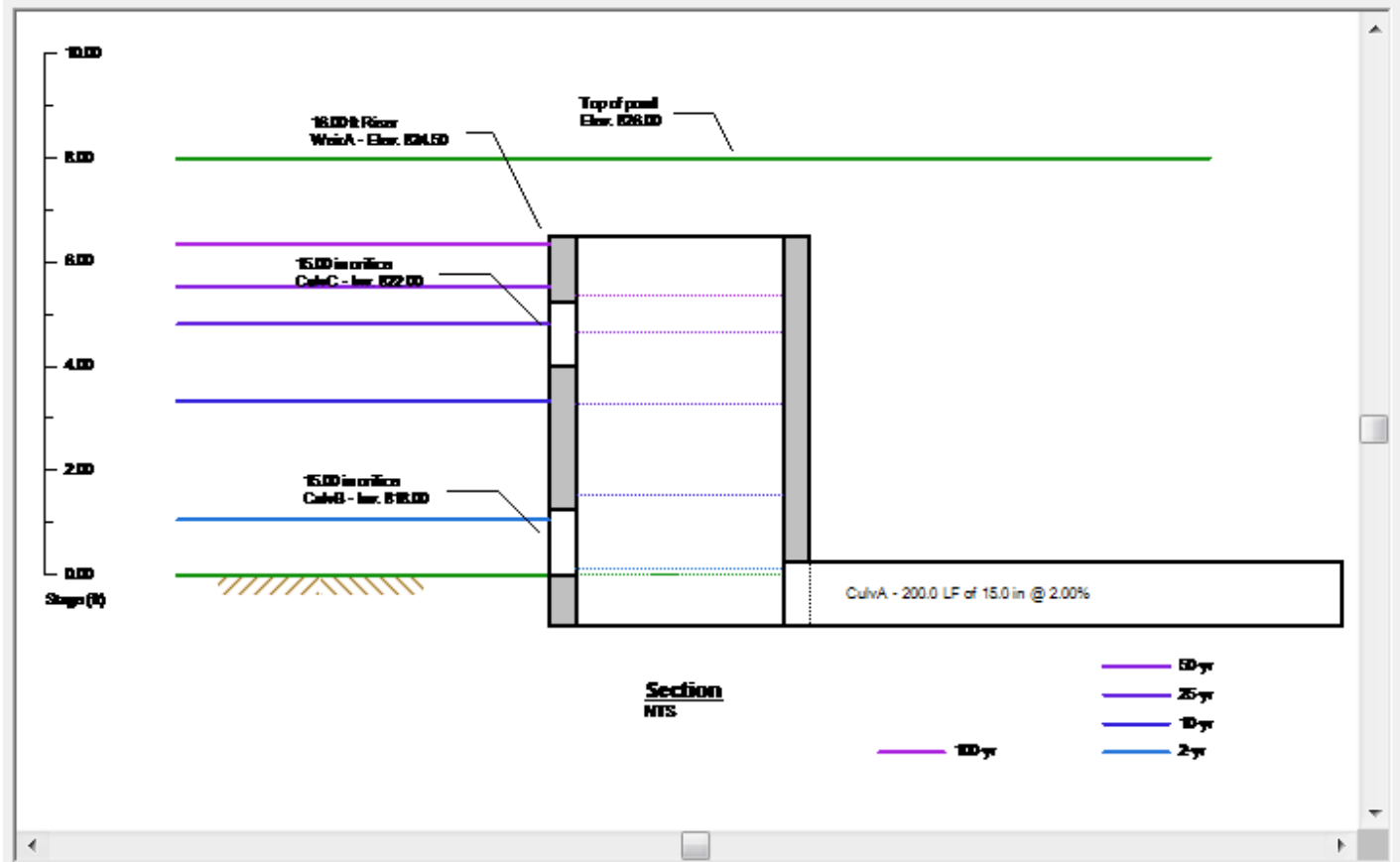
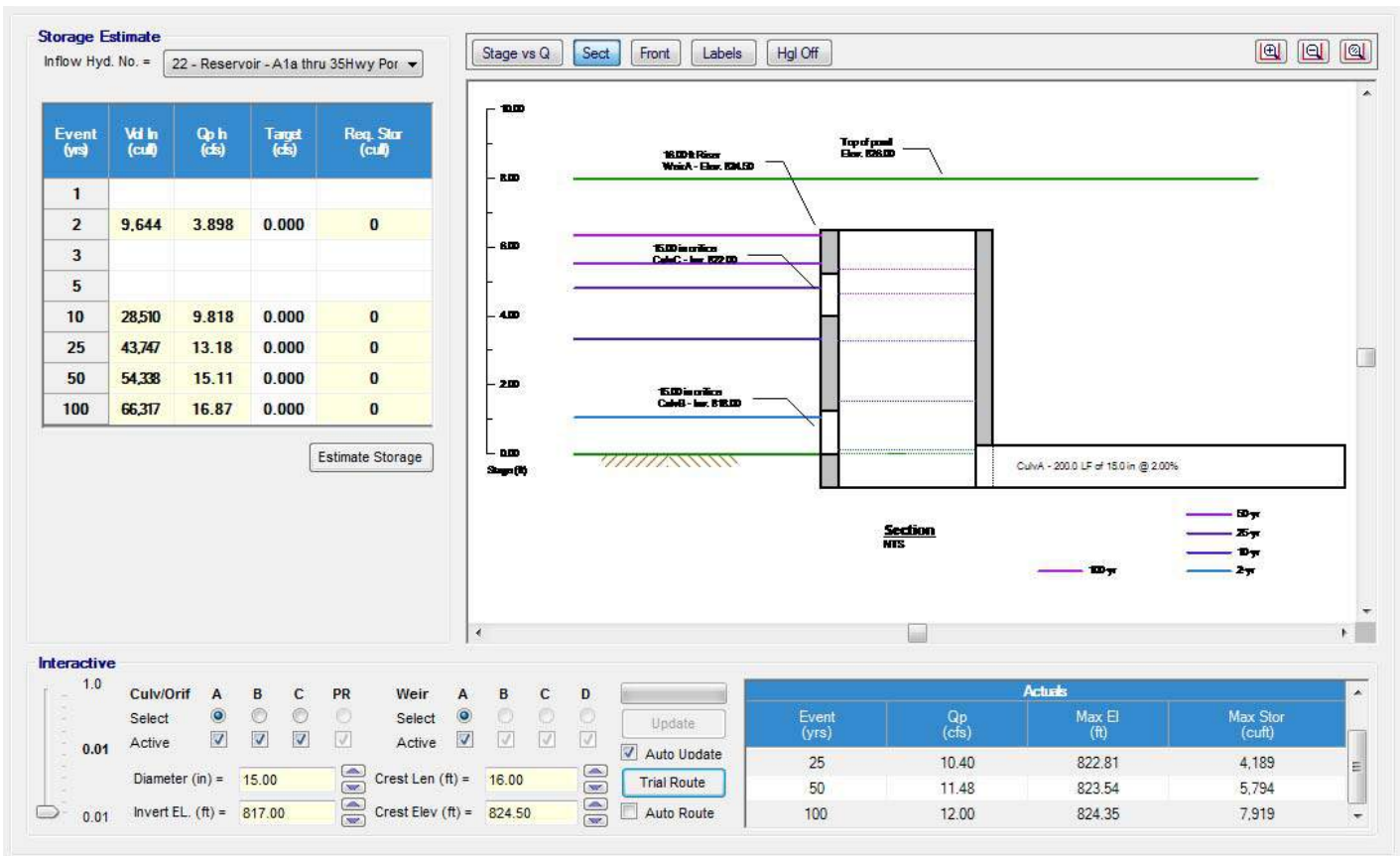
Hydrograph type	= Reservoir	Peak discharge	= 4.528 cfs
Storm frequency	= 100 yrs	Time to peak	= 730 min
Time interval	= 2 min	Hyd. volume	= 49,046 cuft
Inflow hyd. No.	= 20 - Area A3a Conv. Store	Max. Elevation	= 815.96 ft
Reservoir name	= C Store	Max. Storage	= 17,319 cuft

Storage Indication method used.

