

EXAMPLE #1

For projects less than one acre and no new connections to the City/County storm sewers

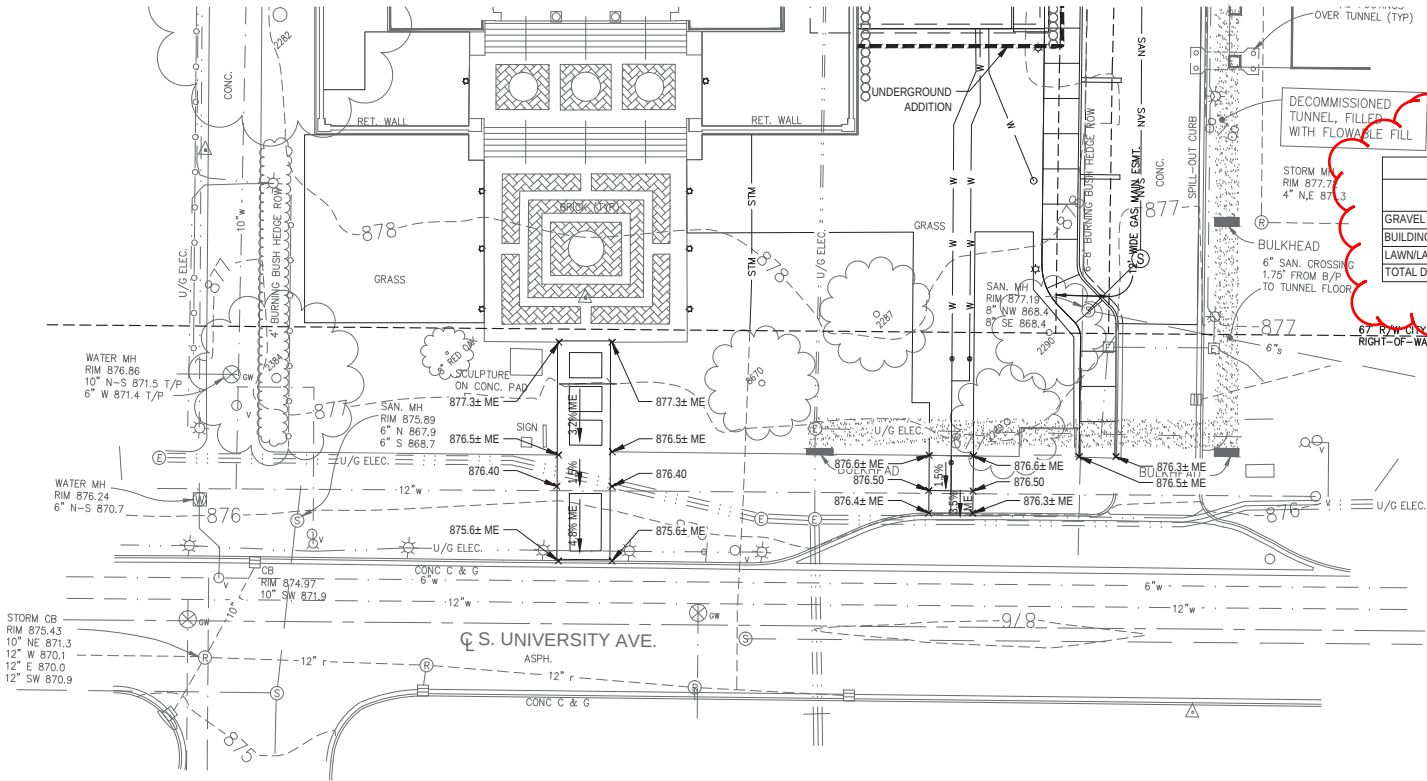
Storm Water Notes:

- 1. No new connections to city storm sewer systems are proposed.
- 2. Proposed earth disturbance is _____ SF (_____ acres).
- 3. U-M NPDES permit post-construction storm water management requirements are not applicable since the proposed earth disturbance is less than one acre.

Show chart of with change in impervious -see attached example chart. Increase in impervious must be reviewed/approved by U-M Campus Planning and project team may be directed to design additional storm water management BMPs.

Provide a list of elective storm water BMP's to be installed and quantify benefits, if feasible.

Include the language: "Construction and operation of the storm water (infiltration/detention pond) or (BMP's on the plans) is/are in compliance with the requirements of State and Federal water pollution control laws."



AREA COMPARISON (TOTAL SITE)		
TYPE	EXISTING AREA (SF)	PROPOSED AREA (SF)
GRAVEL	865	0
BUILDING ROOF/PAVING	18,655	15,285
LAWN/LANDSCAPE	21,193	25,428
TOTAL DISTURBED AREA	40,713	40,713

GRADING & DRAINAGE LEGEND

- STM STORM SEWER PIPING
- W WATER MAIN PIPING; SEE CUL.1
- 800 MAJOR CONTOUR LINE
- 800 MINOR CONTOUR LINE
- 800 EXISTING CONTOUR LINE
- 800 SPOT ELEVATION
- 1% GRADE

GRADING & DRAINAGE ABBREVIATIONS

- G = GUTTER
- ME = MEET EXISTING
- T/C = TOP OF CURB

Replace chart with format matching example chart below

Area Comparison (for earth disturbance)			
Type	CN	Existing Area (sf)	Proposed Area (sf)
Gravel	85	3500	0
Bldg Roof/Pavement	98	3000	3500
Lawn/Landscaping	61	6500	8000
Pervious Pavement	79.5	0	1500
Total Disturbed area		13000	13000
Total Impervious		6500	3500
Composite CN		76	73

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BENCH MARK	SURVEY BOOK	REV. NO.	DESCRIPTION	DATE	DR.BY	CH.BY
		1	CD FINAL REVIEW/CITY PLAN REVIEW	10/3/13	JBW	JBW
		0	CITY PPR SUBMITTAL	8/23/13	JBW	JBW

PROJECT MANAGEMENT - PUBLIC SERVICES - CITY OF ANN ARBOR	
UNIVERSITY OF MICHIGAN WILLIAM L. CLEMENTS LIBRARY INFRASTRUCTURE IMPROVEMENTS AND ADDITION UM PROJECT NUMBER: P00001692 RIGHT OF WAY GRADING PLAN	
SCALE HORIZ. 1"=20' VERT. 1"=2'	0 INCH 1
DRAWING NO.	CG1.1
SHEET NO.	OF

EXAMPLE #2

Greater than an acre, new connection to the City System

UNIVERSITY OF MICHIGAN

ATHLETIC DEPARTMENT OPERATIONS CENTER

PRELIMINARY SITE PLAN REVIEW

UM AEC Proj No #: P00008399;

THE UNIVERSITY OF MICHIGAN
ATHLETICS DEPARTMENT
ANN ARBOR, MI 48105

For City projects only - Title Sheet Listing type of City Review

SPALDING DEDECKER ASSOCIATES, INC.

