DRAINAGE PLAN
AND
SUPPORTING CALCULATIONS

FOR

HING ADDITION
WICHITA, KANSAS

PREPARED FOR:
SAVOY COMPANY, P.A.
433 S. HYDRAULIC
WICHITA, KS 67211

MARCH 4TH, 2013

PREPARED BY:

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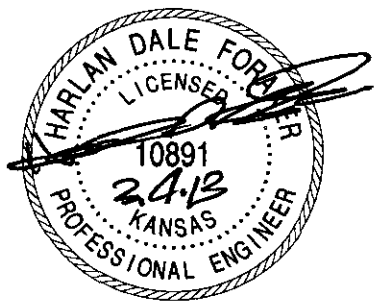

City of Wichita/Sedgwick County
Subdivision Drainage Plan Checklist

Submit completed forms to:
City of Wichita Public Works & Utilities, 455 N. Main 8th Floor, Wichita KS 67202; or
Sedgwick County Stormwater Management, 1144 S. Seneca, Wichita KS 67213.

Project Name:	Hing Addition				
Total Area of Project:	2.5 **acres**				
Development Type:	Commercial	**Other:**			
Developer Name:	Weng Choon Hing	**Contact:**		**Phone:**	316-618-1120
Email:					
Engineer Name:	Harlan Foraker	**Contact:**		**Phone:**	316-262-8808
Email:	hforaker@cedpa.com				

Directions:

(1) Fill-out this checklist completely and include it with the Drainage Plan submittal. This checklist should be included in the bound copy, behind the cover sheet for the submittal. Incomplete Drainage Plans and checklists will not be accepted.

*(2) Indicate whether a plan element is included or not included in the submittal by choosing "**Yes**" or "**No**" from the dropdown list in the **"Element Included?"** column. The question must be answered for every plan element for this checklist to be considered complete. An explanation must be provided for all **"No"** answers.*

Drainage Plan Checklist

#	Plan Element Description	Element Included?	Explanation/Notes
1.0	**General Information**		
1.1	*Digital copy of* drainage plan, including preliminary Master Grading Plan, preliminary plat and proposed plat, in PDF format and one half size, bound, paper copy.	Yes	
1.2	Professional Engineer's seal, signature and date on plan cover.	Yes	
1.3	Site location map, using color ortho-imagery and showing the project boundaries, a north arrow and an accurate scale.	Yes	
1.4	Narrative of the development type, existing conditions and proposed impacts on stormwater runoff, wetlands, riparian zones and floodplains/floodways.	Yes	
1.5	Discussion of off-site conditions surrounding the proposed development.	Yes	
1.6	Summary table of runoff calculations (pre/post development).	Yes	
1.7	Narrative description of the type and function of the permanent structural stormwater management facilities.	Yes	
2.0	**Existing Conditions Information**		
2.1	**Existing Conditions Drainage Map**		
2.1.1	On-site and *off-site topography*: NAVD 88 datum, one-foot contours with spot elevations	Yes	
2.1.2	On-site and off-site drainage features, including perennial and intermittent streams (with names labeled), conveyance systems such as open channels, ditches, swales and areas of overland flow. Flow direction must be indicated by arrows.	Yes	
2.1.3	Storm sewer system components, including storm drains, inlets, catch basins, gutters, manholes, headwalls, pipes and culverts. Material and size must be noted for all pipes and culverts.	Yes	N/A
2.1.4	Location and boundaries of natural features such as wetlands, lakes, ponds with the normal water elevation noted, rock outcroppings, wooded areas and tree rows.	No	N/A
2.1.5	Location, dimensions and elevations of existing bridges and culvert crossings.	No	N/A
2.1.6	Location of existing utilities (e.g., water, sewer, gas, electric, cable, etc.) with labels and easement boundaries.	Yes	
2.1.7	Groundwater elevations, if applicable.	Yes	
2.1.8	Delineation of predominant soil based on USDA soil surveys and/or on-site soil borings; indicate NRCS soil name and Hydrologic Soil Group for undisturbed surface soils.	Yes	
2.1.9	Land use types per NRCS nomenclature.	Yes	
2.1.10	Footprint of existing impervious areas (labeled, area given in acres).	Yes	
2.1.11	Internal drainage subbasin boundaries used for hydrologic calculations (labeled with ID, total area in acres, impervious area in acres and curve number).	Yes	
2.1.12	Time of concentration flow paths. Indicate and label each segment separately (i.e., overland flow, shallow concentrated, channel1, channel2, etc.). For each segment, provide the appropriate data to calculate Tc (e.g., length, slope, cover type, paved/unpaved, roughness parameters, geometric properties, etc.).	Yes	
2.2	**Existing Conditions Hydrology and Hydraulics Analysis**		

Drainage Plan Checklist			
#	Plan Element Description	Element Included?	Explanation/Notes
2.2.1	Narrative of the hydrologic analysis methodology used (e.g., unit hydrograph or other approved methods).	Yes	
2.2.2	A summary table of drainage subbasin hydrologic parameters (subbasin ID, area in acres, curve number, Tc, etc.).	Yes	
2.2.3	Table of existing condition runoff curve numbers with supporting data and calculations.	Yes	
2.2.4	Table of existing condition times of concentration with supporting data and calculations.	Yes	
2.2.5	A summary table of rainfall data used in the hydrologic analysis, and a reference for the source of the data.	Yes	
2.2.6	Cross-sections and other diagrams of existing open channels, bridge and culvert sections and other hydraulic features as required to illustrate the basis for hydraulic analysis.	No	N/A
2.2.7	Hydrologic and hydraulic analyses for runoff rates, volumes, velocities and elevations. Provide supporting data not specified above and identify assumptions. Include detailed calculations for the 2, 5, 10, 25 & 100-year, 24-hour storm events. Provide results in a tabular form. Provide digital copies of any computer files and models used.	Yes	
3.0	**postdevelopment Conditions Information**		
3.1	**postdevelopment Conditions Drainage Map**		
3.1.1	Proposed project boundary.	Yes	
3.1.2	on-site and off-site topography: NAVD 88 datum, one-foot contours with spot elevations.	Yes	
3.1.3	Existing on-site and off-site drainage features that are to remain after development, including perennial and intermittent streams (with names labeled), conveyance systems such as open channels, ditches, swales and areas of overland flow. Flow direction must be indicated by arrows.	Yes	
3.1.4	Location and description of off-site through-drainage conveyances which are confined to an easement, dedication and/or reserve.	No	N/A
3.1.5	Footprint of proposed impervious areas, including roads, parking lots, buildings and other structures.	Yes	
3.1.6	Location of proposed utilities (e.g., water, sewer, gas, electric, cable, etc.) with labels and easement boundaries.	No	
3.1.7	Delineation of predominant soils, based on anticipated soil textures and NRCS guidelines if different from predevelopment soil conditions; indicate NRCS soil name and Hydrologic Soil Group for surface soils.	Yes	
3.1.8	Land use cover per NRCS nomenclature.	Yes	
3.1.9	Internal drainage subbasin boundaries used for hydrologic calculations (labeled with ID, total area in acres, impervious area in acres and curve number).	Yes	
3.1.10	Proposed limits of land disturbing activity (i.e., grading limits).	Yes	Phase 1 Limits of Disturbance are shown
3.1.11	Time of concentration flow paths. Indicate and label each segment separately (i.e., overland flow, shallow concentrated, channel1, channel2, etc.). For each segment, provide the appropriate data to calculate Tc (e.g., length, slope, cover type, paved/unpaved, roughness parameters, geometric properties, etc.).	Yes	
3.2	**Proposed Conveyances Map**		
3.2.1	on-site and off-site drainage features, including perennial and intermittent streams (with names labeled), proposed conveyance systems (such as open channels, ditches, swales and areas of overland flow, including backyard drainage). Flow direction must be indicated by arrows.	Yes	
3.2.2	Storm sewer system components, including storm drains, inlets, catchbasins, gutters, manholes, headwalls, pipes and culverts. Material and size must be noted for all pipes and culverts.	No	N/A
3.2.3	For any subbasin or drainage area > 40 acres, show that the stormwater flow is confined to an open channel with required side benches and freeboard, or conformance to applicable policy and design requirements if partially enclosed.	No	Not greater than 40 acres
3.2.4	Location(s) of stormwater management facilities and any associated drainage easements.	Yes	
3.2.5	Proposed energy dissipaters and other channel protection devices.	No	N/A
3.2.6	Location(s) and dimension(s) of proposed channel, bridge and culvert crossings.	No	N/A
3.2.7	Normal pool and 100-year pool elevations for ponds and lakes.	No	N/A
3.2.8	Permanent concrete outfall control structure(s) for ponds.	No	N/A
3.2.9	Emergency overflow spillways and top of berm elevations for ponds and other volume/peak discharge control facilities.	No	N/A
3.2.10	Floodplains, ponds, and stormwater management facilities located in reserves.	No	N/A
3.3	***postdevelopment* Conditions Hydrology & Hydraulics**		
3.3.1	Narrative of the hydrologic analysis methodology used (e.g., unit hydrograph or other approved methods).	Yes	

Drainage Plan Checklist			
#	Plan Element Description	Element Included?	Explanation/Notes
3.3.2	A summary table of drainage subbasin hydrologic parameters (subbasin ID, area in acres, curve number, Tc, etc.).	Yes	
3.3.3	Table of postdevelopment condition runoff curve numbers with supporting data and calculations.	Yes	
3.3.4	Table of postdevelopment condition times of concentration with supporting data and calculations.	Yes	
3.3.5	Cross-sections and other diagrams of existing open channels, bridge and culvert sections and other hydraulic features as	No	
3.3.6	Hydrologic and hydraulic analyses for runoff rates, volumes, velocities and elevations. Provide supporting data not specified above and identify assumptions. Include detailed calculations for the 2, 5, 10, 25 & 100-year, 24-hour storm events. Provide results in a tabular form. Provide digital copies of any computer files and models used.	Yes	
3.3.7	Downstream peak discharge assessment (10% Rule) results and supporting data and calculations. Provide digital copies of any computer files and models used.	No	
3.3.8	Stage-storage-discharge or other outlet rating curves and inflow/outflow hydrographs for all ponds.	No	N/A
3.3.9	Demonstrate that the pond contours on the master grading plan and the stage-storage-discharge data are consistent for all ponds.	No	N/A
3.3.10	Demonstrate that all ponds have one foot of freeboard above the 100-year, 24-hour high water level.	No	N/A
3.3.11	Demonstrate that runoff from the proposed project site is discharged in the same manner as prior to development, using level spreaders, energy dissipaters, other devices or grading as required, or identify an appropriate flowage easement.	Yes	
3.4	**Stormwater Quantity Control Sizing**		
3.4.1	Hydraulic sizing calculations for all stormwater management controls.	No	N/A
3.4.2	Table(s) listing all stormwater management controls. Present the types, sizes, elevations, flows, velocities and depths for each control, as applicable. Verify that velocities are self-cleaning and non-erosive.	No	N/A
3.4.3	Typical details (including cross-sections where applicable) for outlet structures, embankments, spillways, grade control structures, conveyance channels, etc.	No	N/A
3.5	**Stormwater Quality Management Facilities**		
3.5.1	Table(s) listing all stormwater management facilities. Present the description, % TSS removal value, water quality volume handled, contributing drainage area in acres and contributing impervious area in acres.	Yes	Hydrodynamic Separator Used
3.5.2	Indicate the responsible party for maintenance, as shown in the plat text (i.e., Home Owners Association, Lot Owners Association, property owner, etc.).	Yes	
3.5.3	Water quality volume (total and by facility), with supporting data and calculations.	No	Water Quality Flow Rate Computed Instead
3.5.4	% TSS removal value (total and by facility) with supporting data and calculation. Must be equal to or greater than 80%.	Yes	
3.5.5	Channel protection volume with supporting data and calculations.	No	N/A
3.5.6	Water quality volume and channel protection volume orifice size calculations.	No	N/A
3.5.7	Other calculations required for each stormwater management facility as specified in the Wichita/Sedgwick County Stormwater Manual.	Yes	
3.5.8	Typical details (including cross-sections where applicable) for outlet structures, embankments, internal grading, forebays and other siltation prefilters, filtration/infiltration media, vegetation, check dams, operational controls, etc.	No	N/A
4.0	**Floodplains**		
4.1	Reference the source of flood profile, floodplain, floodway and stream discharge information.	No	No floodplain located on the property
4.2	Delineation of nearest base flood elevations.	No	N/A
4.3	Delineation of predevelopment regulatory floodplain/floodway limits using FEMA's current GIS database; limits to be per elevation and scaled location.	No	N/A
4.4	Delineation of postdevelopment regulatory floodplain/floodway limits; limits to be per elevation and scaled location, with project limits shown.	No	N/A
4.5	Floodway data table and discharges.	No	N/A
4.6	Hydrologic and hydraulic study information for local floodplain analysis, unnumbered Zone A elevation determinations and floodplain map revisions or required permits.	No	N/A
4.7	Regulatory floodway and four natural profile models (10, 50, 100 and 500-year) for existing and postdevelopment conditions.	No	N/A
4.8	Floodplains and floodways located within a reserve, where necessary.	No	N/A
4.9	Floodplain cut and fill calculations for volume sensitive basins.	No	N/A