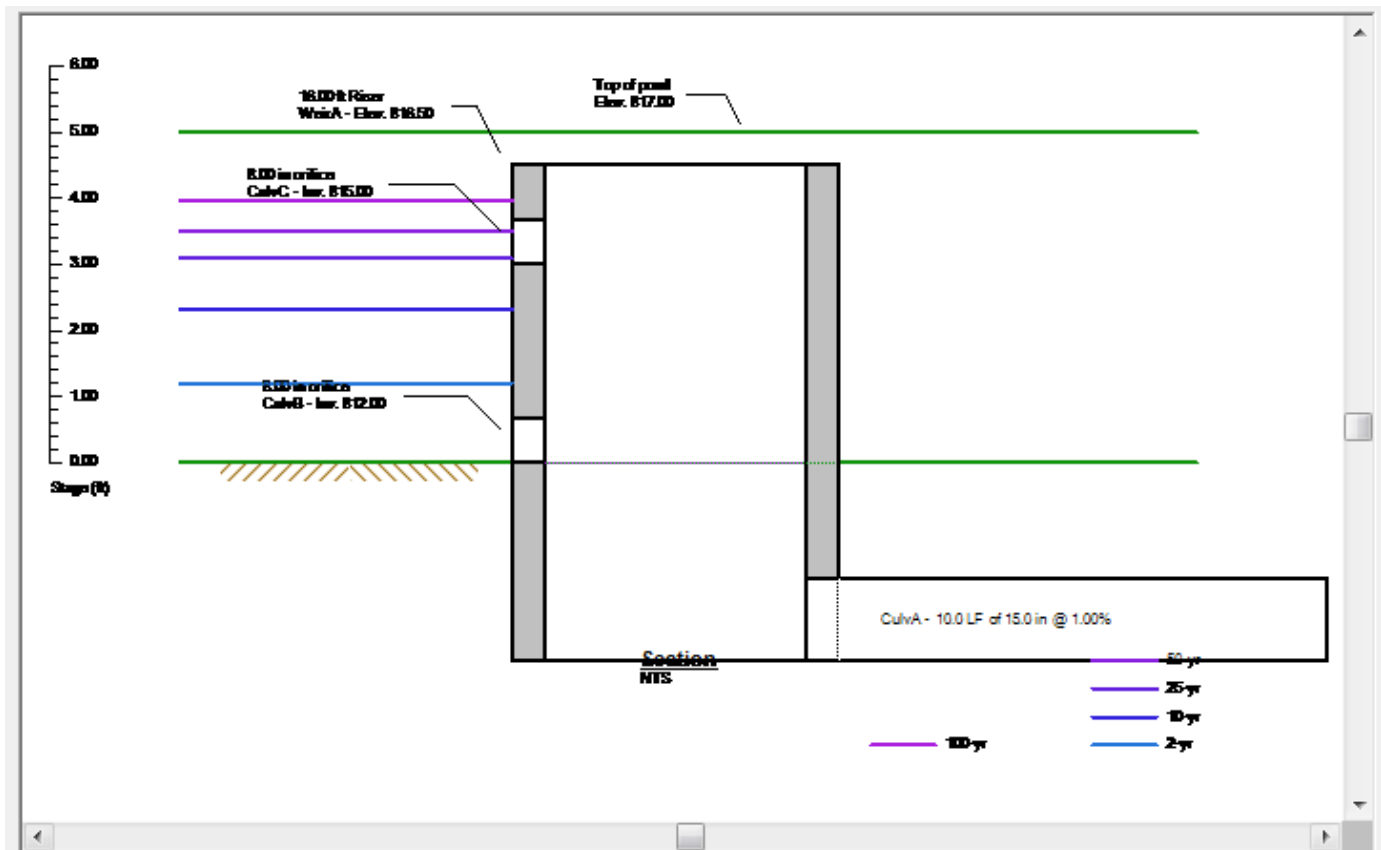
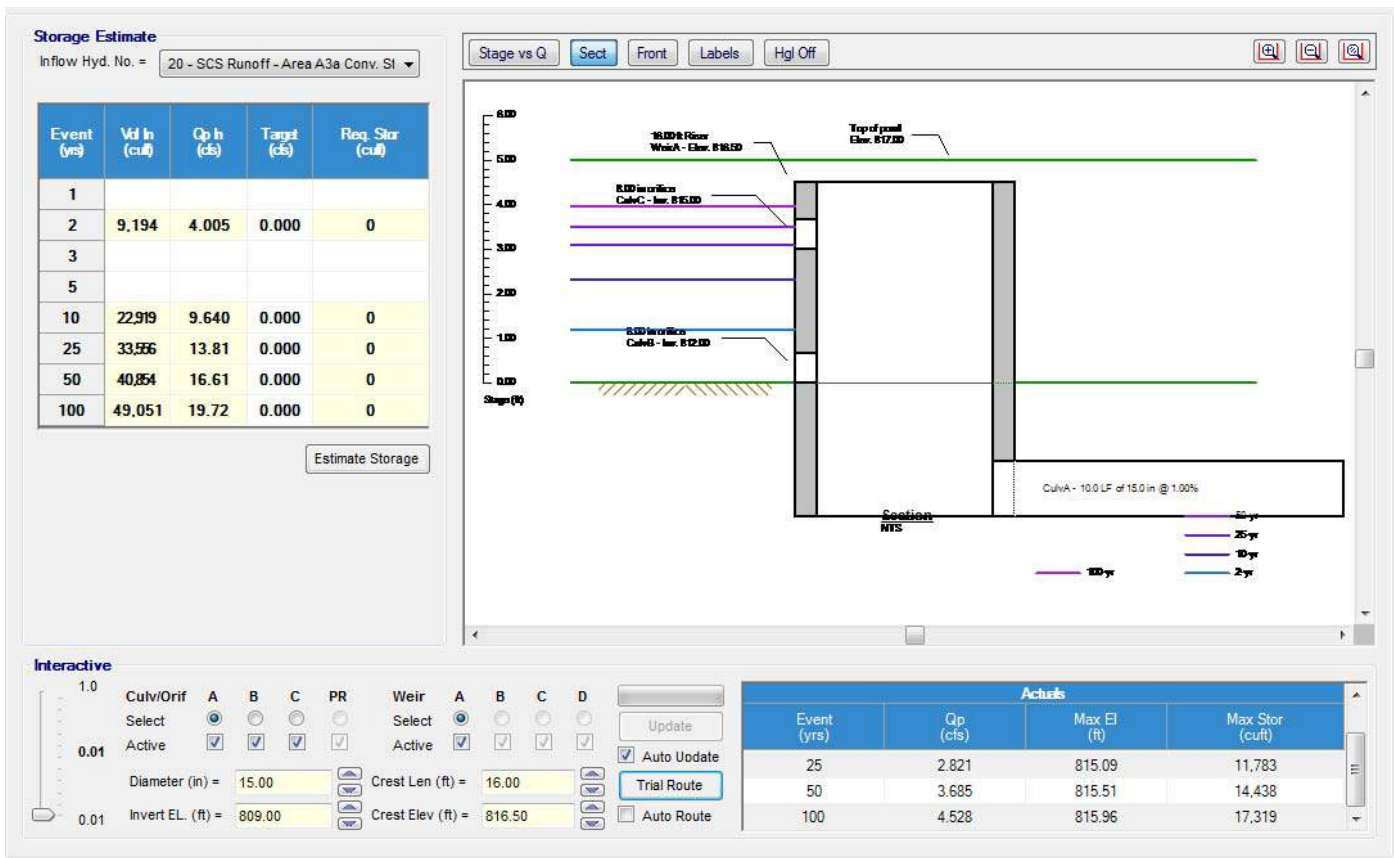