SPALDING DEDECKER ASSOCIATES
905 SOUTH BOULEVARD EAST
ROCHESTER HILLS, MI 48307
P (248) 844 - 5400

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- C002C
- C101C
- C102C
- C103C
- C104C
- C104AC
- C104BC
- C105C
- COVER SHEET
- TOPO SURVEY
- DEMOLITION PLAN
- SITE PLAN
- UTILITY PLAN - RIGHT-OF-WAY
- PAVING PLAN - RIGHT-OF-WAY
- STORMWATER MANAGEMENT SUMMARY SHEET
- STORMWATER MANAGEMENT PLAN
- STORMWATER MANAGEMENT DETAILS
- FIRE SAFETY SITE PLAN



VICINITY PLAN

SCALE: NTS

UNIVERSITY of MICHIGAN

UM Athletic Department
Operations Center
ANN ARBOR, MICHIGAN
48105

WORK SCOPE

NEW OPERATIONS BUILDING
INCLUDES ADMINISTRATION OFFICES, LAUNDRY FACILITIES, ATHLETICS GENERAL STORAGE, LOADING DOCK AND A MAINTENANCE SHOP FOR MINOR REPAIRS. THESE REPAIR FUNCTIONS MILLWORK, WELDING, PAINTING AND SMALL EQUIPMENT. THE BUILDING IS APPROXIMATELY 18,500 SF OF SPACE. THE BUILDING IS STEEL FRAMED W/ INSULATED METAL PANEL AND INSULATED MASONRY VENEER WALLS. INTERIOR FINISHES INCLUDE CMU, GYPSUM BOARD, CEILINGS ARE EXPOSED METAL DECK PAINTED.

THE UNIVERSITY OF MICHIGAN

Architecture, Engineering and Construction
University Architect's Office
326 E. Hoover Ave.
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ANN ARBOR, MICHIGAN 48109-1002

NIAGARA MURANO

ARCHITECTURE
2215 COLE STREET
BIRMINGHAM, MICHIGAN 48009
TELEPHONE: 248.646.5765
FACSIMILE: 248.646.5813

Architect's Project No. - 13144.0

issue: date:

City Site Plan Review	April 28, 2014
Prelim. City Site Plan Review	March 19, 2014
Owner Review	Feb 19, 2014
DD Review	December 20, 2013
SD Review	November 27, 2013
Owner Review	October 28th 2013
Owner Review	October 28th 2013
Owner Review	October 21st 2013
Owner Review	October 9th 2013

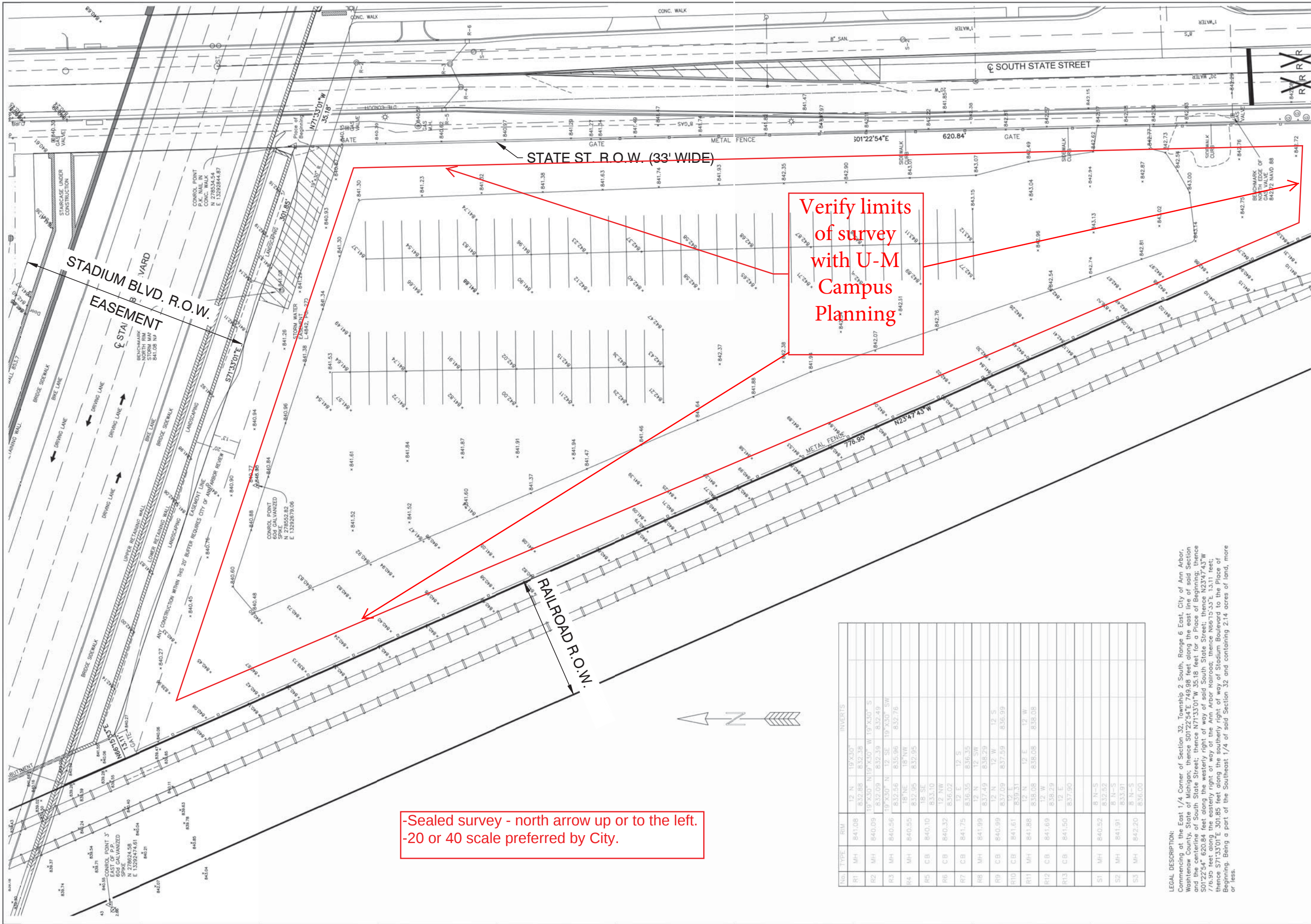


submitted to: HFES	NO	BFS:	NO
AEC constr mgmt no.	P00008399		
building no.			
designed	David B		
drawn	SB, RHS & GG		
coordination checked	John K.		
checked	R Sherman approved	John K.	
um design manager			
location	UM Athletic Ops Center		
keywords	TITLE		

project:
UM Athletic Department
Operations Center

sheet title:
PRELIMINARY CITY
SITE PLAN REVIEW

project number: sheet number:
UM AEC :
P00008399 T-1C



LEGAL DESCRIPTION:
Commencing at the East 1/4 Corner of Section 32, Township 2 South, Range 6 East, City of Ann Arbor, Washtenaw County, State of Michigan; thence S01°22'54"E 749.98 feet along the east line of said Section and the centerline of South State Street; thence N71°33'01"W 35.18 feet for a Place of Beginning, thence S01°22'54" 620.84 feet along the westerly right of way of said South State Street; thence N23°47'43"W 776.95 feet along the easterly right of way of the Ann Arbor Railroad; thence N66°13'33"E 111.11 feet, thence S71°33'01"E 301.85 feet along the easterly right of way of Stadium Boulevard to the face of a Benchmark, Being a part of the Southeast 1/4 of said Section 32 and containing 2.14 acres of land, more or less.