Drainage Plan Checklist			
#	Plan Element Description	Element Included?	Explanation/Notes
4.10	Demonstrate that floodway elevations and velocities do not increase due to construction in the floodway ("No Rise Certification").	No	N/A
5.0	**Federal, State and Local Permits**		
5.1	US Army Corps of Engineers regulatory program permits (Section 404 permit)	No	N/A
5.2	Kansas Department of Agriculture - Division of Water Resources Permits (Stream Obstruction, Channel Change, Floodplain Fill, Levee, Water Appropriations, Dam Safety permit, etc.).	No	N/A
5.3	FEMA letters of map change/revision - LOMA, LOMR, LOMR-f, CLOMR, etc.; shall be included and approved when project modifies the limits of the floodplain/floodway.	No	N/A
6.0	**Half Scale Preliminary Master Grading Plan**		
6.1	One set of plans and associated PDF of plans.	Yes	
6.2	Professional Engineer's seal, signature and date.	Yes	
6.3	Title block including subdivision name and phase and dated revision documentation.	Yes	
6.4	Future phases shown but cross-hatched as information only.	Yes	
6.5	Scale, not greater than 1-inch = 60 feet.	Yes	
6.6	North arrow.	Yes	
6.7	Index or legend key.	Yes	
6.8	Benchmarks (minimum of 2) used for site control (NAVD 88 vertical datum).	Yes	
6.9	Existing contours of entire site with contour interval of one foot.	Yes	
6.10	Proposed contours for channels, ponds, and other permanent stormwater management facilities, with contour interval of one foot.	No	
6.11	Spot elevations shown to the nearest tenth of a foot for critical locations, including lot and property boundaries.	Yes	
6.12	Proposed lot and street layout.	Yes	
6.13	Locations of underground storm drains.	Yes	
6.14	Overflow locations for storms exceeding storm drain capacity, with elevations.	Yes	
6.15	Top elevations of storm drains at all inlets, manholes, and flow line elevations for all outfalls.	No	
6.16	Locations of open ditches and lakes.	No	
6.17	Flow direction arrows.	Yes	
6.18	Proposed flow line elevations of all open ditches at maximum 100 foot intervals, and 100-year flood elevations thereon.	No	
6.19	Ponds: Location, bottom elevation, normal pool elevation, 100-year flood elevation, emergency overflow elevation.	No	
6.20	Proposed top-of-curb elevations at points where drainage will be required to flow over the curb.	Yes	
6.21	Platted minimum building opening elevation for each lot, in table form for all lots (excluding basement floor elevations).	No	
6.22	Standard foundation and elevation detail for slab on grade, full basement, view-out, partial view-out and/or walk-out construction.	No	N/A
6.23	Top of foundation elevation for each lot.	No	
6.24	Notation for builders for each lot as to the type of structure that may be constructed and the view-out, walk-out or pad elevation, as applicable.	No	
6.25	Indicate that all lots are above the 100-year flood elevation.	No	
6.26	Indicate that grading around structures conforms to perimeter drainage requirements.	Yes	
6.27	Indicate that backyard drainage grading conforms to backyard drainage requirements.	Yes	
6.28	Adjacent subdivision lot lines, with lot labels and subdivision names.	Yes	
6.29	Boundaries and labels for all easements, rights-of-way and reserves.	Yes	
6.30	Statement on proposed final plat: "*A drainage plan has been developed for the subdivision and all drainage easements, rights-of-way, or reserves shall remain at the established grades and remain unobstructed to allow for the conveyance of stormwater.*"	Yes	
End of Checklist			

CERTIFIED ENGINEERING DESIGN, P.A
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(316)262-8808 Office
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LETTER OF TRANSMITTAL

DATE: March 4th, 2013

TO: Mr. Scott Lindebak, P.E.
Engineering Division
City of Wichita
8th Floor, City Hall
455 N. Main
Wichita, KS 67202

RE: Drainage Plan
Hing Addition
Wichita, KS

FROM: Harlan D. Foraker, P.E. HDF

cc: Mr. Mark Savoy, Savoy Company, P.A.

I. TAB 1 – PROJECT NARRATIVE:

Discussion of Development

The goal of this report is to analyze the existing drainage patterns and design the proposed drainage system to serve Hing Addition in Wichita, KS. This site is located northwest of the intersection of S. Woodchuck and W Irving St. The north half of the site is developed as a car lot with customer service building. The south half of the site is developed as a residential lot with an existing house. Existing Conditions reveal an impervious area of 1.37 acres. The SCS soil types present on the site are the Nalim Loam (SCS Type C Soil) and Tabler Silty Clay Loam (SCS Type D Soil).

The proposed improvements include adding a 125'x80' building with parking area. The total area of the proposed property is 2.46 acres, with approximately 0.66 acres to be disturbed during phase 1 improvements. Phase 1 improvements will cause an increase in the amount of impervious area by 0.51 acres. An aerial photograph of the proposed plat site is located in the Appendix. Phase 1 limits of disturbance can be seen on the Developed Drainage Map in the Appendix.

Future Development

In addition to phase 1 improvements, future development is projected to occur on the southern portion of the lot. When the total land disturbance becomes more than 1 acre for the property, including the phase 1 improvements, a water quality device will need to be installed. Detention will not be required for this site as long as the increase

in impervious area stays less than 1 acre for the property when compared to existing conditions. An approximate future phase development outline can be seen in the Developed Drainage Map in the Appendix.

Offsite Conditions

It appears that no offsite drainage enters the site from surrounding properties based on looking at the LIDAR data for the City of Wichita. A copy of the USGS map is located in the Appendix.

Description of Best Management Practices

The proposed limits of disturbance are less than 1 acre for phase 1 improvements. Therefore there are no best management practices incorporated into the site design at this time.

Summary of Runoff Calculations

The runoff calculations were computed assuming both phase 1 and future development were mostly impervious. The entire property was assumed to have a percent impervious area of 97 percent. The proposed runoff calculations cause an increase in peak discharge for all storm events when compared with existing runoff calculations. Table 1 shows existing and developed runoff calculations.

Total Existing vs Developed Runoff			
Description	*Percent Impervious (%)*	*Area (acres)*	*Q (cfs)*
Existing Peak Runoff (2 yr.)	56	2.46	5.66
Existing Peak Runoff (5 yr.)		2.46	6.95
Existing Peak Runoff (10 yr.)		2.46	8.52
Existing Peak Runoff (25 yr.)		2.46	10.16
Existing Peak Runoff (100 yr.)		2.46	13.60
Developed Peak Runoff (2 yr.)	97	2.46	8.03
Developed Peak Runoff (5 yr.)		2.46	9.67
Developed Peak Runoff (10 yr.)		2.46	11.34
Developed Peak Runoff (25 yr.)		2.46	13.32
Developed Peak Runoff (100 yr.)		2.46	16.56

TABLE 1 – EXISTING AND DEVELOPED RUNOFF CALCULATIONS

Runoff Method

The rational method was used to compute the peak discharges for existing and proposed conditions. Rational 'C' factors were assigned to the existing site and proposed improvements from the City of Wichita Storm Water Manual. Rainfall intensity tables from the manual were utilized to determine the rainfall intensity for the 2, 5, 10, 25, and 100 year design storms. The Soil Conservation Service TR-55 manual was used to compute the time of concentration for the drainage areas. A design assumption was made as follows: that the minimum time of concentration is 15 minutes. Time of concentration calculations can be seen in the Appendix.

Soil Types were determined from the Natural Resource Conservation Soil Survey website. The SCS soil types present are the Nalim Loam (SCS Type C Soil) and Tabler Silty Clay Loam (SCS Type D Soil).

II. TAB 2 – EXISTING CONDITIONS RUNOFF CALCULATIONS

Existing Conditions

The proposed plat site has been divided into two existing sub-basins. A summary of the existing drainage calculations can be seen in Table 2. The existing drainage basins can be seen on the Existing Drainage map located in the Appendix.

Existing Peak Runoff						
Description	Percent Impervious (%)	C	Tc	I (in./hr)	Area (acres)	Q (cfs)
Existing Sub-Basin A (2 yr.)	98	0.86	15	3.83	0.47	1.55
Existing Sub-Basin A (5 yr.)		0.87	15	4.56	0.47	1.86
Existing Sub-Basin A (10 yr.)		0.89	15	5.22	0.47	2.18
Existing Sub-Basin A (25 yr.)		0.90	15	6.06	0.47	2.56
Existing Sub-Basin A (100 yr.)		0.92	15	7.37	0.47	3.19
Existing Sub-Basin B (2 yr.)	46	0.54	15	3.83	1.99	4.12
Existing Sub-Basin B (5 yr.)		0.56	15	4.56	1.99	5.08
Existing Sub-Basin B (10 yr.)		0.61	15	5.22	1.99	6.34
Existing Sub-Basin B (25 yr.)		0.63	15	6.06	1.99	7.60
Existing Sub-Basin B (100 yr.)		0.71	15	7.37	1.99	10.41

Table 2 – Existing Runoff Calculations

The combined 100-yr existing peak discharge for the existing site is 13.60 cfs.

Ground Water Elevations

According to the Kansas Geological Survey's Kansas Water Well Database, the static water surface elevation of the ground water in this area is around 30 ft below the existing ground.

III. TAB 3 – DEVELOPED CONDITIONS RUNOFF CALCULATIONS

Developed Conditions

The proposed plat site is divided into three developed sub-basins. For developed conditions, the site will continue to drain the same as existing conditions. The only change to the site will be the addition of curb and gutter along the west property line to keep runoff from draining to the adjacent property. This curb and gutter system will direct the runoff to the south where it will exit onto W. Irving Ave. For drainage analysis purposes, sub-basin C was assumed to be 96% impervious. This includes existing, phase 1, and future development impervious areas. A summary of the developed drainage calculations can be seen in Table 3. The developed drainage basins can be seen on the Developed Drainage Map located in the Appendix.

Developed Peak Runoff						
Description	Percent Impervious (%)	C	Tc	I (in./hr)	Area (acres)	Q (cfs)
Developed Sub-basin A (2 yr.)	98	0.86	15	3.83	0.47	1.55
Developed Sub-basin A (5 yr.)		0.87	15	4.56	0.47	1.86
Developed Sub-basin A (10 yr.)		0.89	15	5.22	0.47	2.18
Developed Sub-basin A (25 yr.)		0.90	15	6.06	0.47	2.56
Developed Sub-basin A (100 yr.)		0.92	15	7.37	0.47	3.19
Developed Sub-basin B (2 yr.)	97	0.85	15	3.83	0.36	1.17
Developed Sub-basin B (5 yr.)		0.86	15	4.56	0.36	1.41
Developed Sub-basin B (10 yr.)		0.89	15	5.22	0.36	1.67
Developed Sub-basin B (25 yr.)		0.90	15	6.06	0.36	1.96
Developed Sub-basin B (100 yr.)		0.92	15	7.37	0.36	2.44
Developed Sub-basin C (2 yr.)	96	0.85	15	3.83	1.63	5.31
Developed Sub-basin C (5 yr.)		0.86	15	4.56	1.63	6.39
Developed Sub-basin C (10 yr.)		0.88	15	5.22	1.63	7.49
Developed Sub-basin C (25 yr.)		0.89	15	6.06	1.63	8.79
Developed Sub-basin C (100 yr.)		0.91	15	7.37	1.63	10.93

Table 3 – Developed Runoff Calculations

The combined 100-yr developed peak discharge for the site is 16.56 cfs. This gives an increase in the peak discharge of about 2.96 cfs for the 100 yr design storm. The increase in runoff should not adversely effect the runoff onto W. Irving Ave.