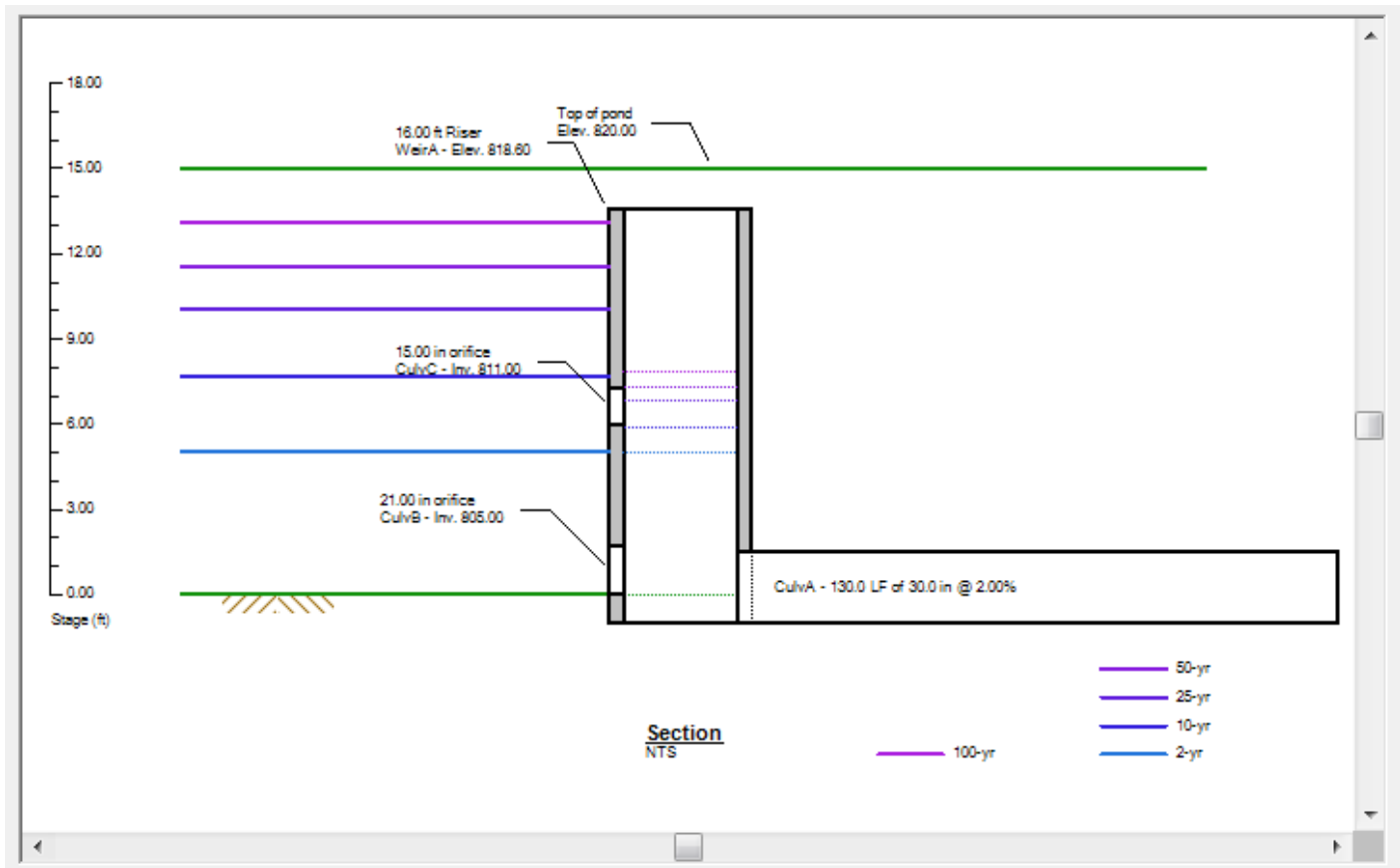
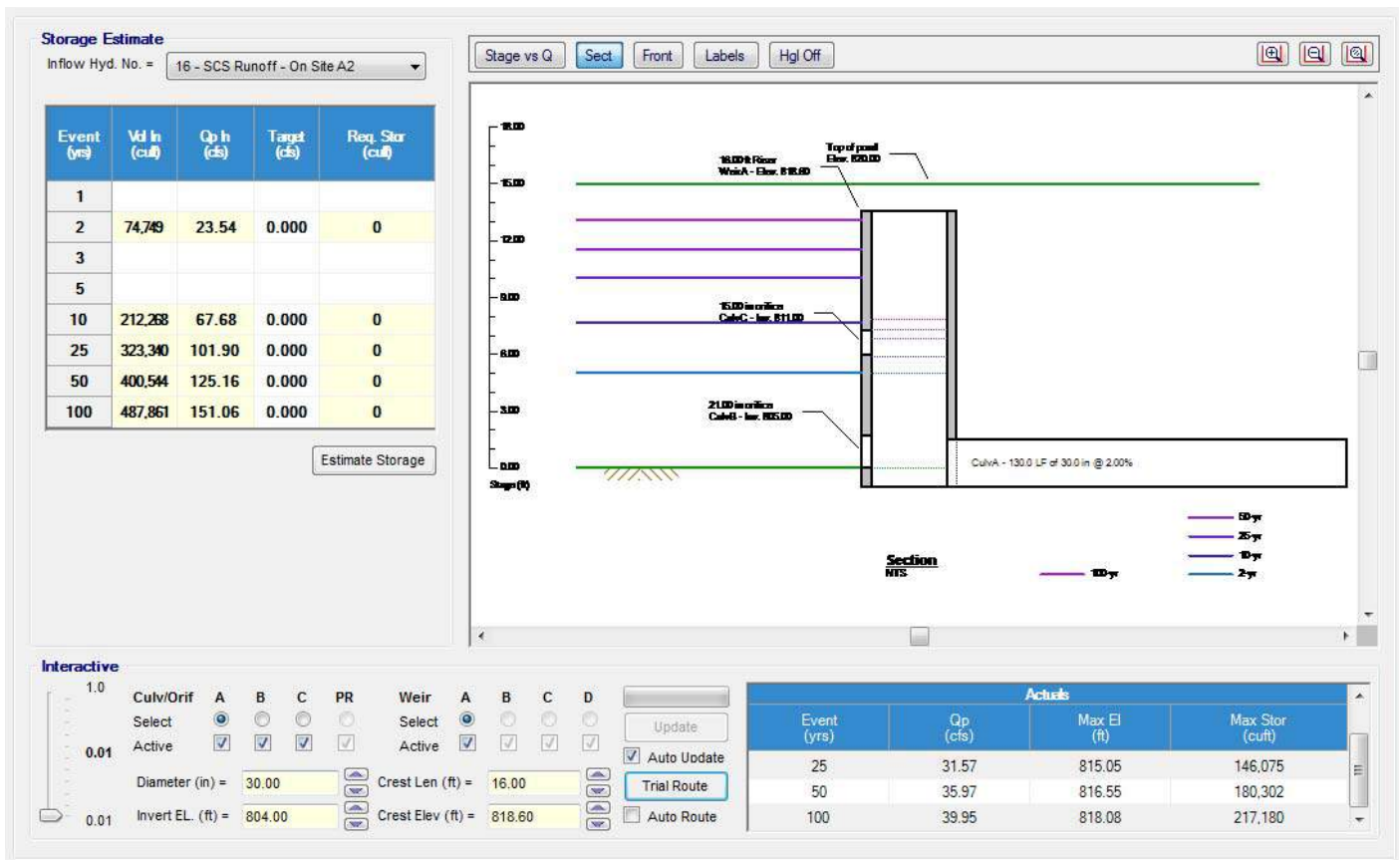
Pond A - (South Pond along I-35 Highway)



North B - (North Pond along I-35 Highway)



Pond D - (C-Store Pond)



Pond C - (Grocery Store Pond)