NO.	TYPE	RIM	INVERT/S
R1	MH	841.08	12 N 19°X30" 832.68
R2	MH	840.09	19°X30" N19°X30" W 19°X30" S 832.39
R3	MH	840.56	19°X30" N 12 SE 19°X30" SW 832.09
R4	MH	840.55	18°NE 18°NW 832.56
R5	CB	840.10	18 SE 832.05
R6	CB	840.32	12 NW 833.10
R7	CB	841.75	12 E 12 S 836.35
R8	MH	841.99	12 N 12 SW 837.49
R9	CB	840.99	12 N 12 W 837.09
R10	CB	841.61	12 E 837.31
R11	MH	841.88	12 N 12 E 838.08
R12	CB	841.69	12 W 838.29
R13	CB	841.50	12 E 837.90
S1	MH	840.52	8 N-S 832.52
S2	MH	841.91	8 N-S 833.91
S3	MH	842.20	8 N-S 836.00



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FOUND IRON ROD
SET IRON PIPE
SET MAG NAIL
FOUND MAG NAIL
CONTROL POINT
MEASURED DIMENSION
RECORDED DIMENSION
SURFACE FLOW

WATER MANHOLE
FIRE HYDRANT
GATE VALVE
BEEHIVE CATCH BASIN
CURB CATCH BASIN
STORM MANHOLE
CULVERT / END SECTION
SANITARY MANHOLE
LIGHT POLE
UTILITY POLE
TELEPHONE RISER
GAS MAIN RISER

ELECTRIC LINE
GAS MAIN
WATER MAIN
STORM LINE
SANITARY LINE
CABLE TV LINE
PHONE LINE
CHAIN LINK FENCE
WOOD FENCE
BARBED WIRE FENCE

CLIENT: UNIVERSITY OF MICHIGAN

RED LOT PARKING AREA
TOPOGRAPHICAL SURVEY
S. STATE ST. @ STADIUM BLVD.
SECTION 32, T2S, R6E,
CITY OF ANN ARBOR
MICHIGAN

Paul J. Schmitt
Professional Land Surveyors

Arbor Land Consultants, Inc.
Professional Land Surveyors
2936 Madrona Ct.
Ann Arbor, MI 48103
Tel 1-734-669-2960
Fax 1-734-669-2961

DATE: 11-25-2011
REVISION: 10-03-2013
JOB NO. 10912/03613/11313
SHEET 8 OF 8
SCALE 1 INCH = 20 FEET

THE UNIVERSITY OF MICHIGAN

Architecture, Engineering and Construction
University Architect's Office
326 E. Hoover Ave.
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Architect's Project No. - 13144.0

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Infrastructure • Land Development • Surveying
905 South Blvd. East
Rochester Hills, MI 48307
Phone: (248) 844-5400
Fax: (248) 844-5404
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(800) 598-1600

SDA Project No. - NP13033

issue: date:

City Site Plan Review	April 28, 2014
Prelim. City Site Plan Review	April 25, 2014
Prelim. City Site Plan Review	March 19, 2014
Owner Review - City Submitted	February 19, 2014
DD Review	December 20, 2013
SD Review	November 27, 2013
Owner Review #2	November 7, 2013
Owner Review	October 24, 2013



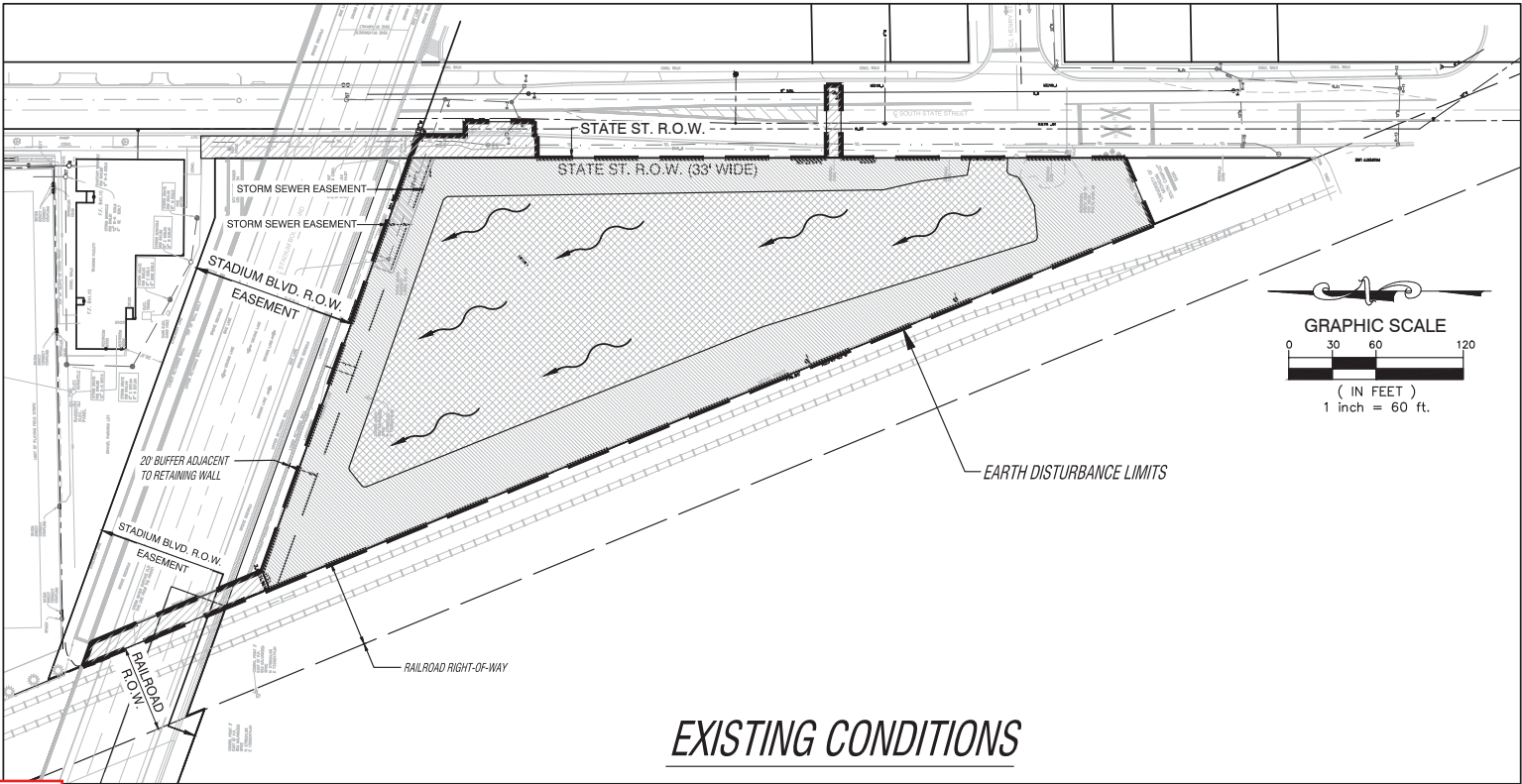
submitted to: HFES	NO	BFS:	NO
AEC constr mgmt no.	P00008399		
building no.	-		
designed	T. Sovel		
drawn	J. Ensley		
coordination checked	T. Sovel		
checked	T. Sovel approved	T. Sovel	
um design manager			
location	UM Athletics Ops Center		
keywords			