Storm Water Quantity

Detention will not be required for this site as long as the net increase in impervious area is less than 1 acre for any property improvements. The total amount of impervious area for existing conditions is 1.37 acres. Therefore the total amount of impervious area for the proposed property can be no more than 2.36 acres. This gives a cumulative increase in impervious area of 0.99 acres.

Storm Water Quality

The proposed land disturbance for phase 1 improvements will be less than 1 acre, therefore no storm water quality will be required for this site. However, if the total land disturbance becomes more than 1 acre for the property, including the phase 1 improvements, the site will need to provide water quality treatment.

Water Quality will be achieved by the use of a hydrodynamic separator at the southwest end of the property. The curb and gutter system will direct runoff to the proposed hydrodynamic separator.

The proposed storm water quality calculations were computed to meet the regulations in the City of Wichita "Storm Water Manual" for re-developments. Existing conditions reveal an impervious area of 1.37 acres. The reduced water quality treatment area was calculated to be 1.50 acres.

Sub-basin C drains an area of 1.63 acres. This area will be treated by the water quality unit since it is larger than the 1.50 acres that are required to be treated. Computed water quality peak flow calculations for the hydrodynamic separator can be seen in Table 4 below.

DATA		
Area =	1.63	acres
Tc =	0.25	hours
P =	1.2	inches
Rv =	0.92	
CALCULATIONS		
Qwv =	1.104	inches
CN =	99.2	
S =	0.08	inches
Ia =	0.02	inches
Ia/P =	0.014	
qu (Fig. 4-6) =	730	cfs/mi^2*in
Qwq =	2.05	cfs

Table 4 – Water Quality Peak Flow Calculations for Sub-basin A

The calculated water quality peak flow rate from the calculations above is 2.05 cfs. The hydrodynamic separator selected to treat the water quality flow rate is a model number HG6 produced by Hydroworks, LLC. This unit can treat a particle size of 200 microns with a 2.4 cfs water quality flow rate at a %TSS (total suspended solids) removal rate of around 93%. The program used to size the hydrodynamic separator is called Hydroworks Stormwater Treatment Simulation produced by Hydroworks, LLC. The program output used in the design of the unit is attached in the Appendix along with a detail of the HG6 unit.

The total %TSS removal rate for the site is equal to the %TSS removal rate of the hydrodynamic separator of around 93%. The responsible party for maintenance of the hydrodynamic separator will be the property owner(s) of Hing Addition, an addition to Wichita, Sedgwick County, Kansas.

Channel Protection

Channel protection is not required since the total amount of disturbed area will be less than 5 acres.

IV. TAB 4 – FLOODPLAIN SUBMITTAL

FEMA Floodplain Boundary

There is no FEMA floodplain located on this property. A copy of the FEMA floodplain map is attached for review in the Appendix.

V. TAB 5 – FEDERAL, STATE, AND LOCAL PERMITS

A. US Army Corps of Engineers

Not Applicable

B. Kansas Department of Agriculture

Not Applicable

C. Federal Emergency Management Agency (FEMA)

Not Applicable

D. Kansas Department of Transportation

Not Applicable

E. Sedgwick County Right-of-way Permit

Not Applicable

APPENDIX

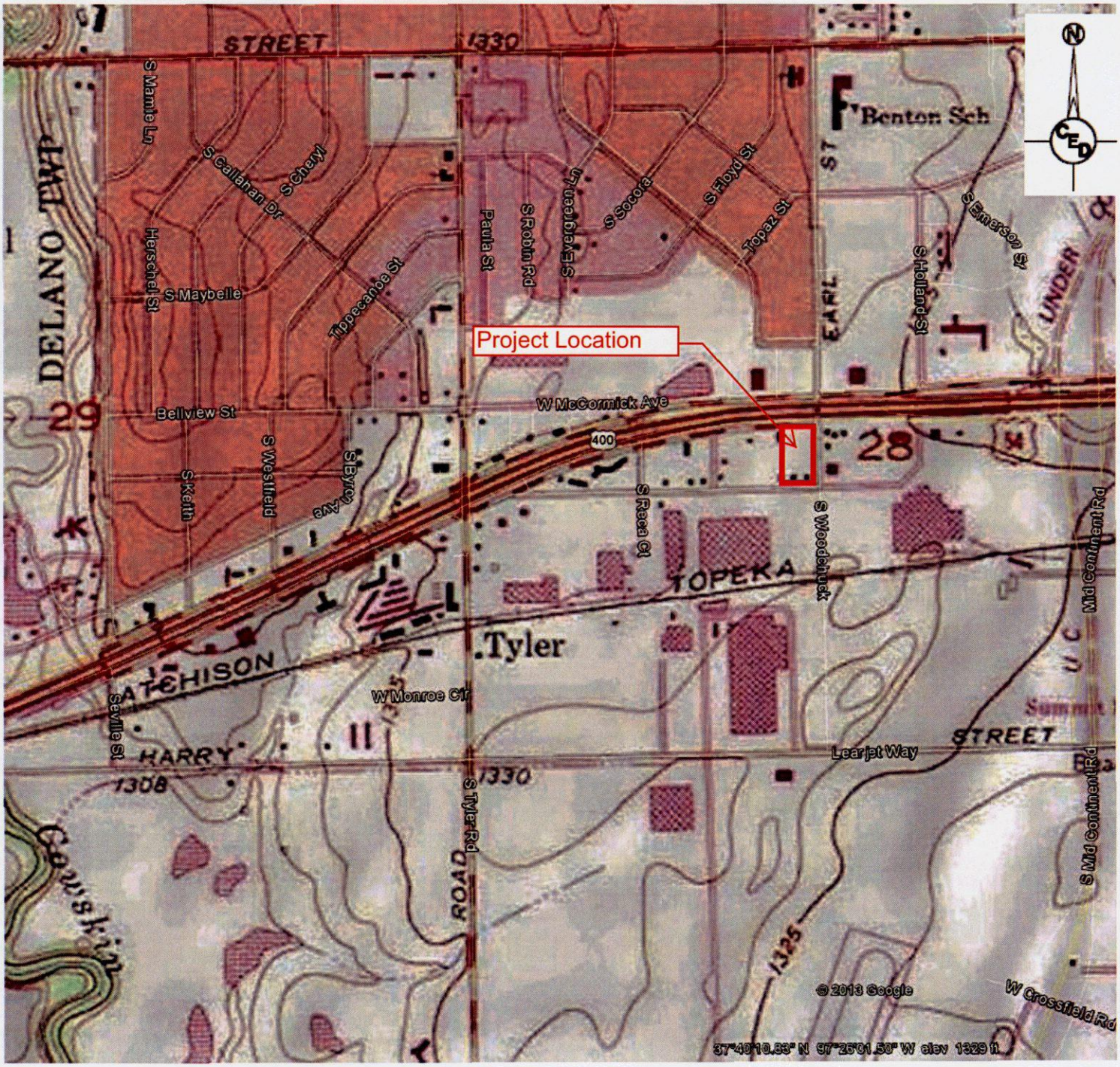
GENERAL MAPS

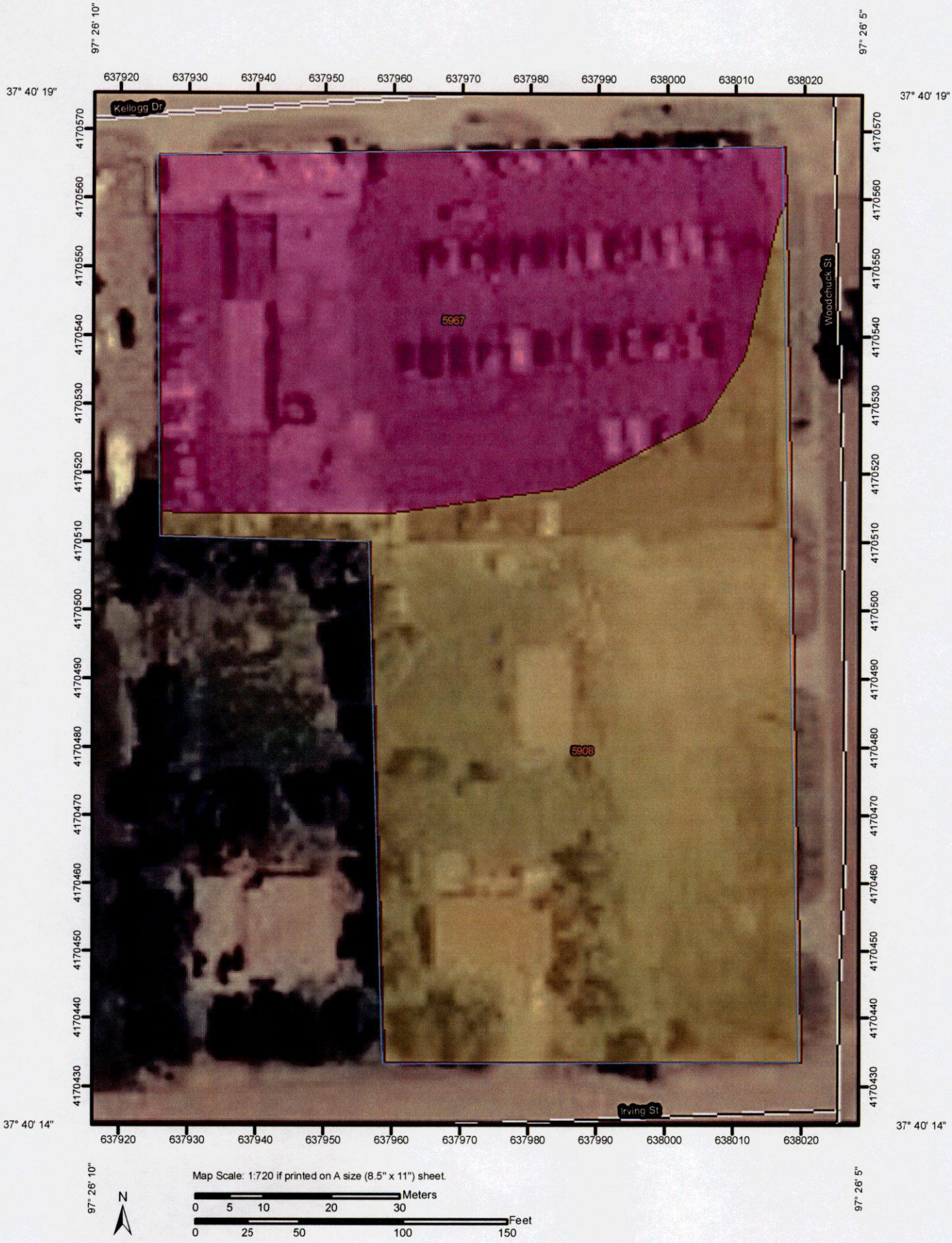
Aerial Photo

Hing Addition
An Addition to
Wichita, Sedgwick County, KS
CED Job # 20132089

Quad Map

Hing Addition
An Addition to
Wichita, Sedgwick County, KS
CED Job # 20132089




97° 26' 10"
97° 26' 5"
37° 40' 19"
37° 40' 14"
637920
637930
637940
637950
637960
637970
637980
637990
638000
638010
638020
4170570
4170560
4170550
4170540
4170530
4170520
4170510
4170500
4170490
4170480
4170470
4170460
4170450
4170440
4170430
Kellogg Dr
Woodchuck St
Irving St
5967
5908
Map Scale: 1:720 if printed on A size (8.5" x 11") sheet.
N
Meters
0 5 10 20 30
Feet
0 25 50 100 150

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Soil Ratings

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Political Features

- Cities

Water Features

- Streams and Canals

Transportation

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

MAP INFORMATION

Map Scale: 1:720 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 14N NAD83

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

Soil Survey Area: Sedgwick County, Kansas
Survey Area Data: Version 8, Sep 20, 2012

Date(s) aerial images were photographed: 6/20/2006

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.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Sedgwick County, Kansas (KS173)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
5908	Nalim loam, 0 to 1 percent slopes	C	1.4	56.6%
5967	Tabler silty clay loam, 0 to 1 percent slopes	D	1.1	43.4%
Totals for Area of Interest			**2.4**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