## Large Culvert Sizing





# Culvert Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc.

Thursday, Dec 6 2012

## Downstream Leg 12' x 8'

Invert Elev Dn (ft) = 794.00  
Pipe Length (ft) = 30.00  
Slope (%) = 0.67  
Invert Elev Up (ft) = 794.20  
Rise (in) = 96.0  
Shape = Box  
Span (in) = 144.0  
No. Barrels = 1  
n-Value = 0.012  
Inlet Edge = 0  
Coeff. K,M,c,Y,k = 0.498, 0.667, 0.0327, 0.75, 0.2

### Embankment

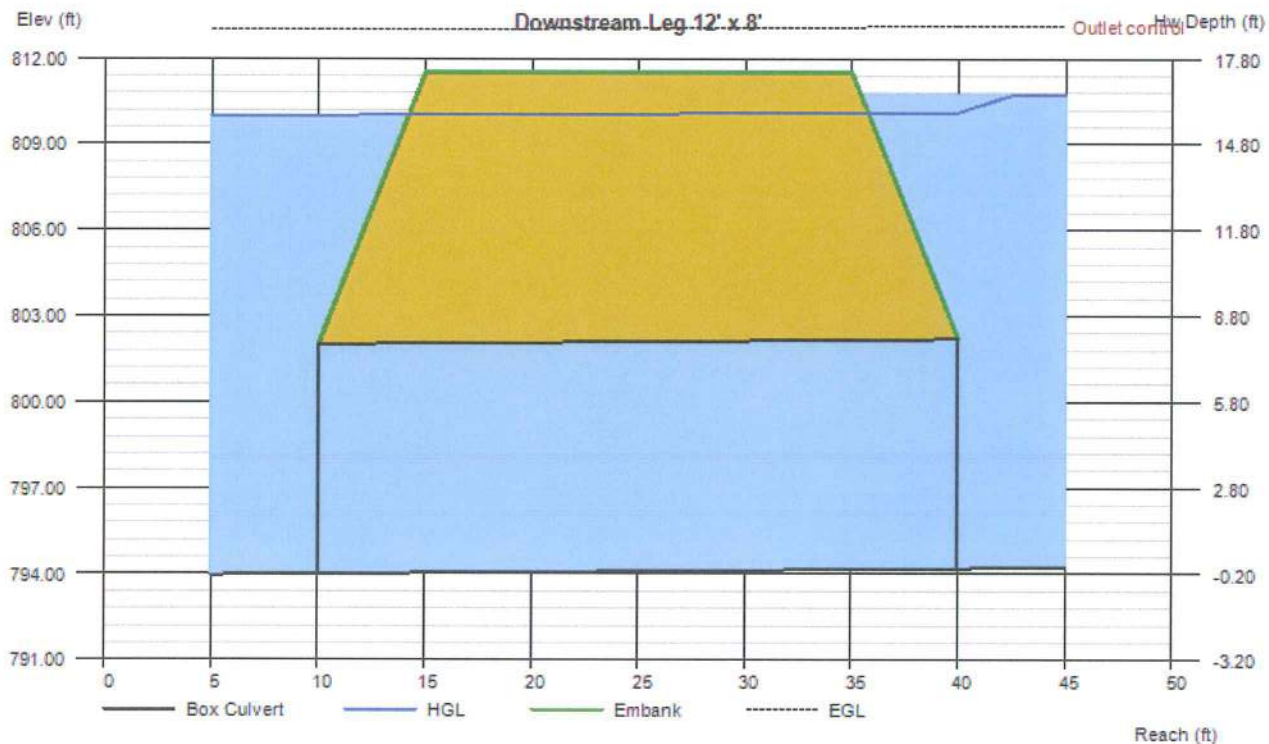
Top Elevation (ft) = 811.50  
Top Width (ft) = 20.00  
Crest Width (ft) = 100.00

### Calculations

Qmin (cfs) = 1334.00  
Qmax (cfs) = 1553.00  
Tailwater Elev (ft) = 810

### Highlighted

Qtotal (cfs) = 1334.00  
Qpipe (cfs) = 1334.00  
Qovertop (cfs) = 0.00  
Veloc Dn (ft/s) = 13.90  
Veloc Up (ft/s) = 13.90  
HGL Dn (ft) = 810.00  
HGL Up (ft) = 810.12  
Hw Elev (ft) = 810.72  
Hw/D (ft) = 2.06  
Flow Regime = Outlet Control



Q			Veloc		Depth		HGL			
Total	Pipe	Over	Dn	Up	Dn	Up	Dn	Up	Hw	Hw/D
(cfs)	(cfs)	(cfs)	(ft/s)	(ft/s)	(in)	(in)	(ft)	(ft)	(ft)	
1334.00	1334.00	0.00	13.90	13.90	96.00	96.00	810.00	810.12	810.72	2.06
1384.00	1384.00	0.00	14.42	14.42	96.00	96.00	810.00	810.13	810.77	2.07
1434.00	1434.00	0.00	14.94	14.94	96.00	96.00	810.00	810.14	810.83	2.08
1484.00	1484.00	0.00	15.46	15.46	96.00	96.00	810.00	810.15	810.89	2.09
1534.00	1534.00	0.00	15.98	15.98	96.00	96.00	810.00	810.16	810.95	2.09

# Culvert Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc.

Thursday, Dec 6 2012

## Downstream Portion of West Culvert 8' x 8'

Invert Elev Dn (ft)	= 794.60
Pipe Length (ft)	= 160.00
Slope (%)	= 5.03
Invert Elev Up (ft)	= 802.65
Rise (in)	= 96.0
Shape	= Box
Span (in)	= 96.0
No. Barrels	= 1
n-Value	= 0.012
Inlet Edge	= 0
Coeff. K,M,c,Y,k	= 0.021, 1.33, 0.0463, 0.75, 0.7

### Embankment

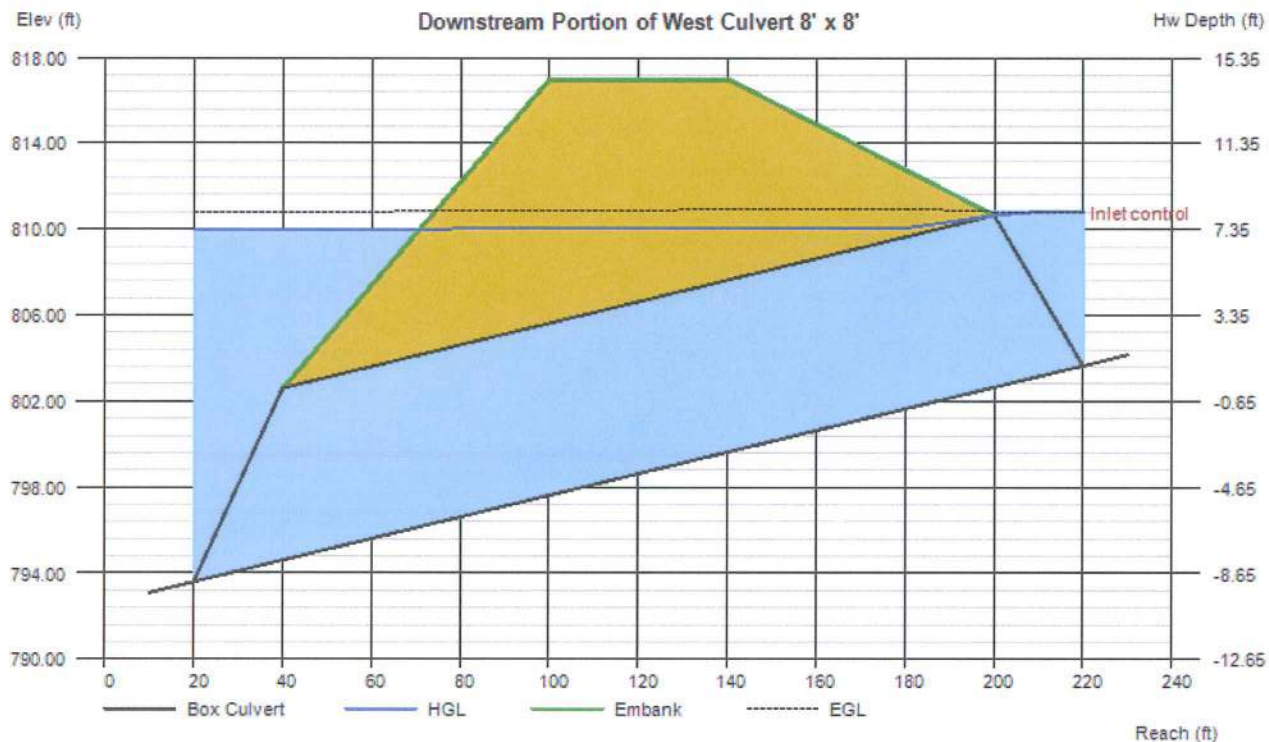
Top Elevation (ft)	= 817.00
Top Width (ft)	= 40.00
Crest Width (ft)	= 50.00