project:
UM Athletics
Department Operations
Center

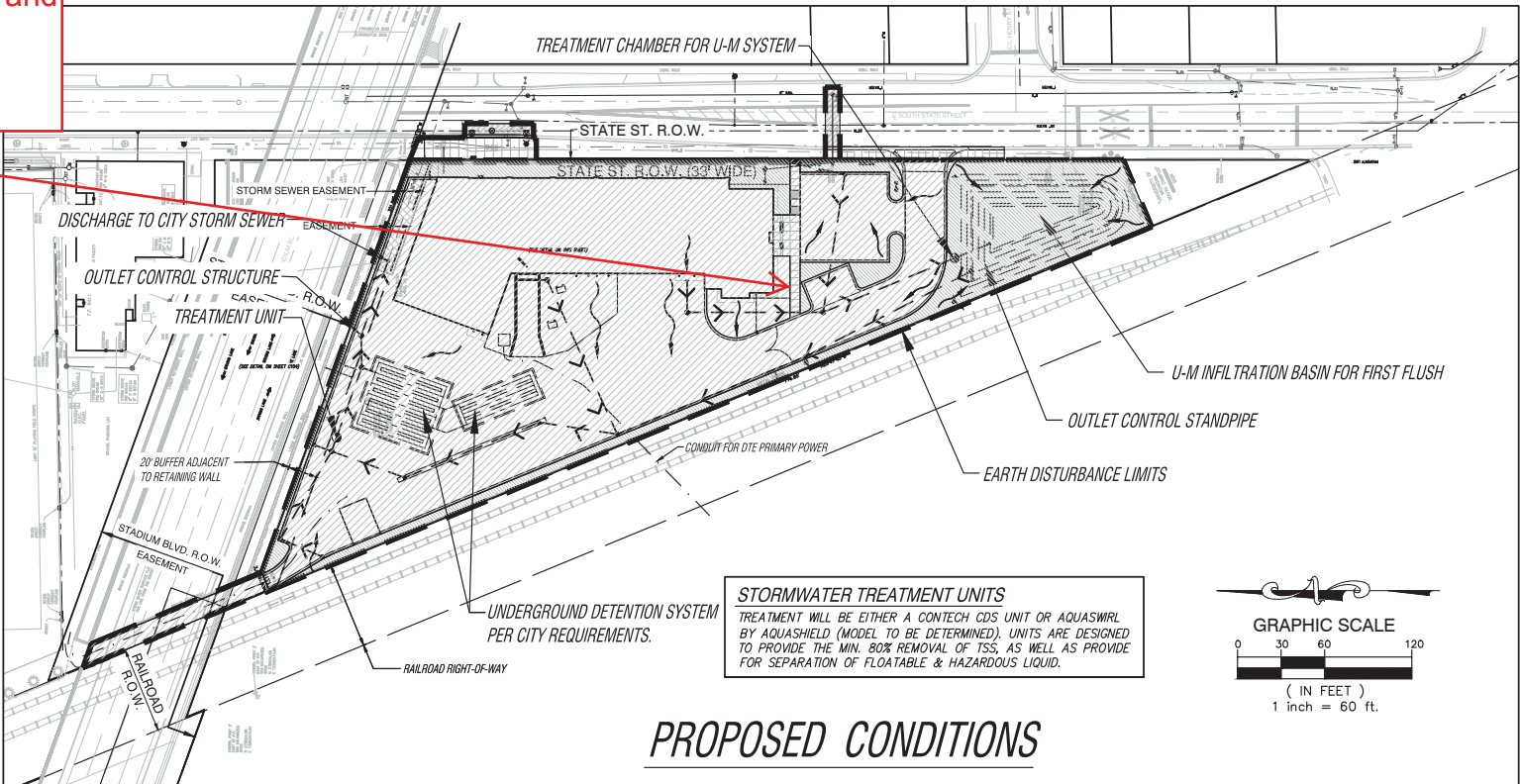
sheet title:
Storm Water
Management Plan
Summary Sheet

project number: sheet number:
UM AEC :
P00008399

C104C

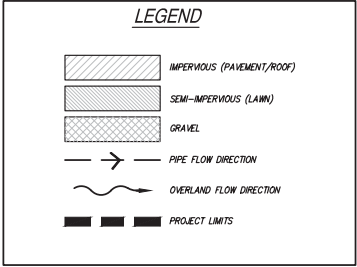


EXISTING CONDITIONS



PROPOSED CONDITIONS

STORMWATER TREATMENT UNITS
TREATMENT WILL BE EITHER A CONTECH CDS UNIT OR AQUASHIELD BY AQUASHIELD (MODEL TO BE DETERMINED). UNITS ARE DESIGNED TO PROVIDE THE MIN. 80% REMOVAL OF TSS, AS WELL AS PROVIDE FOR SEPARATION OF FLOATABLE & HAZARDOUS LIQUID.



- Storm water sheet.
- Show drainage patterns of proposed and existing conditions with different hatching based on imperviousness. (See Campus Planning level of detail provided on U-M property)
- Provide narrative summarizing storm water as noted below.

STORM WATER NARRATIVE:

1. EXISTING CONDITIONS STORM WATER SUMMARY (SEE SHEET C104BC FOR SUPPORTING CALCULATIONS):
EXISTING DRAINAGE IS OVERLAND IN A NORTH AND WEST DIRECTION TOWARDS THE NORTHWEST CORNER OF THE SITE. THE DRAINAGE FLOWS INTO THE RAILROAD DRAINAGE DITCH AND TO THE NORTH, WITH ULTIMATE DISCHARGE TO THE ALLEN CREEK DRAIN.