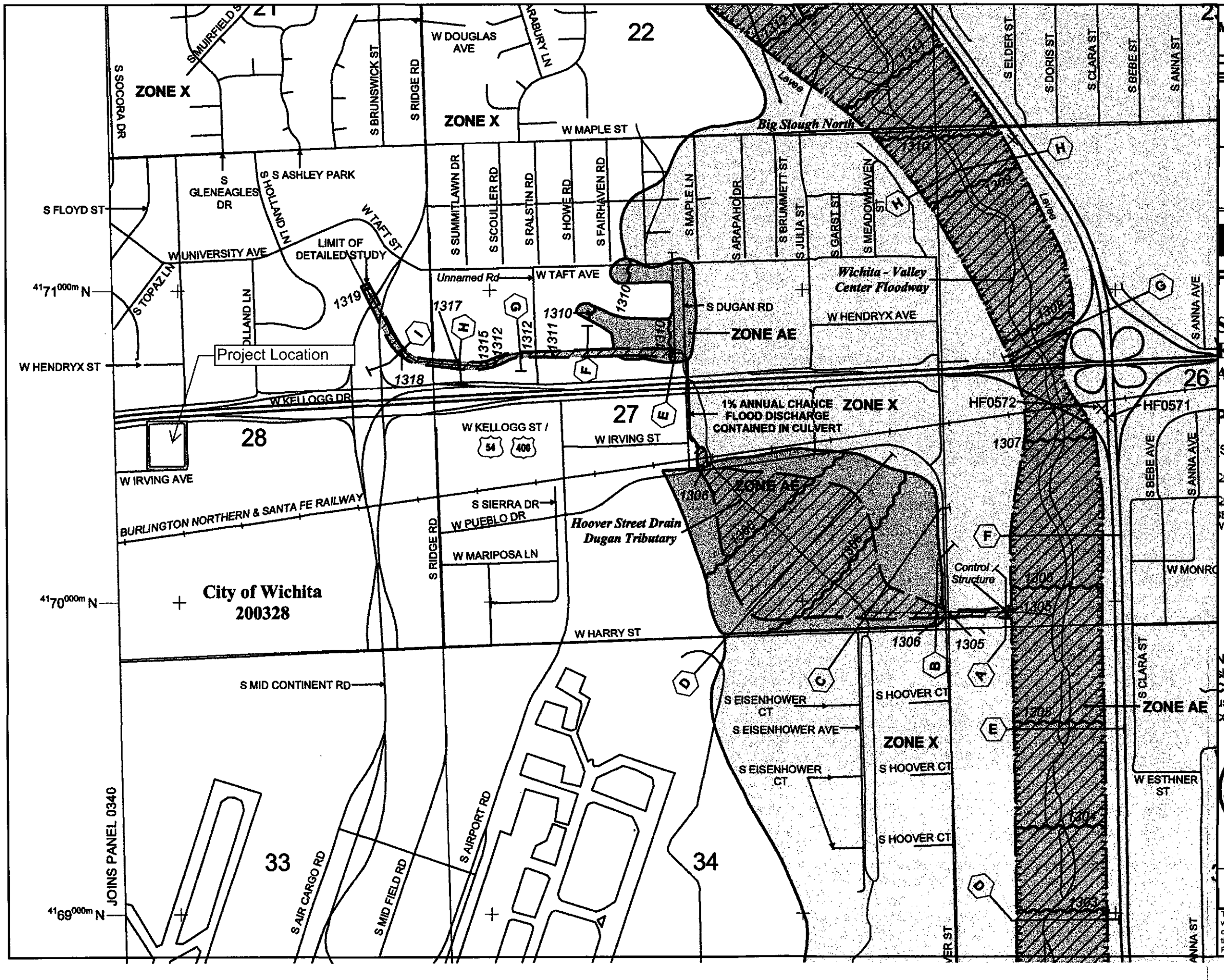
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher



PANEL 0345E

FIRM

FLOOD INSURANCE RATE MAP

SEDGWICK COUNTY, KANSAS AND INCORPORATED AREAS

PANEL 345 OF 700

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
SEDGWICK COUNTY	200321	0345	E
WICHITA, CITY OF	200328	0345	E

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on Insurance applications for the subject community.

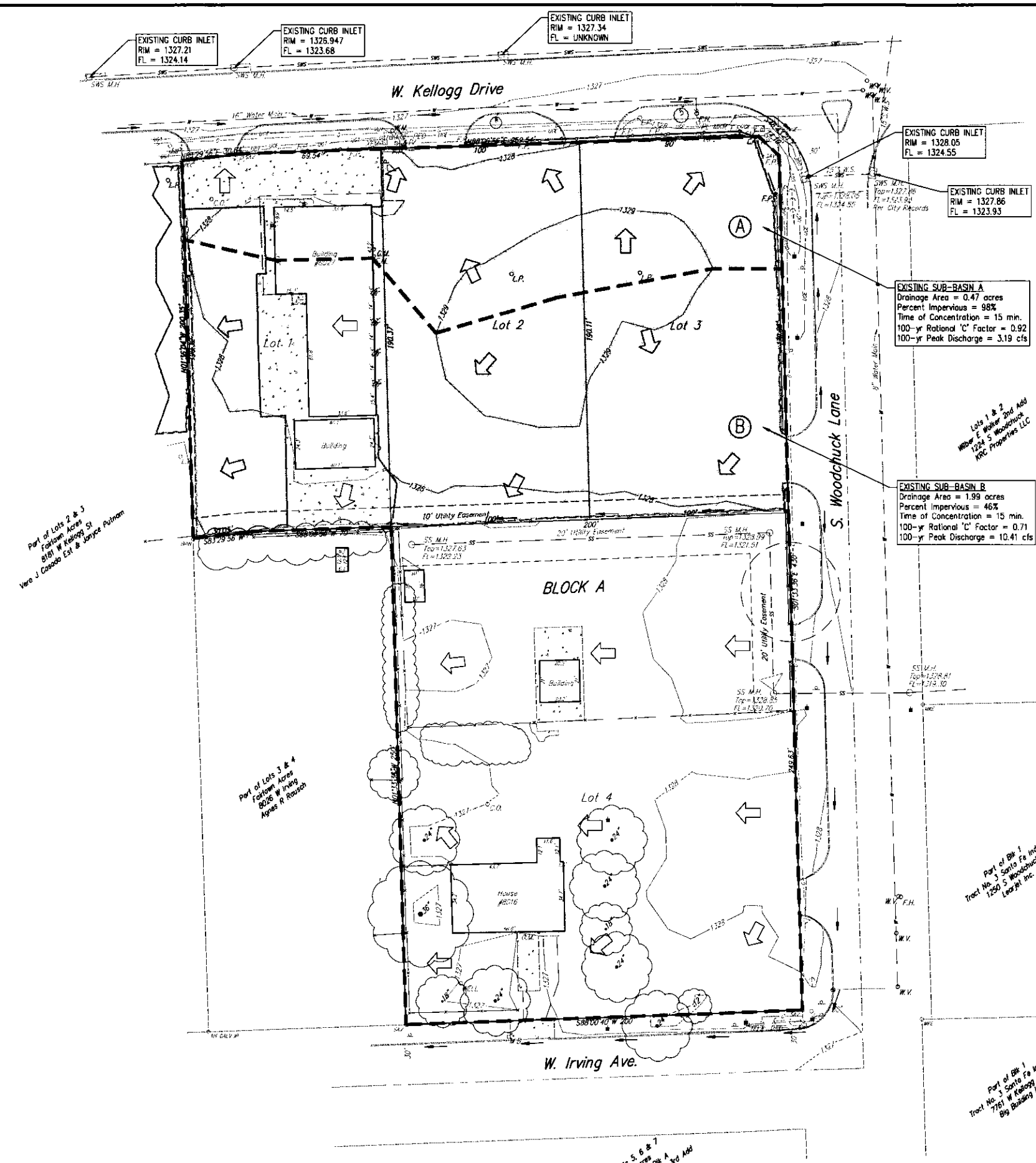
MAP NUMBER
20173C0345E

EFFECTIVE DATE
FEBRUARY 2, 2007

Federal Emergency Management Agency

Static Water Level Depth (ft)

EXISTING AND DEVELOPED DRAINAGE MAP



DRAINAGE LEGEND

- SHEET FLOW
- CONCENTRATED FLOW
- DRAINAGE FLOW PATH
- DRAINAGE SUB-BASIN BOUNDARY
- 1329 EXISTING CONTOURS

EXISTING AREA CALCULATIONS:

PROPERTY AREA = 2.46 ACRES
EXISTING IMPERVIOUS AREA = 1.37 ACRES

SURVEY MARKER LEGEND

- = 1" Galvanized Iron Pipe
- = 3/4" Iron Pipe
- = 1/2" Rebar w/Boughman Cap
- = 1/2" Rebar w/Mid Kansas Engineering Cap
- = 1/2" Rebar w/Professional Engineering Consultants Cap
- = 1/2" Rebar w/Survey Cap (Set)

LEGEND

G = GAS MAIN
W = WATER MAIN
SS = SANITARY SEWER
SWS = STORM WATER SEWER
UGE = UNDER GROUND ELECTRIC
UGT = UNDER GROUND TELEPHONE

- B.M. . . . . BENCH MARK
- TELE PED . . . . . TELEPHONE PEDESTAL
- C.O. . . . . CLEAN OUT
- CATV . . . . . CABLE TELEVISION PEDESTAL
- E.B. . . . . ELECTRIC BOX
- E.M. . . . . ELECTRIC METER
- F.H. . . . . FIRE HYDRANT
- F.P. . . . . FLAG POLE
- GUY ANCHOR
- G.M. . . . . GAS METER
- G.P. . . . . GUARD POST
- L.P. . . . . LIGHT POLE
- M.B. . . . . MAIL BOX
- O.H. . . . . OBSERVATION HOLE
- PL MKR . . . . . PIPELINE MARKER
- POWER POLE
- SIGN
- WELL . . . . . WATER WELL
- W.M. . . . . WATER METER
- W.V. . . . . WATER VALVE
- XFMR . . . . . ELECTRIC TRANSFORMER
- SS M.H. . . . . SANITARY SEWER MANHOLE
- SWS M.H. . . . . STORM WATER SEWER MANHOLE

REV.	DESCRIPTION	DATE

N

GRAPHIC SCALE
30' 0 30'
(IN FEET)
1"=30'

HALF SCALE 1" = 60'