### Calculations

Qmin (cfs)	= 458.00
Qmax (cfs)	= 547.00
Tailwater Elev (ft)	= 810

### Highlighted

Qtotal (cfs)	= 458.00
Qpipe (cfs)	= 458.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 7.16
Veloc Up (ft/s)	= 7.73
HGL Dn (ft)	= 810.00
HGL Up (ft)	= 810.06
Hw Elev (ft)	= 810.82
Hw/D (ft)	= 1.02
Flow Regime	= Inlet Control



Q			Veloc		Depth		HGL			
Total	Pipe	Over	Dn	Up	Dn	Up	Dn	Up	Hw	Hw/D
(cfs)	(cfs)	(cfs)	(ft/s)	(ft/s)	(in)	(in)	(ft)	(ft)	(ft)	
458.00	458.00	0.00	7.16	7.73	96.00	88.93	810.00	810.06	810.82	1.02
508.00	508.00	0.00	7.94	8.55	96.00	89.17	810.00	810.08	811.37	1.09

# Culvert Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc.

Thursday, Dec 6 2012

## Upstream Portion of West Culvert 8' x 8'

Invert Elev Dn (ft) = 802.65  
 Pipe Length (ft) = 310.00  
 Slope (%) = 0.10  
 Invert Elev Up (ft) = 802.96  
 Rise (in) = 96.0  
 Shape = Box  
 Span (in) = 96.0  
 No. Barrels = 1  
 n-Value = 0.012  
 Inlet Edge = 0  
 Coeff. K,M,c,Y,k = 0.021, 1.33, 0.0463, 0.75, 0.7

### Embankment

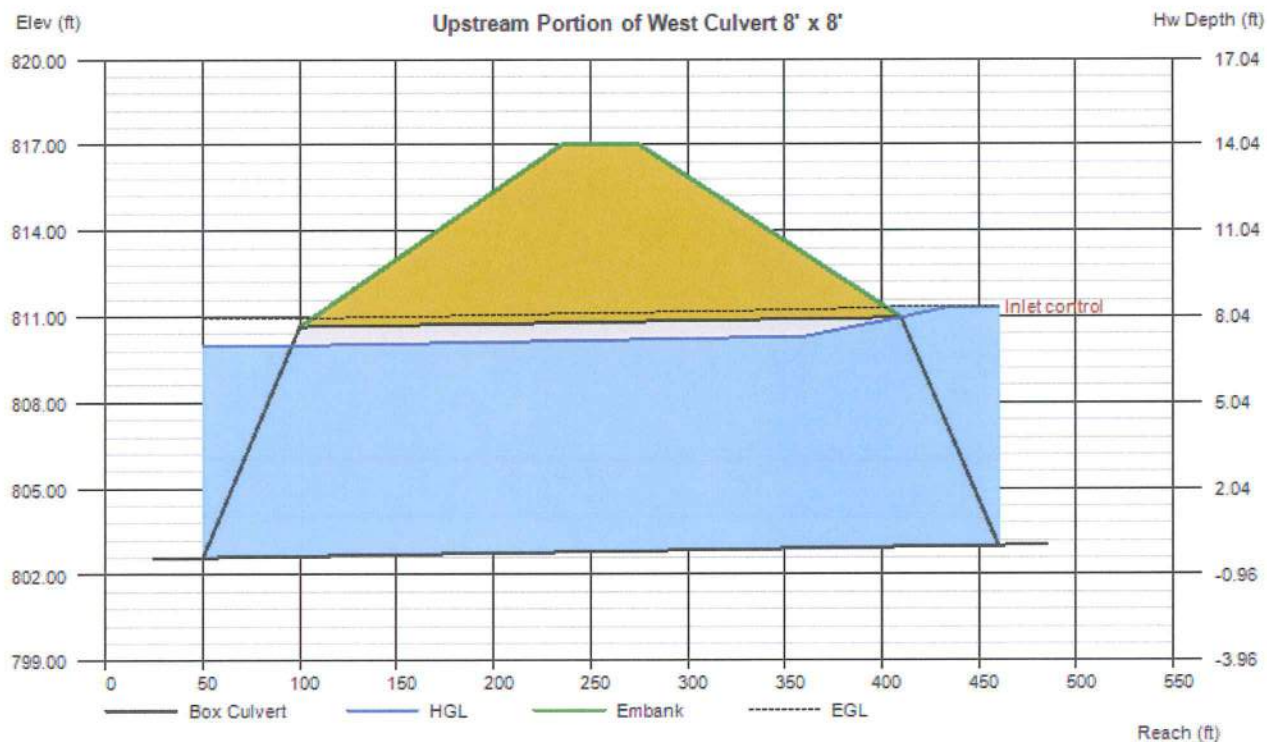
Top Elevation (ft) = 817.00  
 Top Width (ft) = 40.00  
 Crest Width (ft) = 50.00

### Calculations

Qmin (cfs) = 458.00  
 Qmax (cfs) = 547.00  
 Tailwater Elev (ft) = 810

### Highlighted

Qtotal (cfs) = 458.00  
 Qpipe (cfs) = 458.00  
 Qovertop (cfs) = 0.00  
 Veloc Dn (ft/s) = 7.79  
 Veloc Up (ft/s) = 7.75  
 HGL Dn (ft) = 810.00  
 HGL Up (ft) = 810.35  
 Hw Elev (ft) = 811.33  
 Hw/D (ft) = 1.05  
 Flow Regime = Inlet Control



Q			Veloc		Depth		HGL			
Total	Pipe	Over	Dn	Up	Dn	Up	Dn	Up	Hw	Hw/D
(cfs)	(cfs)	(cfs)	(ft/s)	(ft/s)	(in)	(in)	(ft)	(ft)	(ft)	
458.00	458.00	0.00	7.79	7.75	88.20	88.69	810.00	810.35	811.33	1.05
508.00	508.00	0.00	8.64	8.47	88.20	90.01	810.00	810.46	811.87	1.11



# Culvert Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc.

Thursday, Dec 6 2012

## North Leg 8' x 8'

Invert Elev Dn (ft)	= 794.25
Pipe Length (ft)	= 99.00
Slope (%)	= 0.64
Invert Elev Up (ft)	= 794.88
Rise (in)	= 96.0
Shape	= Box
Span (in)	= 96.0
No. Barrels	= 1
n-Value	= 0.012
Inlet Edge	= 0
Coeff. K,M,c,Y,k	= 0.0145, 1.75, 0.0419, 0.64, 0.5