COVER TYPE	AREA (AC)	C	CN
GRAVEL PARKING	1.12	.85	85
OPEN SPACE (LAWN)	.88	.25	81
TOTAL	2.00	.59	78

EXISTING RUNOFF VOLUME = 1,884 CF
EXISTING PEAK RUNOFF RATE = 0.384 CFS
(VOLUME AND RATE SHOWN FOR 2 YR, 24-HR STORM PER U-M CALCS PROVIDED ON SHEET C104BC)

2. PROPOSED CONDITIONS STORM WATER SUMMARY (SEE SHEET C104BC FOR SUPPORTING CALCULATIONS):
PROPOSED EARTH DISTURBANCE IS 9385.4 SF (2.13 ACRES). THIS INCLUDES DISTURBED AREAS OUTSIDE THE PROPERTY LIMITS THAT DO NOT CONTRIBUTE TO THE DRAINAGE SYSTEM. DISTURBED AREA CONTRIBUTING TO THE DRAINAGE SYSTEM IS 87,120 SF (2.00 ACRES).
A NEW CONNECTION TO THE CITY STORM WATER SYSTEM IS PROPOSED. PROPOSED STORM DRAINAGE WILL BE DIRECTED INTO THE CITY'S STORM SEWER SYSTEM LOCATED IN THE NORTHEAST CORNER OF THE SITE BY CONNECTION TO THE EXISTING CITY STORM MANHOLE. IN ACCORDANCE WITH U-M REQUIREMENTS, THE INCREASED VOLUME FOR 2 YEAR 24 HOUR STORM CALCULATED PER U-M NPDES PERMIT REQUIREMENTS WILL BE DISCHARGED THROUGH AND RETAINED IN AN INFILTRATION SYSTEM AT THE SOUTH END OF THE SITE. THE INCREASED RUNOFF VOLUME RESULTING FROM SITE DEVELOPMENT FOR THE 2 YEAR 24 HOUR STORM EVENT 65,381 CUBIC FEET, WHICH EXCEEDS THE CITY'S FF REQUIREMENT OF 2,504 CF, WITH CITY FF REQUIREMENTS ACCOMMODATED WITHIN THE INFILTRATION SYSTEM, THE CITY'S DETENTION REQUIREMENTS WILL BE A TWO-STAGE SYSTEM, ACCOMMODATING THE BANKFULL AND DETENTION VOLUME REQUIREMENTS (LESS THE VOLUME ACCOMMODATED WITHIN THE INFILTRATION SYSTEM). THE PROPOSED STORM SYSTEM IS ROUTED THROUGH A TREATMENT UNIT AT THE NORTH END OF THE SITE PRIOR TO ENTERING THE UNDERGROUND DETENTION PIPING AND ULTIMATELY DISCHARGING INTO THE CITY STORM SEWER SYSTEM.

COVER TYPE	AREA (AC)	C	CN
PAVING/ROOF	1.57	.85	98
OPEN SPACE (LAWN)	.43	.25	81
TOTAL	2.00	.80	90

PROPOSED RUNOFF VOLUME = 9,075 CFS
PROPOSED PEAK RUNOFF RATE = 0 CFS (BASED ON SOIL TESTING, THE FIRST FLUSH VOLUME WILL INFILTRATE WITH NO DISCHARGE)
(VOLUME AND RATE SHOWN FOR 2 YR, 24-HR STORM PER U-M CALCS PROVIDED ON SHEET C104BC)

3. CHANNEL PROTECTION
U-M NPDES PERMIT
REQUIRED: 5,581 CF OF RETENTION REQUIRED FOR FIRST FLUSH VOLUME (DIFFERENCE BETWEEN EXISTING AND PROPOSED RUNOFF VOLUMES NOTED ABOVE)
PROVIDED: 9,808 CF WILL BE PROVIDED WITHIN INFILTRATION BASIN AT THE SOUTH END OF THE SITE
CITY OF ANN ARBOR
REQUIRED:
300 YR DETENTION = 21,088 CF (SUBTRACT 9,808 CF OF RETENTION PROVIDED) = 11,280 CF
BANKFULL FLOOD VOLUME = 13,888 CF (SUBTRACT 9,808 CF OF RETENTION PROVIDED) = 4,080 CF
FIRST FLUSH (FF) VOLUME = 2,504 CF (SUBTRACT 9,808 CF OF RETENTION PROVIDED) = NO FURTHER REQUIREMENTS
PEAK RUNOFF RATE = 0.30 CFS (0.13 CFS/ACRE FOR 4 ACRES)
PROVIDED:
RETENTION = 9,808 CF WILL BE PROVIDED WITHIN INFILTRATION BASIN ON THE SOUTH END OF THE SITE
DETENTION = 13,830 CF WILL BE PROVIDED WITHIN DETENTION PIPING ON THE NORTH END OF THE SITE
4. MINIMUM TREATMENT VOLUME STANDARD - TSS REMOVAL
THERMAL/QUALITY TREATMENT IS DESIGNED TO REMOVE 80 PER CENT OF THIS TOTAL SUSPENDED SOLIDS (AS COMPARED TO UNCONTROLLED RUNOFF) FOR 90 PERCENT ANNUAL NON-EXCESSIVE STORMS.
REQUIRED: QUALITY TREATMENT FOR 2,504 CF OF WATER WITH 15 MINUTE TIME OF CONCENTRATION AND PEAK DISCHARGE OF 0.30 CFS (THIS DOES NOT INCLUDE THE SEPARATE U-M SYSTEM, WHICH PROVIDES TREATMENT AND INFILTRATION FOR 9,808 CF OF WATER).
PROVIDED: TWO STORMWATER TREATMENT UNITS ARE PROPOSED AND WILL BE EITHER CONTECH CDS UNIT OR AQUASHIELD BY AQUASHIELD (MODEL TO BE DETERMINED). THE UNITS WILL BE SIZED TO MEET THE REMOVAL AND PEAK DISCHARGE FLOW CRITERIA.
THE PROJECT WILL BE DESIGNED TO MEET THE U-M POST CONSTRUCTION NPDES PERMIT AND CITY STORM WATER REQUIREMENTS.

Storm water narrative

REFER TO SHEETS C1044C AND C104BC FOR
SYSTEM LAYOUT, DETAILS AND CALCULATIONS

Architecture, Engineering and Construction
University Architect's Office
326 E. Hoover Ave.
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ANN ARBOR, MICHIGAN 48109-1002

Architect's Project No. - 13144.0



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DA Project No. - NP13033

ISSUE:	date:
City Site Plan Review	April 28, 2014
Prelim. City Site Plan Review	April 25, 2014
Prelim. City Site Plan Review	March 19, 2014
Owner Review - City Submitted	February 19, 2014
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submitted to: HFES	NO	BFS:	NO
AEC constr mgmt no.	P00008399		
building no.	-		
designed	T. Sovel		
drawn	J. Ensley		
coordination checked	T. Sovel		
checked	T. Sovel	approved	T. Sovel
um design manager			
location	UM Athletics Ops Center		
keywords			

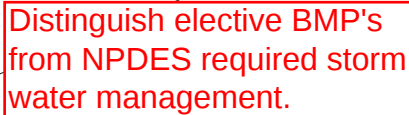
project:
UM Athletics
Department Operations
Center

sheet title:
Storm Water
Management Plan

project number: sheet number:

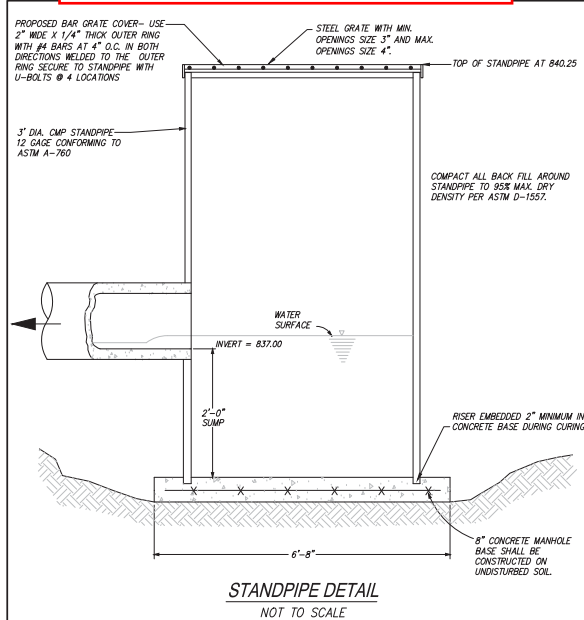
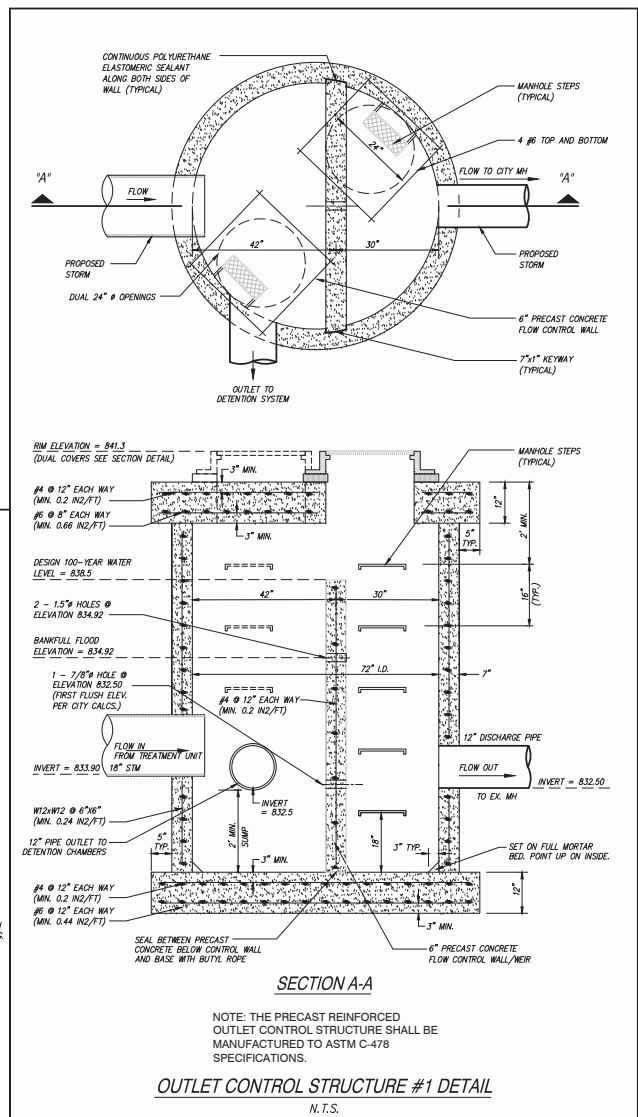
UM AEC :
P00008399

C104AC



Provide sheet with storm water management plan.

Include details for storm water management structures.



INFILTRATION BASIN VOLUME			
Contour (FT)	Area (SFT)	Volume (CFT)	Total Storage Volume (CFT)
840.25	4590.85	1111.44	9,632.79
840.00	4300.64	3758.92	8,521.35
839.00	3217.20	2737.39	4,762.43
838.00	2267.57	1839.67	2,025.05
837.00	1421.76	617.94	185.38
836.50	1050.00		
(NOTE: VOLUME BETWEEN 836.50 AND 837.00 WILL BE FILLED WITH STONE)			
Volume Provided =	9,632.79	cft	
Design water depth =	3.75	ft	

LEGEND

----	PROPOSED WATERMAIN	●	PROPOSED SAN MANHOLE (SAN)
----	PROPOSED SANITARY	⊖	PROPOSED STORM MANHOLE (NM)
----	PROPOSED STORM SEWER	⊕	PROPOSED CATCH BASIN (CB)
----	PROPOSED GAS MAIN	⊖	PROPOSED INLET (NL)
----	PROPOSED ELECTRIC	⊕	PROPOSED END SECTION (ES)
⦿	PROPOSED HYDRANT	⊕	PROPOSED FIELD CATCH BASIN (FOB) W/ REEVEE COVER OR STANDPIPE (SP) W/ BAR GRATE COVER
⊗	PROPOSED GATE VALVE & WELL (GVW)		
⊗	PROPOSED TAPPING SLEEVE, VALVE & WELL (TSVW)		

	STANDARD BITUMINOUS PAVEMENT		UTILITY CROSSING (SEE DATA TABLE)
	HEAVY-DUTY BITUMINOUS PAVEMENT		CB — STRUCT. TYPE 2+ — STRUCT. NO.
	DEEP-STRENGTH BITUMINOUS PAVEMENT		SANITARY SEWER STRUCTURE
	CONCRETE PAVEMENT		WATERMAIN STRUCTURE 10 — STRUCT. NO. XXX — STRUCT. TYPE
	CONCRETE SIDEWALK		
	MILL PAVEMENT		

Architecture, Engineering and Construction
University Architect's Office
326 E. Hoover Ave.
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ANN ARBOR, MICHIGAN 48109-1002