HING ADDITION

AN ADDITION TO
WICHITA, SEDGWICK COUNTY, KS

ALEXANDER MOTORS
8027 W. KELLOGG

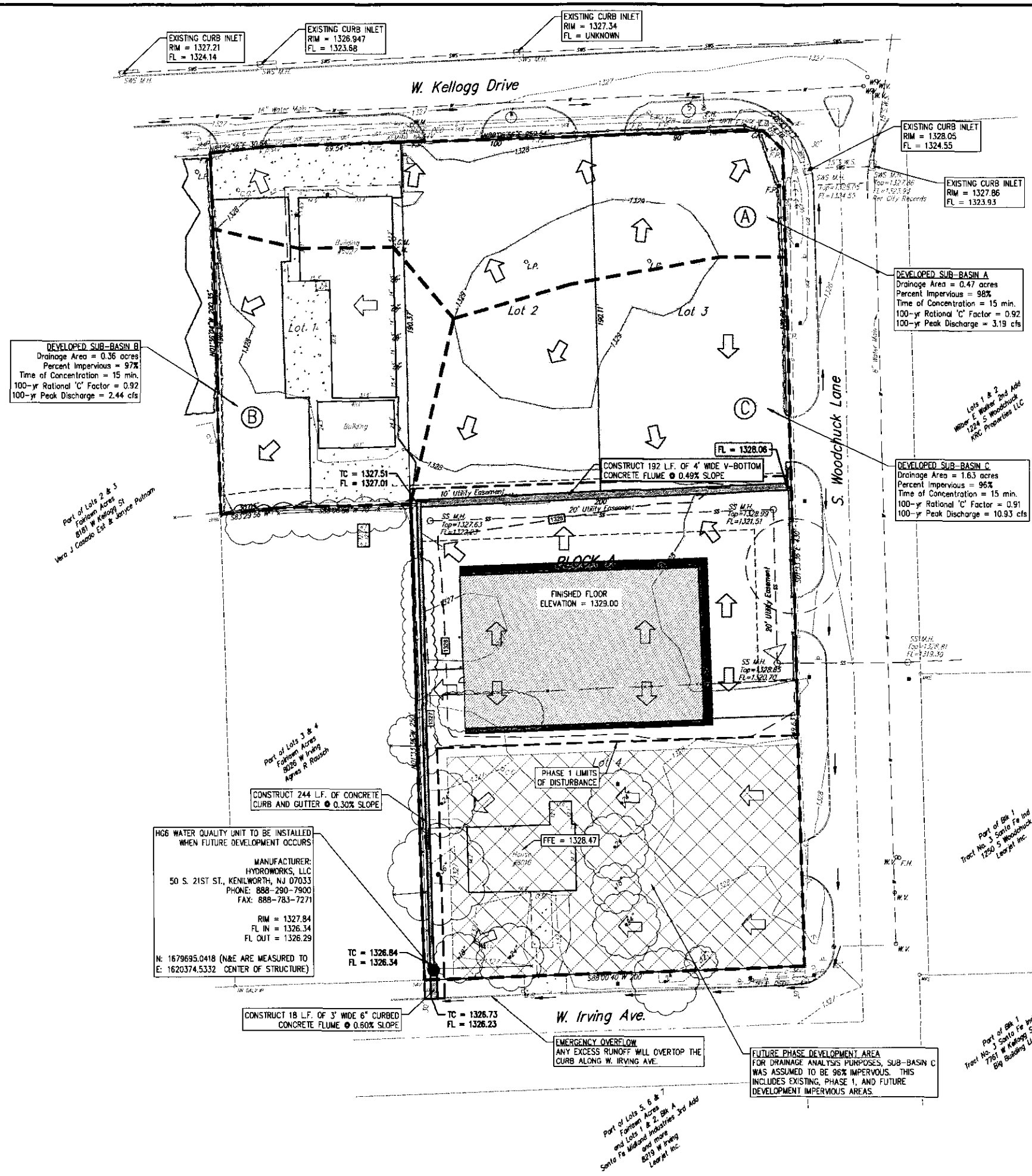
CERTIFIED ENGINEERING DESIGN, P.A.
CIVIL ENGINEERING SERVICES

1935 WEST MAPLE STREET
WICHITA, KANSAS 67213
PH.(316)262-8808 FAX.(316)262-1669

HARLAN DALE FORAKER
LICENSED
10891
3-13
KANSAS
PROFESSIONAL ENGINEER

PROJECT NO.: 20132089
ISSUE DATE: 03/04/13
CONTACT: L. MILLS / H. FORAKER
CHECKED BY:

EXISTING DRAINAGE



REV.	DESCRIPTION	DATE

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30' 0 30'
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1"=30'

HALF SCALE 1" = 60'

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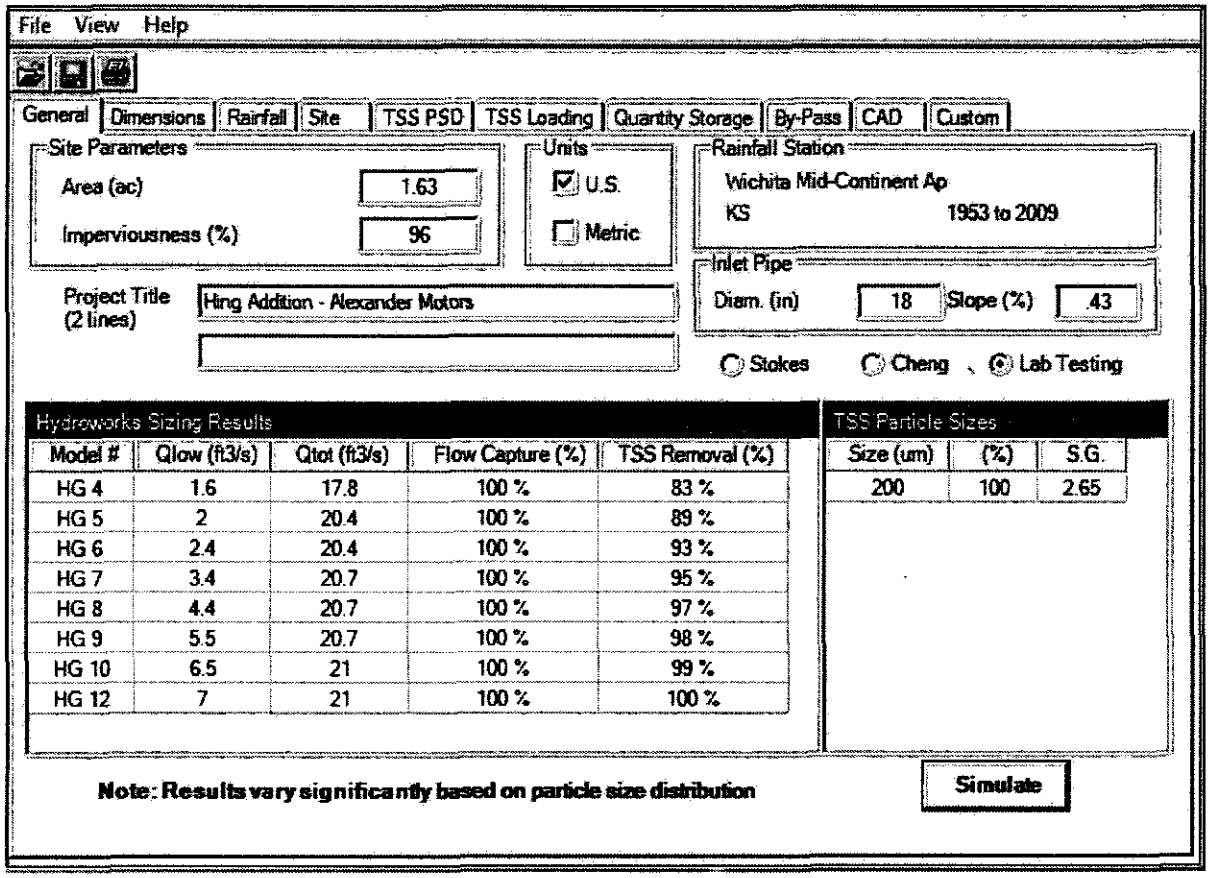
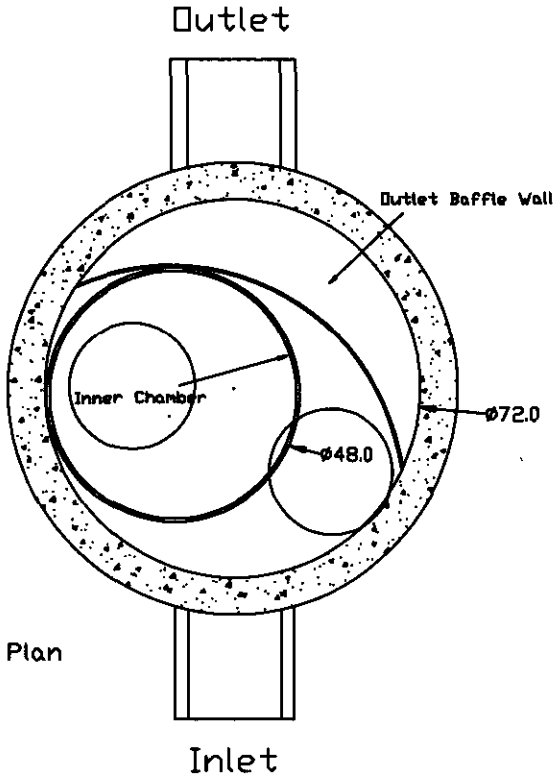
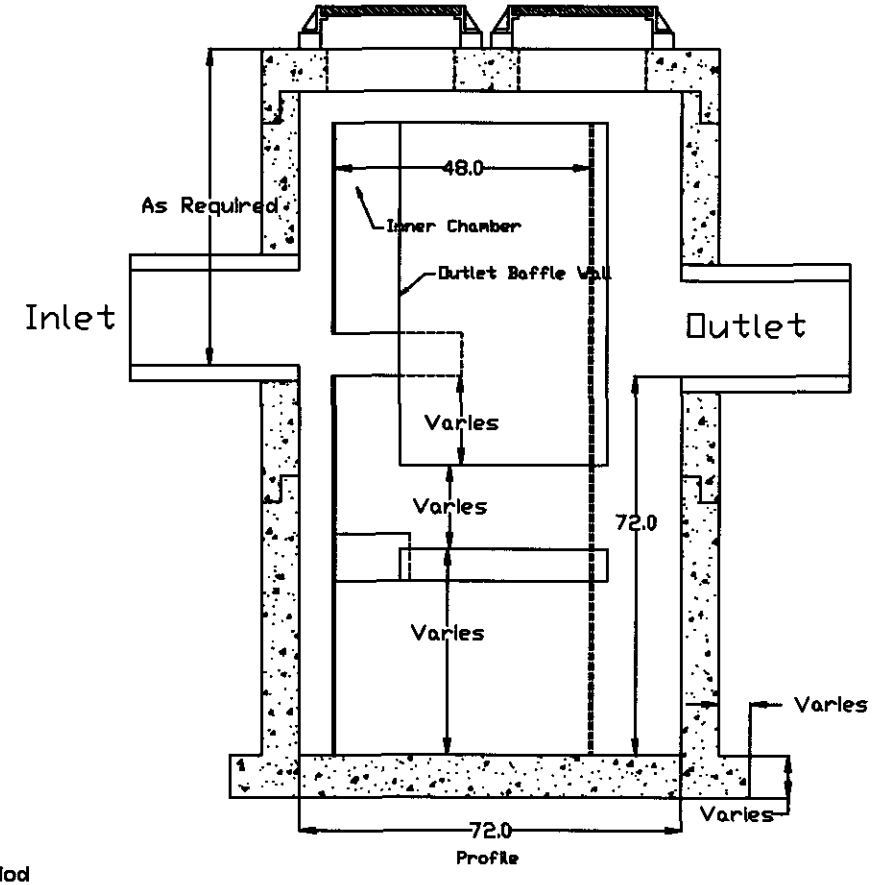
PROJECT NO.: 20132089
ISSUE DATE: 03/04/13
CONTACT: L. MILLS / H. FORAKER
CHECKED BY:

DEVELOPED DRAINAGE

HYDRODYNAMIC SEPARATOR INFORMATION


File View Help
General
Dimensions
Rainfall
Site
TSS PSD
TSS Loading
Quantity Storage
By-Pass
CAD
Custom
Site Parameters
Area (ac)
1.63
Imperviousness (%)
96
Units
U.S.
Metric
Rainfall Station
Wichita Mid-Continent Ap
KS
1953 to 2009
Inlet Pipe
Diam. (in)
18
Slope (%)
.43
Project Title (2 lines)
Hing Addition - Alexander Motors
Stokes
Cheng
Lab Testing
Hydroworks Sizing Results
Model # | Qlow (ft3/s) | Qtot (ft3/s) | Flow Capture (%) | TSS Removal (%)
HG 4 | 1.6 | 17.8 | 100 % | 83 %
HG 5 | 2 | 20.4 | 100 % | 89 %
HG 6 | 2.4 | 20.4 | 100 % | 93 %
HG 7 | 3.4 | 20.7 | 100 % | 95 %
HG 8 | 4.4 | 20.7 | 100 % | 97 %
HG 9 | 5.5 | 20.7 | 100 % | 98 %
HG 10 | 6.5 | 21 | 100 % | 99 %
HG 12 | 7 | 21 | 100 % | 100 %
TSS Particle Sizes
Size (um) | (%) | S.G.
200 | 100 | 2.65
Note: Results vary significantly based on particle size distribution
Simulate





U.S. Patent No. 6,951,619

Dimensions in inches
Permanent Pool Volume = 1250 US gallons
The Hydroguard must be cleaned after the construction period if it is used as a sediment and erosion control measure
The Hydroguard should be inspected once per year for stabilized sites
Inspection will determine the maintenance frequency (annual maintenance or once every two years typical for stabilized sites)
Sites with unstable conditions (exposed soil or materials storage) will require more frequent inspection and maintenance

Hydroworks, LLC
50 S. 21st St., Kenilworth, NJ 07033
Phone: 888-290-7900 Fax: 888-783-7271
Web: www.hydroworks.com

Hydroworks HG6 (72"ø)

PROJECT:

LOCATION:

REVISION DATE: 02/10/2011

Hydroworks

Hydroworks® Hydroguard

Maintenance Manual

Version 1.3

Introduction

The Hydroguard is a state of the art hydrodynamic separator. Hydrodynamic separators remove solids, debris and lighter than water (oil, trash, floating debris) pollutants from stormwater. Hydrodynamic separators and other water quality measures are mandated by regulatory agencies (Town/City, State, Federal Government) to protect storm water quality from pollution generated by urban development (traffic, people) as part of new development permitting requirements.