### Embankment

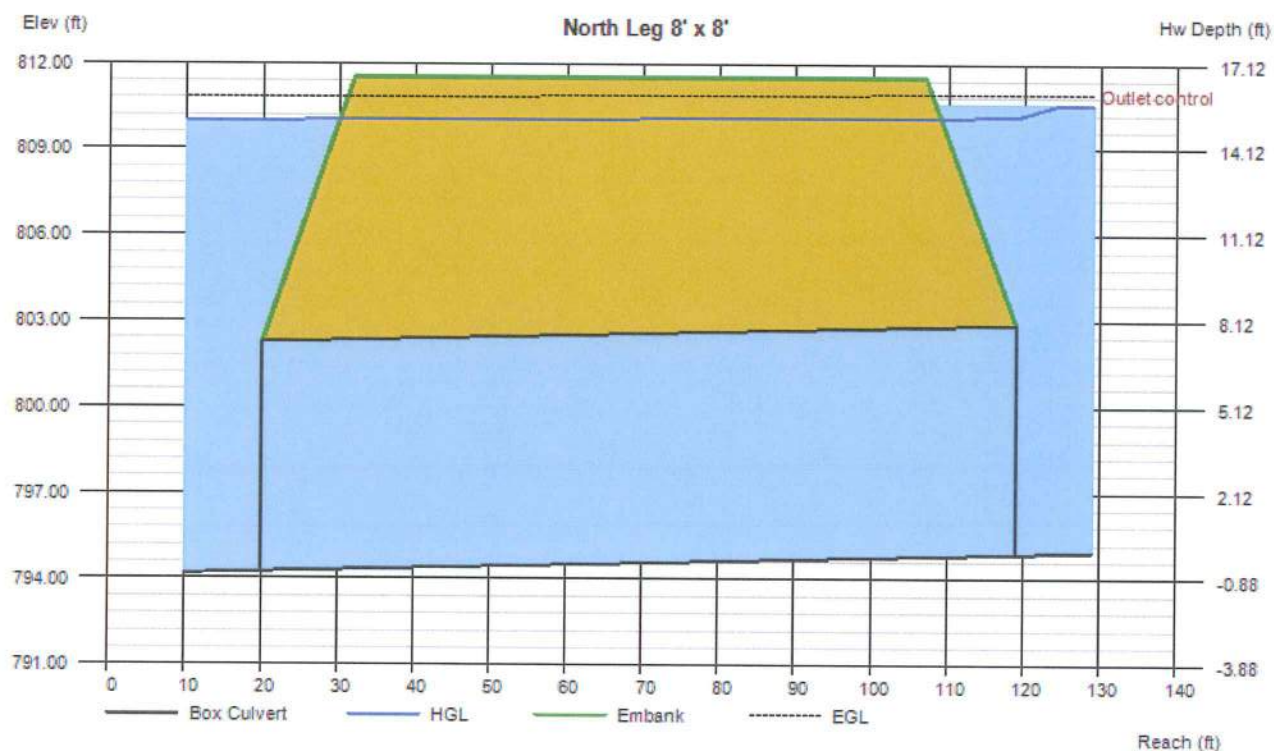
Top Elevation (ft)	= 811.50
Top Width (ft)	= 75.00
Crest Width (ft)	= 100.00

### Calculations

Qmin (cfs)	= 458.00
Qmax (cfs)	= 547.00
Tailwater Elev (ft)	= 810

### Highlighted

Qtotal (cfs)	= 458.00
Qpipe (cfs)	= 458.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 7.16
Veloc Up (ft/s)	= 7.16
HGL Dn (ft)	= 810.00
HGL Up (ft)	= 810.13
Hw Elev (ft)	= 810.53
Hw/D (ft)	= 1.96
Flow Regime	= Outlet Control



Q			Veloc		Depth		HGL			
Total	Pipe	Over	Dn	Up	Dn	Up	Dn	Up	Hw	Hw/D
(cfs)	(cfs)	(cfs)	(ft/s)	(ft/s)	(in)	(in)	(ft)	(ft)	(ft)	
458.00	458.00	0.00	7.16	7.16	96.00	96.00	810.00	810.13	810.53	1.96
508.00	508.00	0.00	7.94	7.94	96.00	96.00	810.00	810.16	810.65	1.97



## **ARMY Corp of Engineers Permit**





REPLY TO  
ATTENTION OF

**DEPARTMENT OF THE ARMY**  
CORPS OF ENGINEERS, KANSAS CITY DISTRICT  
635 FEDERAL BUILDING  
601 E 12<sup>TH</sup> STREET  
KANSAS CITY MO 64106-2824

January 17, 2012

Regulatory Branch  
(NWK- 2009-01141)  
Clay County, Missouri

Mr. David L. Flick  
Terra Technologies, Inc.  
1920 West 143<sup>rd</sup> Street, Suite 140  
Leawood, Kansas 66224

Dear Mr. Flick:

Permit No. 2009-01141 has been executed. One copy is enclosed for your records and one copy has been retained for our files. When you are ready to begin work, it is necessary that you contact Mr. Michael T. McFadden at 816-389-3432 (FAX 816-389-2032).

Special condition "a" of the permit requires you to sign and return the enclosed "Compliance Certification" upon completion of the authorized work and any required mitigation.

Sincerely,

David R. Hibbs  
Regulatory Program Manager

Enclosures

Copies Furnished (electronically w/enclosures):

Environmental Protection Agency,  
Watershed Planning and Implementation Branch  
U.S. Fish and Wildlife Service, Columbia, Missouri  
Missouri Department of Natural Resources,  
Water Protection Program  
Missouri Department of Conservation

## DEPARTMENT OF THE ARMY PERMIT

**Permittee** Star Development Corporation

**Permit No.** NWK 2009-01141

**Issuing Office** U.S. Army Engineer District, Kansas City

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate district or division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below, and with the plans and drawings attached hereto which are incorporated in and made a part of this permit.

**Project Description: PROPOSED WORK:** Develop the Shoppes at Kearney, a new 37-acre commercial retail shopping area, along several tributaries of Fishing River. As indicated in the submitted plans, project activities involve the piping of 585 feet and angular rock fill of 26 feet of an ephemeral stream, and the piping of 250 feet of an intermittent stream. The permittee is authorized to excavate and/or fill 861 feet of streams in the designated project location. Compensatory mitigation for the loss of aquatic habitat will be completed by purchasing 2,585 stream mitigation credits from an approved mitigation bank for that service area.

**Permit Drawings:** Project Area Location map (sheet 1 of 3), Project Boundary map (sheet 2 of 3), and Project Impacts map (sheet 3 of 3), dated 27 December 2011.

**Project Location:** The project is located along unnamed tributaries of Fishing River in Section 34, Township 53 north, Range 31 west, in Clay County, Missouri.

Latitude: 39.366105° N, Longitude: -94.370435° W

### Permit Conditions:

#### General Conditions:

1. The time limit for completing the work authorized ends on 31 December 2014. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.
2. You must maintain the activity authorized by this permit in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.
3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and state coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit, you must obtain the signature of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for your project, you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions.

6. You must allow representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of your permit.

Special Conditions:

See continuation sheets, pages 4 and 5, of this document.

Further Information:

1. Congressional Authorities: You have been authorized to undertake the activity described above pursuant to:

( ) Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403).

(X) Section 404 of the Clean Water Act (33 U.S.C. 1344).

( ) Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. 1413).

2. Limits of this authorization.

a. This permit does not obviate the need to obtain other Federal, state, or local authorization required by law.

b. This permit does not grant any property rights or exclusive privileges.

c. This permit does not authorize any injury to the property or rights of others.

d. This permit does not authorize interference with any existing or proposed Federal project.

3. Limits of Federal Liability. In issuing this permit, the Federal Government does not assume any liability for the following:

a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.

b. Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf of the United States in the public interest.

c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit.

d. Design or construction deficiencies associated with the permitted work.

e. Damage claims associated with any future modification, suspension, or revocation of this permit.

4. Reliance on Applicant's Data: The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.

5. Reevaluation of Permit Decision: This office may reevaluate its decision on this permit at any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:

- a. You fail to comply with the terms and conditions of this permit.
- b. The information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate (See 4 above).
- c. Significant new information surfaces which this office did not consider in reaching the original public interest decision.

Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 CFR 325.7 or enforcement procedures such as those contained in 33 CFR 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you to comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measures ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 CFR 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.


6. Extensions. General condition 1 establishes a time limit for the completion of the activity authorized by this permit. Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give favorable consideration to a request for an extension of this time limit.