Architect's Project No. - 13144.0

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University of Michigan

UM AEC :
P00008399

C104BC

Bankfull flood:			
The bankfull flood must be detained 36-48 hours, discharge will be through holes in the restrictor manhole, in the weir wall, at the first flush elevation. Since first flush is handled in the U-M retention system, set first flush elevation at the outlet elevation of the system.			
$h_{BF} = 2/3 (elev_{BF} - elev_{SF}) =$	$2/3 (834.92 - 832.5)$		
$h_{BF} =$	1.61 ft		
To target a detention time of 36 hours, compute the flow rate, Q, to discharge the bank full flood volume:			
$T = V_{BF} / Q$, solve for $Q = V_{BF} / T$, where $V =$	3.435 (note - volume references cfs; requirement less UM volume)	$t = 36$ hrs	
$= 3.435$	$=$	95.42 cfs/hr or	0.027 cfs
$=$	36		
Now compute orifice sizing to achieve 0.027 CFS			
$Q = 0.62 * A_o * \sqrt{2 * g * h_{BF}}$, solve for A_o			
$A_o = 0.0042$	SFT =	0.60	square inches
Solving for radius gives 0.438 inches, or 0.88 inch diameter hole			
to be set at the first flush elev. or outlet elev. of the system = 832.50			
Since the 1.08 in. dia. hole is not a standard dimension, use 0.875 (7/8) inch			
This gives an actual area of 0.0042 square feet so the calculations below will use this area.			
100-year flood:			
$Q_{100} =$	0.30	cfs (using 0.15 cfs/acre)	
Q_{100} is a peak or maximum flow. Calculate the maximum flow passing through the bankfull orifice, using the total head, and subtract from Q_{100} to determine the additional orifice size to release the 100-year storm volume:			
$Q_{BF} = 0.62 * A_o * \sqrt{2 * g * h_{BF}^M}$	$h_{BF}^M =$	6.0	
$Q_{BF} =$	0.05	cfs	0.0042
$Q_{100} = Q_{100} - Q_{BF}$	(this is the additional flow required to achieve the 0.3 cfs max outflow)		
$Q_{100} =$	0.25	cfs	
Compute orifice area at the bank full elevation to attain the addl 0.25 cfs			
$A_{100} = Q_{100} / (0.62 * \sqrt{2 * g * h_{100}})$	where $h_{100} =$	3.58	feet from 100-year water level to bank full level
$A_{100} =$	0.026	sf	
A 1.5" diameter orifice has an area of 0.0123 sf			
$\# = A_{100} / \text{area per orifice}$			
$\# =$	2.15		
Therefore, use 2 - 1.5" diameter holes @ elev. 834.92			
Calculation of Detention Volume Detention Time			
First, calculate discharge time from 100-year HWL (834.5) to bank full elevation (834.92) through the holes at the bankfull elevation.			
$h_{BF} = 2/3 (elev_{100} - elev_{BF})$	$elev_{100} =$	838.50	
$h_{BF} =$	2.39 ft	$elev_{BF} =$	834.92
$Q = 0.62 * A * \sqrt{2 * g * h_{BF}}$	$A =$	0.0264	
$Q_{100} =$	0.20	cfs (discharge rate through holes at bank full elev)	
Next, calculate discharge through the holes at the discharge elevation (832.5) between the 100-year level (838.5) and bank full level (834.92).			
Average water level =	837.31	Average head =	837.31 - 832.5 = 4.81
$Q = 0.62 * A * \sqrt{2 * g * h_{BF}}$	$A =$	0.0042	
$Q_{100} =$	0.05	cfs (discharge rate through discharge hole at 832.5)	
Total discharge rate between elevation 838.5 and 834.92 = 0.25 CFS.			
In the detention system, the volume stored between 838.5 and 834.92 over 480 LFT is 8,186 CFT.			
The time to drain 8186 CFT at a rate of 0.25 CFS = 32,877 SEC = 9.1 HRS			
Next, calculate discharge time from bank full elev (834.92) to discharge level (832.5) through discharge hole			
$h_{BF} = 2/3 (elev_{BF} - elev_{discharge})$	$elev_{BF} =$	834.92	
$h_{BF} =$	1.61 ft	$elev_{discharge} =$	832.50
$Q_{100} = 0.62 * A_{discharge} * \sqrt{2 * g * h_{BF}}$	$A_{discharge} =$	0.0042	
$Q_{100} =$	0.03	cfs	
In the detention system, the volume stored between 834.92 and 832.5 over 480 LFT is 3,219 CFT.			
The time to drain 3219 CFT at a rate of 0.03 CFS = 121,278 SEC = 33.7 HRS			
Total time to drain the detention system = 9.13 + 33.69 = 42.8 Hours			

UNIVERSITY OF MICHIGAN

OSEH REQUIREMENTS FOR STORMWATER MANAGEMENT

1.1 Minimum Treatment Volume Standard

The minimum treatment volume standard shall be based on the 90 percent annual non-exceedance storm, which is detailed in the MDEQ 2000 memo.

The 90% Annual Non-Exceedance Storm for this area, P =

0.9

inches

Total Disturbed Area, A =

2.00

acres

Use the Small Storm Hydrology Method to compute a volumetric runoff coefficient (Rv) based on the specific characteristics of the penous and impervious surfaces of the drainage catchment.

Area Type	A (acre)	Rv	A/Rv
Silly Sods (HSG-B)	0.45	0.11	0.05
Impervious Paving	1.11	0.97	1.08
Flat Roof	0.43	0.84	0.36
Sum	2.00		1.40
Weighted Volumetric Runoff Coefficient, Rv			0.75

Water Quality Volume, WQV = P x Rv x A

WQV = 0.9 inches x 0.75 x 2 acres x 10/12in x 43,560ft²/acre

WQV =

4901

cft

(Minimum Treatment Volume)

Estimating Peak Discharge for the Water Quality Storm

Solve for the curve number, CN

CN = 1000/(1 + SP + 10Q/10(2 + 1.25Q)^{0.07})

Where Q = P x Rv = 0.9 x 0.75 =

0.68

inches

CN = 1000/(1 + 50(0.9) + 10(0.68) - 10(0.68) + 1.25(0.68)(0.9)/12)

CN =

98

Solve for the Peak Discharge, Qp

Given the CN calculated above, Ia =

0.041

in (TR-55, Table 4-1)

The drainage area is equal to the disturbed area =

0.0013

sq. mi.

Appropriate rainfall distribution type

la/P

0.05

Given the Ia/P and Tc of 15 minutes, Unit Peak Discharge, qu =

750

csm/in (TR-55, Exhibit 44)

Qp = qu x A x Q

Qp = 750 x 0.0013 x 0.68 =

1.6

cfs

(Peak Discharge for Water Quality Storm)

1.2 Minimum Treatment Volume Standard - TSS Removal

The U-M requirement is that a minimum of 60 percent removal of total suspended solids (TSS), as compared with uncontrolled run-off, is required for post-development. This will be accomplished through the use of two stormwater treatment units, one at the south infiltration area, and one at the north side of the site prior to discharge into the City storm system. The units will be either a CDS unit by Stormtech, or an AquaSwirl unit by AquaShield (model to be determined). Both units provide the required 80% TSS removal, as well as providing separation of floatables and hazardous liquids (oil, gas, etc.).

2.0 - 2.2 Channel Protection Criteria, Hazardous Liquids, and Methods for estimating pre-and post development runoff

The channel protection criteria must maintain post-development site runoff volume and peak flow rate at or below existing levels for all storms up to the 2-year, 24-hour event. "Existing levels" means the runoff volume and peak flow rate for the last land use prior to the planned new development or redevelopment.

The rainfall data for calculating runoff volume and peak flow rate shall be the *Rainfall Frequency Atlas of the Midwest*, 1992 (NOAA - Huff & Angel).

The methods used for estimating pre- and post-development runoff shall follow curve number evaluations as described in MDEQ's *Computing Flood Discharges From Small Ungaged Watersheds*, June 2008.