As storm water treatment structures fill up with pollutants they become less and less effective in removing new pollution. Therefore it is important that storm water treatment structures be maintained on a regular basis to ensure that they are operating at optimum performance. The Hydroguard is no different in this regard and this manual has been assembled to provide the owner/operator with the necessary information to inspect and coordinate maintenance of their Hydroguard.

Hydroworks® HG Operation

The Hydroworks HG separator is unique since it treats both high and low flows in one device, but maintains separate flow paths for low and high flows. Accordingly, high flows do not scour out the fines that are settled in the low flow path since they are treated in a separate area of the device as shown in Figure 1.

The HG separator consists of three chambers:

1. an inner chamber that treats low or normal flows
2. a middle chamber that treats high flows
3. an outlet chamber where water is discharged to the downstream storm system

Under normal or low flows, water enters the middle chamber and is conveyed into the inner chamber by momentum. Since the inner chamber is offset to one side of the structure the water strikes the wall of the inner chamber at a tangent creating a vortex within the inner chamber. The vortex motion forces solids and floatables to the middle of the inner chamber. The water spirals down the inner chamber to the outlet of the inner chamber which is located below the inlet of the inner chamber and adjacent to the wall of the structure but above the floor of the structure. Floatables are trapped since the outlet of the inner chamber is submerged. The design maximizes the retention of settled solids since solids are forced to the center of the inner chamber by the vortex motion of water while the outlet of the inner chamber draws water from the wall of the inner chamber.

The water leaving the inner chamber continues into the middle chamber, again at a tangent to the wall of the structure. The water is then conveyed through an outlet baffle wall (high and low baffle). This enhances the collection of any floatables or solids not removed by the inner chamber. Water flowing through the baffles then enters the outlet chamber and is discharged into the downstream storm drain.

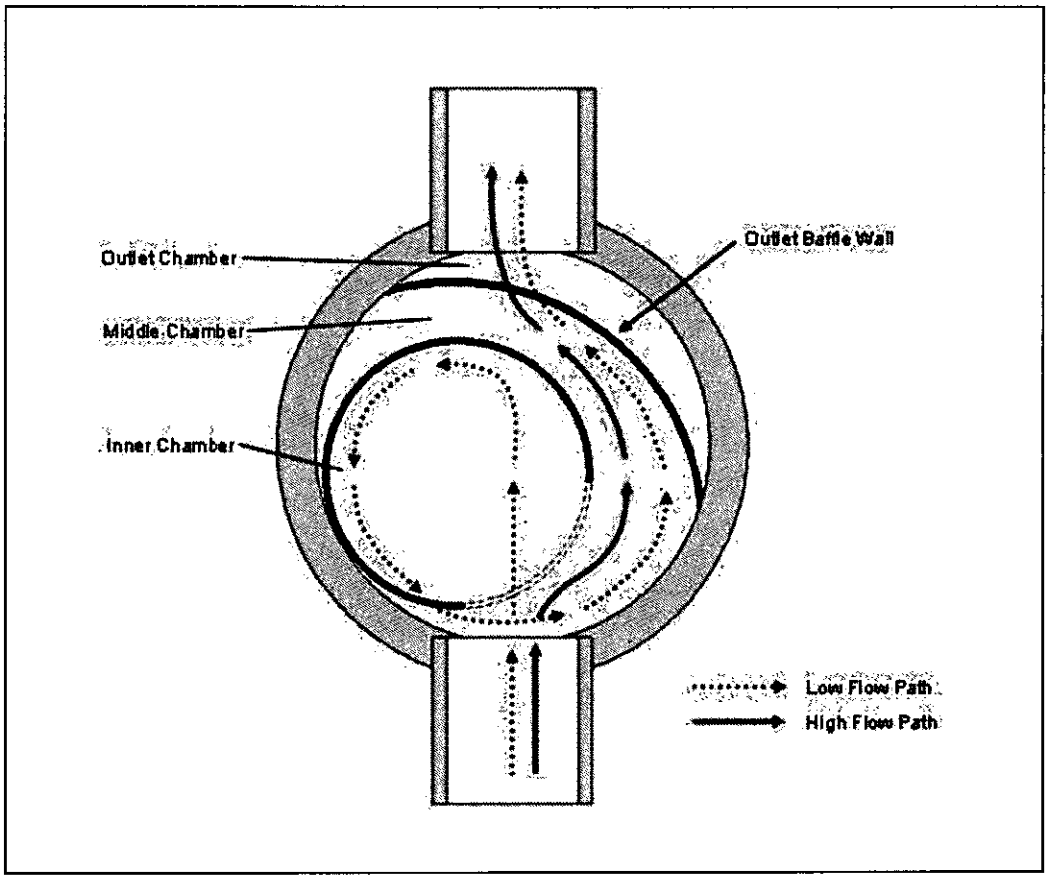


Figure 1. Hydroworks HG Operation – Plan View

During high flows, the flow rate entering the inner chamber is restricted by the size of the inlet opening to the inner chamber. This restriction of flow rate into the inner chamber prevents scour and re-suspension of solids from the inner chamber during periods of high flow. This is important since fines, which are typically considered highly polluted, are conveyed during low/normal flows.

The excess flow is conveyed directly into the middle chamber where it receives treatment for floatables and solids via the baffle system. This treatment of the higher flow rates is important since trash and heavier solids are typically conveyed during periods of higher flow rates. The Hydroworks HG separator is revolutionary since it incorporates low and high flow treatment in one device while maintaining separate low and high flow paths to prevent the scour and re-suspension of fines.

Figure 2 is a profile view of the HG separator showing the flow patterns for low and high flows.

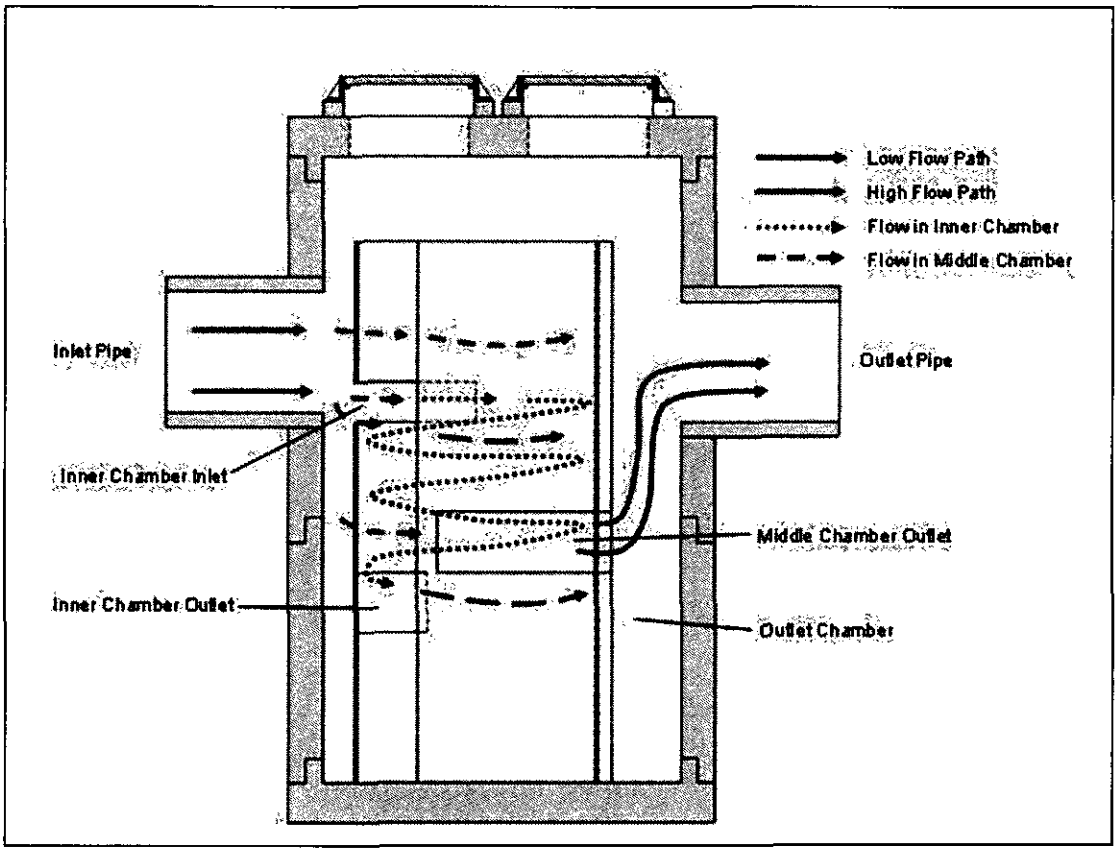
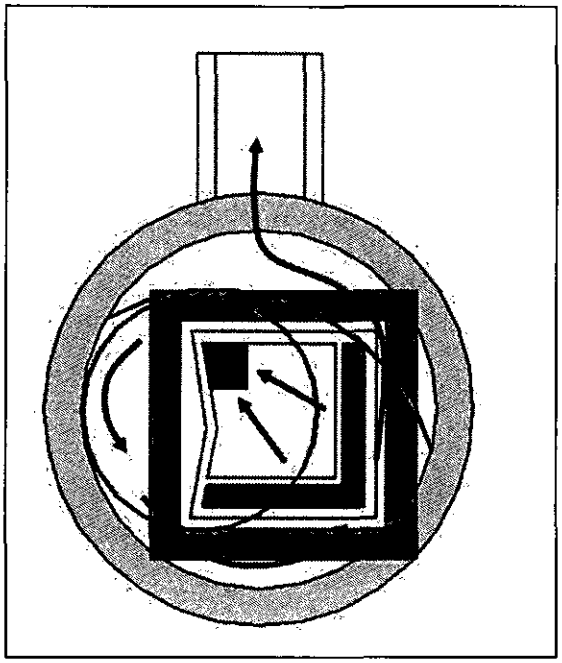


Figure 2. Hydroworks HG Operation – Profile View

The HG 4i is an inlet version of the HG 4 separator. There is a catch-basin grate on top of the HG 4i. Water flows directly into the inner chamber of the HG 4i through the catch-basin grate on top of the structure. The grate is oversized to allow maintenance of the entire structure. A funnel that sits underneath the grate on the top cap of the concrete itself directs the water into the inner chamber during normal flows and the middle chamber during high flows. Figures 3 and 4 show the flow paths for the HG 4i separator.

The inlet funnel is sloped towards the corner inlet and hence the wall of the inner chamber. Water moves in a circular direction in the inner chamber since water enters tangentially along the wall of the inner chamber due to the sloping funnel.

Water continues moving in a circular motion (vortex) through the rest of the structure (through the middle chamber and baffle wall) until it is discharged from the separator.



During periods of peak flow the water will back up from the corner inlet and overflow into two side overflow troughs which discharge directly into the middle chamber. These overflow troughs are covered from the surface such that water cannot directly fall through them (i.e. water must back up to enter the overflow troughs).

Accordingly this funnel provides the same separate flow paths for low and high flow as the other Hydroguard separators.

The whole funnel is removed for inspection and cleaning providing.

Figure 3. Hydroworks Hydroguard HG 4i Normal Flow Path

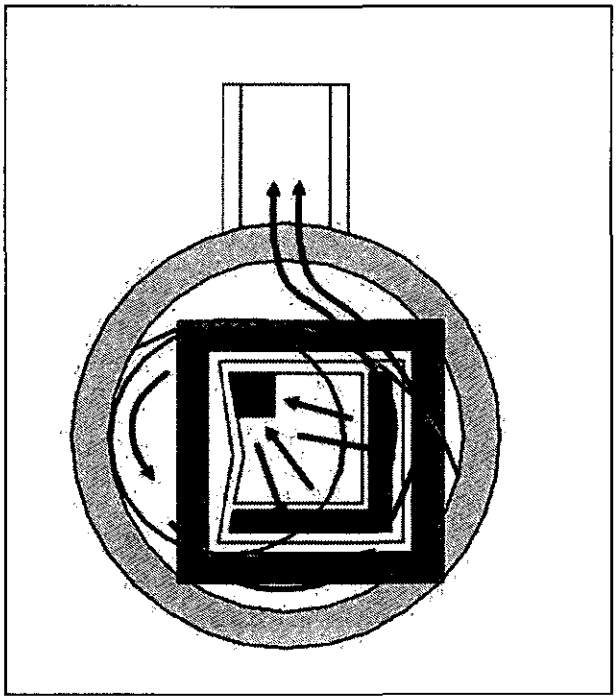


Figure 4. Hydroworks Hydroguard HG 4i Peak Flow Path

Inspection

Procedure

Although all parts of the Hydroguard should be inspected, inspection and maintenance should focus on the inner and middle chambers since this is where the pollutants (floatable and sinking) will accumulate.