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

  
(PERMITTEE)

1-17-12  
(DATE)

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

  
(DISTRICT ENGINEER)  
ANTHONY J. HOFMANN, COLONEL  
BY: David R. Hibbs, Regulatory Program Manager

17 Jan. 2012  
(DATE)

When the structures or work authorized by this permit are still in existence at the time the property is transferred, the terms and conditions of this permit will continue to be binding on the new owner(s) of the property. To validate the transfer of this permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below.

\_\_\_\_\_  
(TRANSFEREE)

\_\_\_\_\_  
(DATE)

### **Special Conditions:**

a. You must sign and return a "Compliance Certification" after you complete the authorized work and any required mitigation. Your signature will certify that you completed the work in accordance with this permit, including general and specific conditions, and that any required mitigation was completed in accordance with the permit conditions.

b. You must develop and install the features of a final stormwater management plan prior to performing work within Waters of the U.S. on the project site. Project site development features which influence any changes in stormwater hydrology will not be initiated until the Kansas City District Regulatory Office has received and approved the coordinated final stormwater management plan.

The stormwater design will predominantly be based upon the Kansas City Metropolitan Chapter of the American Public Works Association (APWA) "Standard Specifications and Design Criteria", Division V, Section 5600 – Storm Drainage Systems & Facilities (Approved & Adopted February 15, 2006). In accordance with that document, the primary design objective for the project site will be to provide on-site stormwater management controls (utilizing proposed stormwater detention facilities) that are designed to limit peak discharge rates to be equal to, or less than the rates achieved by the current Existing Conditions hydrology.

c. You must purchase 2,585 stream mitigation credits, for the impacts of the project to streams, from an approved mitigation bank in the State of Missouri. The project site is located within the service area of the Sni-A-Bar Stream and Wetland Mitigation Bank. Further information and contact information regarding this mitigation provider can be obtained from the Corps of Engineers Kansas City District Regulatory Office. Evidence of purchased mitigation credit must be provided to the Corps of Engineers prior to commencing any work in waters of the United States.

d. If any part of the authorized work is performed by a contractor, before starting work you must discuss the terms and conditions of this permit with the contractor; and, you must give a copy of this entire permit to the contractor.

e. You must use clean, uncontaminated materials for fill in order to minimize excessive turbidity by leaching of fines, as well as to preclude the entrance of deleterious and/or toxic materials into the waters of the United States by natural runoff or by leaching.

f. You must dispose of excess concrete and wash water from concrete trucks and other concrete mixing equipment in a non-wetland area above the ordinary high water mark and at a location where the concrete and wash water cannot enter the water body or an adjacent wetland area.

g. You must excavate, dredge and/or fill in the watercourse in a manner that will minimize increases in suspended solids and turbidity which may degrade water quality and damage aquatic life outside the immediate area of operation.

h. You must immediately remove and properly dispose of all debris during every phase of the project in

order to prevent the accumulation of unsightly, deleterious and/or toxic materials in or near the water body.

i. You must not dispose of any construction debris or waste materials below the ordinary high water mark of any water body, in a wetland area, or at any location where the materials could be introduced into the water body or an adjacent wetland as a result of runoff, flooding, wind, or other natural forces.

j. You must store all construction materials, equipment, and/or petroleum products, when not in use, above anticipated high water levels.

k. You must restrict the clearing of timber and other vegetation to the absolute minimum required to accomplish the work. Clearing, grading and replanting should be planned and timed so that only the smallest area necessary is in a disturbed, unstable or unvegetated condition.

l. You must use only graded rock and/or quarry-run rock for riprap. The material must be reasonably well graded, consisting of pieces varying in size from 20 pounds up to and including at least 150 pound pieces. Generally, the maximum weight of any piece should not be more than 500 pounds. Gravel and dirt should not exceed 15% of the total fill volume.





NWK 2009 - 01141  
Project Location Map  
December 27, 2011  
Sheet 1 of 3

Project  
Area

Google

Eye alt: 6725 ft

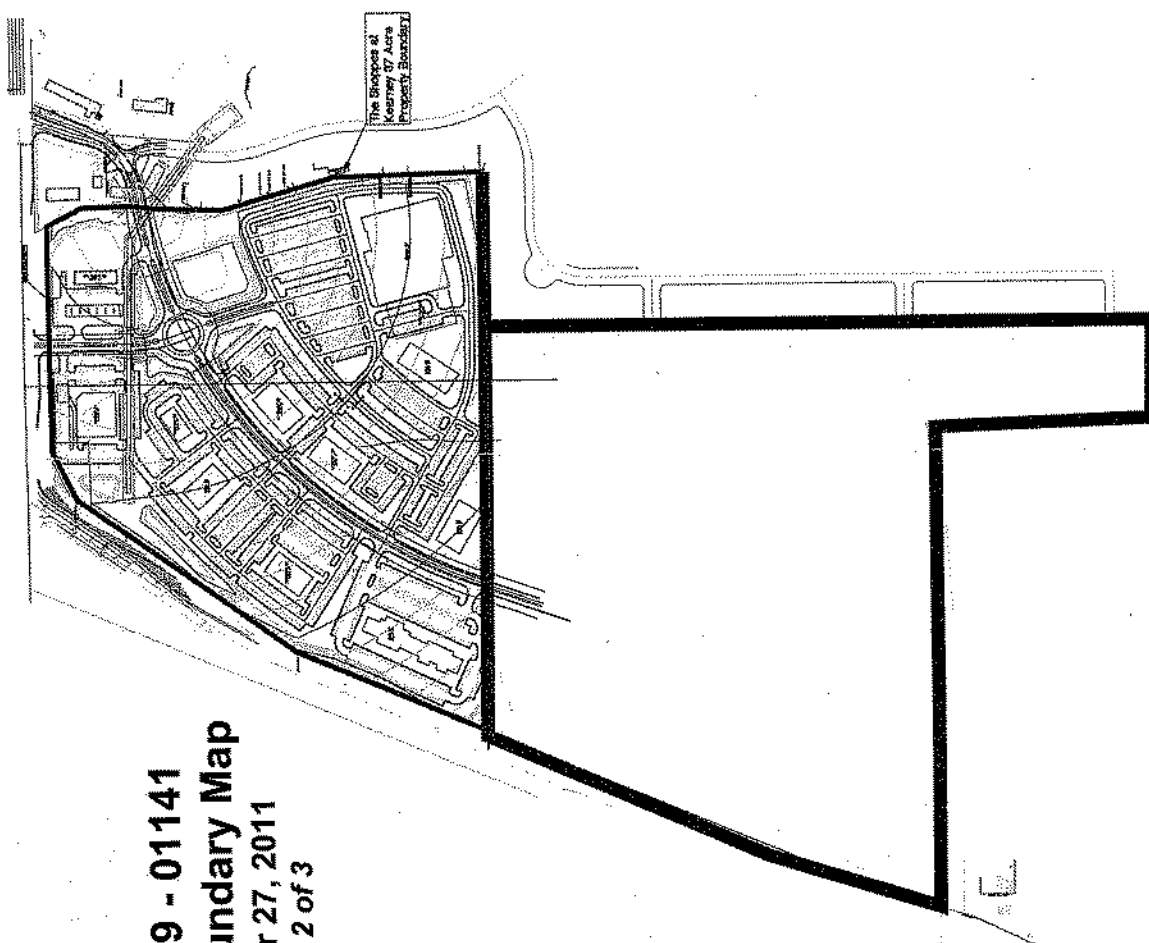
© 2011 Google

lat 39.965072 lon -94.371265 elev 0 ft

Imagery Date: 6/6/2011 1990

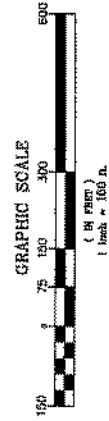


PROPERTY BOUNDARY  
THE SHOPPES AT KEARNEY  
STAR DEVELOPMENT

[illegible]

**NWK 2009 - 01141**  
**Project Boundary Map**  
**December 27, 2011**  
**Sheet 2 of 3**

Sheet 3 of 3

Type of Impact

STATE OF MISSOURI  
DEPARTMENT OF NATURAL RESOURCES

Jeremiah W. (Jay) Nixon, Governor • Sara Parker Pauley, Director

www.dnr.mo.gov

SEP 16 2011

Mr. Tim Harris  
Star Development Corporation  
244 West Mill Street, Suite 101  
Liberty, MO 64068

Clay County  
PN09-1141/CEK006523

Dear Mr. Harris:

The Missouri Department of Natural Resources' Water Protection Program (Department) has reviewed Public Notice No. PN09-1141/CEK006523 in which Star Development Corporation (applicant) will develop a 37-acre retail shopping area to be named "The Shoppes at Kearney." This is a moderate scale commercial development with retail buildings, ingress and egress, parking, site utilities and storm water management facilities.