	Area (ft ²)	Area (acres)
Disturbed Area of Site		2
Estimated Watershed Area (i.e. area of site)	87120	2
Existing Impervious Area in Watershed	40322	0
Existing Gravel Area	67082	1.13
Proposed Impervious Area in Watershed	67082	1.54
Change in Impervious Area in Watershed	67082	1.54

Existing Conditions

Hydrologic Soil Group	Percent of Total Drainage Area	Land Use	Percent of Soil Group	RCN	Partial RCN
B	100	Lawn Area	44	61	26.84
		Gravel Areas	56	85	47.6
				Sum	74

Proposed Conditions

Hydrologic Soil Group	Percent of Total Drainage Area	Land Use	Percent of Soil Group	RCN	Partial RCN
B	100	Lawn Area	23	61	14.03
		Impervious Area	77	98	75.45
				Sum	89

Calculate Surface Runoff (SRO)

SRO = (P-0.25)/2 (P=0.68)P²

where P = 2 Year, 24 hour rainfall (inches) =

2.26

inches for Ann Arbor

and S = Potential Maximum Retention after Rainoff Begins, inches

S = (1000/RCN) - 10

Therefore, computing S for both existing and proposed conditions:

S_{ex} =

3.51

inches

S_p =

1.24

inches

Now calculate SRO for both existing and proposed conditions:

SRO_{ex} =

0.48

inches

SRO_p =

1.25

inches

Runoff increase =

0.77

inches

The drainage area of the site is 87,120 square feet. The required retention volume is based on the increase in runoff from existing to proposed condition. For these sites, that will be 0.77 inches. Therefore, the retention volume is:

Volume =

A x (SRO_p-SRO_{ex})

12" / foot

Volume =

6,681

cubic feet

Storage volume to meet U-M requirements is provided in the open retention/infiltration basin at the south end of the site. Volume is provided between the bottom elevation of 836.50 and the storage elevation of 840.25. Total volume provided is 9,633 cubic feet (refer to volume chart on the plans)

FLOW CALCULATION FOR EXISTING DISCHARGE

TR-55 procedures will be utilized to estimate the discharge from the existing site. Utilizing the flow chart in Figure 1-1, it can be determined that the Graphical Peak Discharge Method should be used.

The first step is to compute the watershed runoff, "Q", per Chapter 2 in TR-55.

The SCS runoff curve number method is used to compute the runoff as follows:

Q = (P-0.25)/2 (P=0.68)

where Q = runoff (in), P = rainfall (in), and S= potential max retention after runoff begins. S is computed as:

S = (1000/CN)-10 =

3.51

inches

P for the 2 year, 24 hour storm is

2.26

inches for Ann Arbor.

Therefore, Q is equal to:

0.479

inches

The second step is to compute the time of concentration, T_c , for the watershed. This is done utilizing the methods indicated in Chapter 3. The existing drainage on the site is from south to north, via sheet flow. Per TR-55, time of concentration for sheet flow should only be computed over a maximum length of 300', after which the surface runoff should be treated as shallow, concentrated flow. The computation for T_c using the two zones follows:

T_c for sheet flow = $0.007(L/n)(P/2)^{0.8}$ (P2/20 * $s^{0.4}$), where n = Manning's coefficient of roughness, L = length of travel, P = 2' zone, 24-hour rainfall (inches), and s = slope of the land.

T_c for shallow, concentrated flow = $L/(3600*V)$, where L = length of travel, and V is determined from Figure 3-1 in TR-55 based on the slope of the land and type of surface.

Time of Concentration, T_c , for Existing Conditions					
Type of Flow	Length (ft)	Change in Elevation (ft)	Slope (ft/ft)	Manning "n"	Incremental T_c (hrs)
Sheet Flow	300	1.0	0.0033	0.34	N/A
Shallow Flow	300	1.8	0.0060	n/a	1.18
Total T_c					1.48

The third step is to compute the peak discharge using the Graphical Peak Discharge Method, described in Chapter 4 of TR-55.

The peak discharge, Q_p = $Q_u \times A_m \times Q \times F_p$, where
 Q_p = peak discharge, CFS
 Q_u = unit peak discharge, c/s/in
 A_m = drainage area, mi^2 = 0.003125 square miles
 Q = runoff, in, as computed above
 F_p = pond adjustment factor (N/A for this project)

Q_u , unit peak discharge, is based on the values of Ia, P, and the CN
 Using Table 4-1 in TR-55, the initial abstraction, Ia, for a CN of 74 is 2.26 inches
 The 24-hour rainfall for the 2-year event is 2.36 inches
 Therefore, IAP is computed as = 0.311

Now utilizing the value of IAP and the T_c computed above, we utilize the graph in Exhibit 4-8 to determine Q_u for the Type II rainfall distribution. The graph indicates a value of 230 c/s/in

Therefore, Q_p for existing conditions = 0.341 CFS

FLOW CALCULATION FOR PROPOSED DEVELOPMENT

In addition to limiting the volume of runoff to the pre-development 2-year, 24-hour storm, the discharge rate/velocity for post-development must also not exceed the pre-development numbers.

Based on the Flow Calculation for Existing Discharge above, the existing discharge from the site is 0.344 CFS.

Per City of Ann Arbor requirements, the discharge from the system will be restricted to 0.15 CFS/acre up to the 100-year storm. The total tributary area is 2 acres, and therefore our max discharge under design conditions is 0.30 CFS, which is less than the 0.344 CFS existing discharge.

It should be noted that the discharge rate from the system for the 2-year, 24-hour storm will be completely eliminated, since the discharge for the 2-year, 24-hour storm will now infiltrate.

STORMWATER SYSTEM DISCHARGE PER U.M. REQUIREMENTS

Discharge to meet the U.M. requirement is proposed via infiltration through the sand/gravel soils on the site. The infiltration zone is proposed at the south end of the site, where infiltration based on testing is at it's highest level of 0.4 inches per hour. SMC recommends an infiltration rate of 1.4 inches per hour at the west and south parts of the site, which takes into account a significant factor of safety for clogging of the soils.

We propose an open infiltration basin at the south end of the site. The design provides a surface area between the 837 contour of 1,422 square feet for the infiltration zone.

Darcy's Law will be used to calculate the time needed to fully infiltrate the channel protection volume.

Darcy's Law, $V = AKt$
 where
 V = Volume of water, CFT = 5,581 CFT
 A = Area of infiltration, sq ft = 1,422 square feet
 t = infiltration rate, inches per hour = 1.4 in/hour = 0.12 ft/hour
 T = time, hours

Solving for Time, Darcy's Law becomes:
 $T = V/(A \times t)$

Therefore, for the volume of 5,581 cubic feet calculated above, the time will be:

$T = \frac{5581}{(1422)(0.12)}$
 $T = 32.7$ hours

Infiltration must infiltrate between 24 and 48 hours, so this is acceptable.

Provide calculation sheet.