Floatables

A visual inspection can be conducted for floatables by removing the covers and looking down into the separator. Multiple covers are provided on Hydroworks HG units to access all areas of the separator (The HG 4 may have a single larger 32" (800mm) cover due to the lack of space for multiple 24" (600mm) covers).

TSS/Sediment

Inspection for TSS build-up can be conducted using a Sludge Judge®, Core Pro®, AccuSludge® or equivalent sampling device that allows the measurement of the depth of TSS/sediment in the unit. These devices typically have a ball valve at the bottom of the tube that allows water and TSS to flow into the tube when lowering the tube into the unit. Once the unit touches the bottom of the device, it is quickly pulled upward such that the water and TSS in the tube forces the ball valve closed allowing the user to see a full core of water/TSS in the unit. The unit should be inspected for TSS through each of the access covers. Several readings (2 or 3) should be made at each access cover to ensure that an accurate TSS depth measurement is recorded.

Frequency

Construction Period

The HG separator should be inspected every two weeks and after every large storm (over 0.5" (12.5 mm) of rain) during the construction period.

Post-Construction Period

The Hydroworks HG separator should be inspected once per year for normal stabilized sites (grassed or paved areas). If the unit is subject to oil spills or runoff from unstabilized (storage piles, exposed soils) areas the HG separator should be inspected more frequently (4 times per year). An initial annual inspection will indicate the required future frequency of maintenance if the unit was maintained after the construction period.

Reporting

Reports should be prepared as part of each inspection and include the following information:

1. Date of inspection
2. GPS coordinates of Hydroworks unit
3. Time since last rainfall
4. Date of last inspection
5. Installation deficiencies (missing parts, incorrect installation of parts)
6. Structural deficiencies (concrete cracks, broken parts)
7. Operational deficiencies (leaks, blockages)
8. Presence of oil sheen or depth of oil layer
9. Estimate of depth/volume of floatables (trash, leaves) captured
10. Sediment depth measured
11. Recommendations for any repairs and/or maintenance for the unit
12. Estimation of time before maintenance is required if not required at time of inspection

A sample inspection checklist is provided at the end of this manual.

Maintenance

Procedure

The Hydroworks HG unit is typically maintained using a vactor truck or clam shell bucket. There are numerous companies that can maintain the HG separator. Envirocalm, LLC, an affiliate company of Hydroworks offers inspection and maintenance services and can inspect and maintain the HG separator. (www.envirocalm.com).

Disposal of the contents of the separator depend on local requirements. Maintenance of a Hydroworks HG unit will typically take 1 to 2 hours.

Frequency

Construction Period

A HG separator can fill with construction sediment quickly during the construction period. The construction sediment will have a much coarser particle size distribution than the suspended solids during the post-development period. Accordingly, scour is not so much of a concern during the construction period compared to the separator filling up with solids. The Hydroguard must be maintained during the construction period when the depth of TSS/sediment reaches 27" (675 mm). This represents 75% of the maximum sediment storage capacity. It must also be maintained during the construction period if there is an appreciable depth of oil in the unit (more than a sheen) or if floatables other than oil cover over 50% of the open water surface on the inlet side of the outlet baffle wall.

The HG separator should be maintained at the end of the construction period, prior to utilization for the post-construction period.

Post-Construction Period

The Hydroguard was independently tested by Alden Research Laboratory in 2008. A HG6 was tested for scour with initial sediment loads of 4.6 ft^3 and 9.3 ft^3. The results from these tests were almost identical. Therefore, the 9.3 ft^3 sediment load was used as 50% of the maximum sediment depth for maintenance in the calculation of the maintenance interval for the HG6 separator based on the NJDEP maintenance interval equation.

Maintenance Interval (months) = 3.565 x (Sediment Storage) / (MTFR x TSS Removal)

Maintenance Interval (HG6) = 3.565 x 9.3 / (1.67x 0.55) = 36 months

All values (flow, sediment storage) can be scaled by the surface area making the sediment depths and maintenance intervals equal for all separators.

The separator was loaded with the sediment in the inner chamber and middle chamber with the majority of sediment (80%) located in the inner chamber. The inner chamber for area represents approximately 44% of the separator surface area. The inner chamber is 4 ft (1200 mm) in diameter in the HG6. Therefore the 50% sediment depth for the HG6 in the inner chamber would be:

9.3 ft^3 x 0.80 / (3.14 x 4 ft^2) x 12 in/ft = 7.1 inches (175 mm)

Accordingly the 100% sediment volume would represent 14.2" (350 mm) of sediment depth in the inner chamber.

The HG separator must be maintained if there is an appreciable depth of oil in the unit (more than a sheen) or if floatables other than oil cover over 50% of the open water surface on the inlet side of the outlet baffle wall. It should also be maintained once the accumulated TSS/sediment depths are greater than 14" (350 mm) in the inner chamber. For typical stabilized post-construction sites (parking lots, streets) it is anticipated that maintenance will be required annually or once every two years. More frequent or less frequent maintenance will be required depending on individual site conditions (traffic use, stabilization, storage piles, etc.). The long term maintenance frequency can be established based on the maintenance requirements during the first several years of operation if site conditions do not change.

HYDROGUARD INSPECTION SHEET

Date _____
Date of Last Inspection _____

Site _____
City _____
State _____
Owner _____

GPS Coordinates _____

Date of last rainfall _____

Site Characteristics	**Yes**	**No**
Soil erosion evident	☐	☐
Exposed material storage on site	☐	☐
Large exposure to leaf litter (lots of trees)	☐	☐
High traffic (vehicle) area	☐	☐

Hydroguard	**Yes**	**No**
Incorrect access orientation	☐ ***	☐
Obstructions in the inlet or outlet	☐ *	☐
Missing internal components	☐ **	☐
Improperly installed internal components	☐ **	☐
Improperly installed inlet or outlet pipes	☐ ***	☐
Internal component damage (cracked, broken, loose pieces)	☐ **	☐
Floating debris in the separator (oil, leaves, trash)	☐	☐
Large debris visible in the separator	☐ *	☐
Concrete cracks/deficiencies	☐ ***	☐
Exposed rebar	☐ **	☐
Water seepage (water level not at outlet pipe invert)	☐ ***	☐
Water level depth below outlet pipe invert _____"		

Routine Measurements

Floating debris depth	**< 0.5" (13mm)**	☐	**>0.5" 13mm)**	☐ *
Floating debris coverage	**< 25% of surface area**	☐	**> 25% surface area**	☐ *
Sludge depth	**< 14" (350mm)**	☐	**> 14" (350mm)**	☐ *

Other Comments: _____
_____
_____

* Maintenance required
** Repairs required
*** Further investigation is required

Please call Hydroworks at 888-290-7900 or email us at support@hydroworks.com if you have any questions regarding the Inspection Checklist. Please fax a copy of the completed checklist to Hydroworks at 888-783-7271 for our records.

Hydroworks® Hydroguard

One Year Limited Warranty

Hydroworks, LLC warrants, to the purchaser and subsequent owner(s) during the warranty period subject to the terms and conditions hereof, the Hydroworks Hydroguard to be free from defects in material and workmanship under normal use and service, when properly installed, used, inspected and maintained in accordance with Hydroworks written instructions, for the period of the warranty. The standard warranty period is 1 year.

The warranty period begins once the separator has been manufactured and is available for delivery. Any components determined to be defective, either by failure or by inspection, in material and workmanship will be repaired, replaced or remanufactured at Hydroworks' option provided, however, that by doing so Hydroworks, LLC will not be obligated to replace an entire insert or concrete section, or the complete unit. This warranty does not cover shipping charges, damages, labor, any costs incurred to obtain access to the unit, any costs to repair/replace any surface treatment/cover after repair/replacement, or other charges that may occur due to product failure, repair or replacement.

This warranty does not apply to any material that has been disassembled or modified without prior approval of Hydroworks, LLC, that has been subjected to misuse, misapplication, neglect, alteration, accident or act of God, or that has not been installed, inspected, operated or maintained in accordance with Hydroworks, LLC instructions and is in lieu of all other warranties expressed or implied. Hydroworks, LLC does not authorize any representative or other person to expand or otherwise modify this limited warranty.

The owner shall provide Hydroworks, LLC with written notice of any alleged defect in material or workmanship including a detailed description of the alleged defect upon discovery of the defect. Hydroworks, LLC should be contacted at 50 S 21st St., Kenilworth, NJ 07033 or any other address as supplied by Hydroworks, LLC. (888-290-7900).

This limited warranty is exclusive. There are no other warranties, express or implied, or merchantability or fitness for a particular purpose and none shall be created whether under the uniform commercial code, custom or usage in the industry or the course of dealings between the parties. Hydroworks, LLC will replace any goods that are defective under this warranty as the sole and exclusive remedy for breach of this warranty.

Subject to the foregoing, all conditions, warranties, terms, undertakings or liabilities (including liability as to negligence), expressed or implied, and howsoever arising, as to the condition, suitability, fitness, safety, or title to the Hydroworks Hydroguard are hereby negated and excluded and Hydroworks, LLC gives and makes no such representation, warranty or undertaking except as expressly set forth herein. Under no circumstances shall Hydroworks, LLC be liable to the Purchaser or to any third party for product liability claims; claims arising from the design, shipment, or installation of the Hydroguard, or the cost of other goods or services related to the purchase and installation of the Hydroguard. For this Limited Warranty to apply, the Hydroguard must be installed in accordance with all site conditions required by state and local codes; all other applicable laws; and Hydroworks' written installation instructions.

Hydroworks, LLC expressly disclaims liability for special, consequential or incidental damages (even if it has been advised of the possibility of the same) or breach of expressed or implied warranty. Hydroworks, LLC shall not be liable for penalties or liquidated damages, including loss of production and profits; labor and materials; overhead costs; or other loss or expense incurred by the purchaser or any third party. Specifically excluded from limited warranty coverage are damages to the Hydroguard arising from ordinary wear and tear; alteration, accident, misuse, abuse or neglect; improper maintenance, failure of the product due to improper installation of the concrete sections or improper sizing; or any other event not caused by Hydroworks, LLC. This limited warranty represents Hydroworks' sole liability to the purchaser for claims related to the Hydroguard, whether the claim is based upon contract, tort, or other legal basis.

3' WIDE CURBED FLUME CALCULATIONS

3' Wide Curbed Concrete Flume

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00600	ft/ft
Normal Depth	0.50	ft
Bottom Width	3.00	ft

Results

Discharge	6.91	ft^3/s
Flow Area	1.50	ft^2
Wetted Perimeter	4.00	ft
Hydraulic Radius	0.38	ft
Top Width	3.00	ft
Critical Depth	0.55	ft
Critical Slope	0.00456	ft/ft
Velocity	4.60	ft/s
Velocity Head	0.33	ft
Specific Energy	0.83	ft
Froude Number	1.15	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.50	ft
Critical Depth	0.55	ft
Channel Slope	0.00600	ft/ft
Critical Slope	0.00456	ft/ft

MISCELLANEOUS DRAINAGE INFORMATION

1988 Drainage Criteria Manual
City of Wichita, Kansas
Rainfall Intensity Table for Sedgwick County, KS

The following tabulation contains rainfall intensity in inches per hour as derived from ESSA Weather Bureau Technical Paper 40 Modified to NWS Hydro-35, 1977 During First Hour.