The project will impact 611 lineal feet of non-relatively permanent ephemeral stream channel by placing riprap at the west upstream end for 26 lineal feet, then piping 585 lineal feet using a 72-inch reinforced concrete pipe. These impacts will provide surface parking lot/retail development, storm water management and roadway crossings. An intermittent stream located at the east end of the project area will be impacted by piping 250 lineal feet using a 96-inch reinforced concrete pipe. The relatively permanent intermittent stream impacts will allow roadway ingress and egress from the project area on the east side. No wetlands are identified on the project site.

The applicant's plan provides avoidance and minimization through the avoidance of 257 lineal feet of a relatively permanent intermittent stream which occurs along the northeastern limits of the project site and avoidance of 465 linear feet of the non-relatively permanent ephemeral stream. Compensatory mitigation for project impacts to jurisdictional waters will be through the purchase of credits from the Sni-A-Bar Stream and Wetland Mitigation Bank.

The project is located at the southeast quadrant of Highway 92 and Interstate 35 in Section 34, Township 53 North, Range 31 West in Clay County, Missouri.

This office certifies that the proposed project will not cause the general or numeric criteria to be exceeded nor impair beneficial uses established in the Water Quality Standards, 10 CSR 20-7.031, provided the following conditions are met:

1. The 861 linear feet of stream impacts were assessed using the State of Missouri Stream Mitigation Method and determined to require 2,585 mitigation credits. Compensatory mitigation shall be satisfied by the purchase of all the above stream credits from the Sni-A-Bar Stream and Wetland Mitigation Bank. Copies of the purchase documents shall be provided to the Department at the address below.

2. Best Management Practices shall be used during all phases of the project to limit the amount of discharge of water contaminants to waters of the state.
3. Only clean, nonpolluting fill shall be used.
4. Clearing of vegetation/trees shall be the minimum necessary to accomplish the activity. A vegetated corridor shall be maintained from the high bank on either side of the jurisdictional channel.
5. Streambed gradient shall not be permanently altered during project construction.
6. Project activities shall not accelerate bed or bank erosion, including the affects of the project on sites downstream.
7. The project plans shall consider environmentally-friendly design techniques such as Low Impact Development (LID). LID is a storm water management strategy that maintains or restores the original site hydrology through infiltration, evaporation or reuse of storm water. Designs might include creating vegetated swales, rain gardens and porous pavement. More information regarding LID can be found at these websites: <http://epa.gov/polwaste/green/> and [www.lid-stormwater.net/lid\\_techniques.htm](http://www.lid-stormwater.net/lid_techniques.htm).
8. Planting of any required vegetated buffer shall maximize the use of native, flood tolerant species to provide soil stabilization and wildlife benefits. Invasive, non-native species are prohibited.
9. All construction materials, equipment and/or petroleum products that are part of the operation, when not in use, shall be stored above anticipated high water levels. All precautions shall be taken to avoid the release of wastes or fuel to streams and other adjacent water bodies as a result of this operation. Petroleum products spilled into any water body or on the banks where the material may enter waters of the state shall be immediately cleaned up and disposed of properly. Any such spills of petroleum shall be reported as soon as possible to the Department's 24-hour Environmental Emergency Response number at (573) 634-2436.
10. Acquisition of a Clean Water Act Section 401 Water Quality Certification (certification) shall not be construed or interpreted to imply the requirements for other permits are replaced or superseded. Any National Pollutant Discharge Elimination System (NPDES) Permits, Land Disturbance Permits, or other requirements shall be complied with. Applicants with questions are encouraged to call the Department's Regional Office in your area. A regional office map can be located at [www.dnr.mo.gov/regions/regions.htm](http://www.dnr.mo.gov/regions/regions.htm).
11. The certification is based on the plans as submitted. Should any plan modifications occur, please contact the Department to determine whether the certification remains valid or may be amended or revoked.

Mr. Tim Harris

Page 3

12. Permittee shall allow representatives from this Department to inspect the authorized activity at any time deemed necessary to ensure compliance with permit conditions.
13. Submit to the Department at the below referenced address a copy of the signed "Compliance Certification" as proof of project completion when the original is submitted to the Army Corps of Engineers.

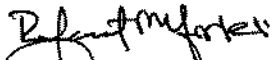
Pursuant to Chapter 644.052.9, RSMo, commonly referred to as the Missouri Clean Water Law, this certification shall be valid only upon payment of a fee of seventy-five dollars (\$75.00). The enclosed invoice contains the necessary information on how to submit your fee. Payment must be received within ten (10) days of receipt of this certification. Upon receipt of the fee, the applicable office of the Army Corps of Engineers will be informed that the certification is now in effect and final.

You may appeal to have the matter heard by the Administrative Hearing Commission (commission). To appeal, you must file a petition with the commission within thirty (30) days after the date this decision was mailed or the date it was delivered, whichever date was earlier. If any such petition is sent by registered mail or certified mail, it will be deemed filed on the date it is mailed; if it is sent by any method other than registered mail or certified mail, it will be deemed filed on the date it is received by the commission.

This certification is part of the Army Corps of Engineers' permit. Water Quality Standards must be met during any operations authorized by these permits. If you have any questions, please contact Ms. Stacia Bax by phone at (573) 526-4586, by e-mail at [stacia.bax@dnr.mo.gov](mailto:stacia.bax@dnr.mo.gov), or by mail at the Missouri Department of Natural Resources, Water Protection Program, NPDES Permits and Engineering Section, P.O. Box 176, Jefferson City, MO 65102-0176. Thank you for working with the Department to protect our environment.

Sincerely,

WATER PROTECTION PROGRAM



Refaat Mefrakis, P.E., Chief  
NPDES Permits and Engineering Section

RM:sbp

Enclosure

- c: Mr. Michael McFadden, Army Corps of Engineers, Kansas City District  
Mr. David L. Flick, Terra Technologies  
Mr. Craig Gump, Terra Technologies  
Mr. Jimmy Coles, Kansas City Regional Office  
Ms. Dorothy Franklin, Kansas City Regional Office  
File Copy

## COMPLIANCE CERTIFICATION

*Special condition "a" of this permit document requires that you submit a signed certification regarding the completed work and any required mitigation. This certification page satisfies this condition if it is provided to the Kansas City District at the address shown at the bottom of this page upon completion of the project.*

**APPLICATION NUMBER:** NWK 2009-01141

**APPLICANT:** Mr. Tim Harris  
Star Development Corporation  
244 West Mill Street, Suite 101  
Liberty, Missouri 64068

**PROJECT LOCATION:** The site is located in Section 34, Township 53 north, Range 31 west, in Clay County, Missouri.

- a. I certify that the authorized work was done in accordance with the Corps authorization, including any general or specific conditions.
- b. I certify that any required mitigation was completed in accordance with the permit conditions.
- c. Your signature below, as permittee, indicates that you have completed the authorized project as certified in paragraphs a and b above.

\_\_\_\_\_  
(PERMITTEE)

\_\_\_\_\_  
(DATE)

Return this certification to:

U.S. Army Corps of Engineers  
Kansas City District  
700 Federal Building  
Kansas City, MO 64106-2824