Table 1 Rainfall Intensity Table (Duration 15 min – 120 min)

DURATION, in hours	DURATION, in minutes	RETURN PERIOD						
		1 YR	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
0.0833	5	4.18	5.57	6.53	7.41	8.52	9.48	10.32
0.1000	6	3.99	5.32	6.25	7.09	8.16	9.09	9.89
0.1167	7	3.81	5.09	5.99	6.81	7.84	8.74	9.50
0.1333	8	3.66	4.89	5.75	6.55	7.55	8.42	9.15
0.1500	9	3.52	4.70	5.54	6.31	7.28	8.13	8.83
0.1667	10	3.39	4.52	5.34	6.09	7.04	7.86	8.54
0.1833	11	3.27	4.36	5.16	5.89	6.81	7.61	8.27
0.2000	12	3.18	4.21	4.99	5.71	6.60	7.38	8.02
0.2167	13	3.05	4.08	4.84	5.53	6.41	7.17	7.79
0.2333	14	2.96	3.95	4.69	5.37	6.23	6.97	7.57
0.2500	15	2.87	3.83	4.56	5.22	6.06	6.78	7.37
0.2667	16	2.78	3.72	4.43	5.08	5.90	6.60	7.18
0.2833	17	2.71	3.61	4.31	4.95	5.75	6.44	7.00
0.3000	18	2.63	3.51	4.20	4.83	5.61	6.29	6.84
0.3167	19	2.56	3.42	4.10	4.71	5.47	6.14	6.68
0.3333	20	2.50	3.33	4.00	4.60	5.35	6.00	6.53
0.3500	21	2.44	3.25	3.90	4.50	5.23	5.87	6.39
0.3667	22	2.38	3.17	3.81	4.40	5.12	5.75	6.26
0.3833	23	2.32	3.10	3.73	4.31	5.01	5.63	6.13
0.4000	24	2.27	3.03	3.65	4.22	4.91	5.52	6.01
0.4167	25	2.22	2.96	3.57	4.13	4.81	5.41	5.90
0.4333	26	2.20	2.90	3.50	4.05	4.72	5.31	5.79
0.4500	27	2.16	2.84	3.43	3.98	4.63	5.21	5.69
0.4667	28	2.14	2.78	3.37	3.90	4.55	5.12	5.59
0.4833	29	2.11	2.72	3.30	3.83	4.47	5.03	5.49
0.5000	30	2.08	2.67	3.24	3.76	4.39	4.94	5.40
0.5167	31	2.05	2.62	3.19	3.70	4.32	4.86	5.32
0.5333	32	2.02	2.57	3.10	3.63	4.25	4.79	5.22
0.5500	33	1.99	2.52	3.05	3.57	4.18	4.71	5.14
0.5667	34	1.96	2.48	3.01	3.51	4.11	4.63	5.07
0.5833	35	1.93	2.44	2.98	3.46	4.05	4.56	5.00
0.6000	36	1.91	2.39	2.93	3.41	3.99	4.50	4.93
0.6167	37	1.89	2.35	2.88	3.36	3.93	4.43	4.86
0.6333	38	1.87	2.32	2.84	3.31	3.87	4.37	4.79
0.6500	39	1.85	2.28	2.80	3.26	3.82	4.31	4.73
0.6667	40	1.83	2.24	2.76	3.22	3.76	4.25	4.66
0.6833	41	1.81	2.21	2.72	3.17	3.71	4.19	4.60
0.7000	42	1.79	2.18	2.68	3.13	3.66	4.13	4.54
0.7167	43	1.77	2.14	2.64	3.09	3.61	4.08	4.49
0.7333	44	1.75	2.11	2.61	3.05	3.57	4.03	4.43

Table C-1 Rational C Values

Land Use or Surface Characteristics	Percent Impervious	Frequency 2	5	10	100
Business					
Downtown Areas	95	0.84	0.85	0.87	0.91
Neighborhood Areas	70	0.68	0.69	0.73	0.80
Residential Single Family (Soil Group D)					
1/8 Acre	50	0.57	0.61	0.66	0.79
1/4 Acre	38	0.50	0.54	0.62	0.76
1/3 Acre	30	0.46	0.50	0.59	0.73
1/2 Acre	25	0.42	0.48	0.56	0.72
3/4 Acre	22	0.42	0.46	0.55	0.71
1 Acre	20	0.41	0.45	0.54	0.71
Residentia Multi-Family (Soil Group D)					
Multi-Unit (detached)	60	0.62	0.66	0.72	0.82
Multi-Unit (attached)	65	0.64	0.68	0.73	0.83
Apartments	75	0.70	0.73	0.79	0.86
Residential Single Family (Soil Group C)					
1/8 Acre	50	0.55	0.58	0.64	0.73
1/4 Acre	38	0.48	0.51	0.57	0.68
1/3 Acre	30	0.43	0.46	0.53	0.65
1/2 Acre	25	0.40	0.43	0.50	0.63
3/4 Acre	22	0.39	0.42	0.49	0.62
1 Acre	20	0.37	0.40	0.48	0.61
Residential Multi-Family (Soil Group C)					
Multi-Unit (detached)	60	0.60	0.63	0.69	0.77
Multi-Unit (attached)	65	0.63	0.66	0.71	0.79
Apartments	75	0.68	0.72	0.77	0.83
Residential Single Family (Soil Group B)					
1/8 Acre	50	0.52	0.54	0.59	0.67
1/4 Acre	38	0.44	0.46	0.52	0.61
1/3 Acre	30	0.39	0.41	0.47	0.57
1/2 Acre	25	0.36	0.38	0.44	0.54
3/4 Acre	22	0.34	0.36	0.42	0.52
1 Acre	20	0.33	0.35	0.40	0.51
Residential Multi-Family (Soil Group B)					
Multi-Unit (detached)	60	0.58	0.60	0.65	0.72
Multi-Unit (attached)	65	0.61	0.64	0.68	0.75
Apartments	75	0.67	0.70	0.74	0.80
Single Family (Soil Group A)					
1/8 Acre	50	0.47	0.50	0.54	0.60
1/4 Acre	38	0.39	0.41	0.45	0.52
1/3 Acre	30	0.33	0.35	0.39	0.47
1/2 Acre	25	0.30	0.31	0.35	0.44

Land Use or Surface Characteristics	Percent Impervious	Frequency 2	5	10	100
3/4 Acre	22	0.28	0.29	0.33	0.42
1 Acre	20	0.26	0.28	0.32	0.40
Multi-Family (Soil Group A)					
Multi-Unit (detached)	60	0.55	0.57	0.61	0.67
Multi-Unit (attached)	65	0.58	0.60	0.64	0.70
Apartments	75	0.65	0.68	0.72	0.77
Industrial					
Light Areas	70	0.68	0.69	0.73	0.80
Heavy Areas	80	0.74	0.76	0.79	0.84
Playgrounds	15	0.33	0.35	0.42	0.55
Schools	40	0.49	0.51	0.56	0.66
Railroad Yard Areas	30	0.43	0.45	0.50	0.62
Undeveloped Urban Areas					
Offsite Flow Analysis (when land use not defined)	45	0.52	0.54	0.59	0.68
Streets					
Paved	99	0.87	0.88	0.90	0.93
Gravel	00	0.24	0.26	0.33	0.48
Drive, Parking Lots and Walks:	96	0.87	0.87	0.88	0.89
Roofs	90	0.80	0.85	0.90	0.93
Urban Lawn Areas (Soil Group A)					
Slope less than 1%	00	0.08	0.09	0.13	0.23
Slope 1% to 4%	00	0.12	0.13	0.17	0.27
Slope more than 4%	00	0.16	0.17	0.21	0.31
Urban Lawn Areas (Soil Group B)					
Slope less than 1%	00	0.16	0.18	0.24	0.37
Slope 1% to 4%	00	0.20	0.22	0.28	0.41
Slope more than 4%	00	0.24	0.26	0.32	0.45
Urban Lawn Areas (Soil Group C)					
Slope less than 1%	00	0.24	0.27	0.35	0.51
Slope 1% to 4%	00	0.26	0.29	0.37	0.53
Slope more than 4%	00	0.28	0.31	0.39	0.55
Urban Lawn Areas (Soil Group D)					
Slope less than 1%	00	0.28	0.33	0.43	0.63
Slope 1% to 4%	00	0.30	0.35	0.45	0.65
Slope more than 4%	00	0.32	0.37	0.47	0.67

Table A-1 Roughness Coefficients (Manning's n) for Sheet Flow

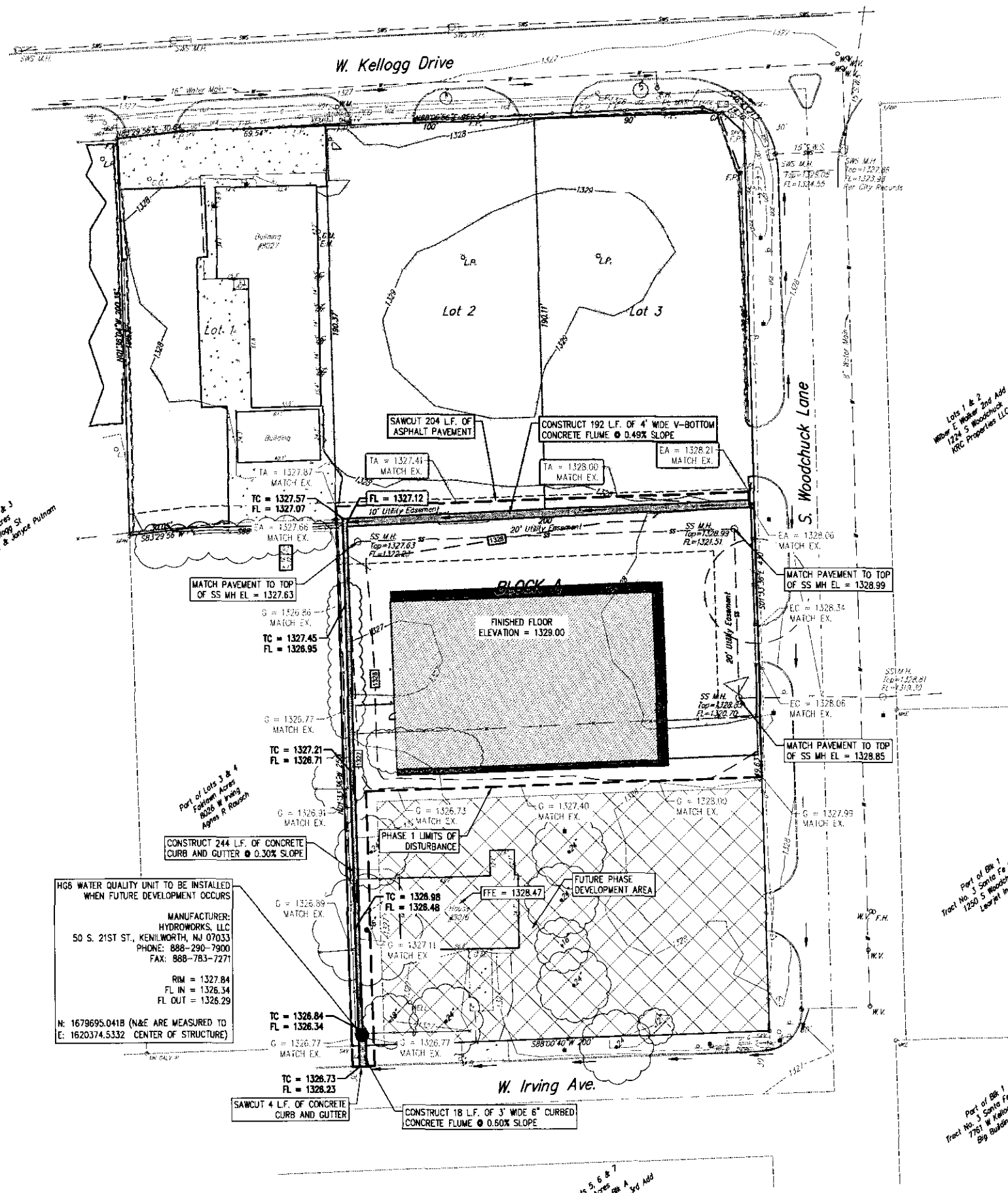
Surface Description[1]	Manning's n
Smooth surfaces (concrete, asphalt, gravel or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover < 20%	0.06
Residue cover > 20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[A]	0.24
Bermuda grass	0.41
Range (natural)	0.13
Woods[B]	
Light underbrush	*0.40*
Dense underbrush	0.80

[1] Source: SCS, TR-55, Second Edition, June 1986.
[A] Includes species such as bluestem grass, buffalo grass, grama grass, and native grass mixtures.
[B] When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

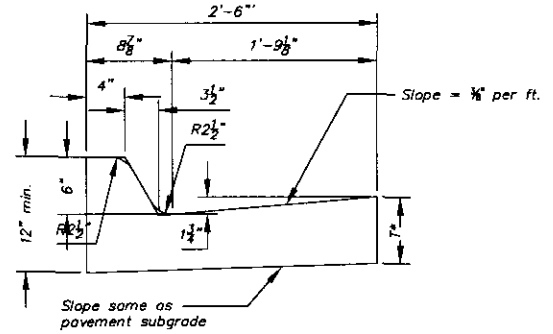
Table A-2 Manning's n Values

Street and Pavement Gutters [2]		Manning's n
Asphalt pavement		0.016
Concrete gutter		0.016
Concrete pavement		0.018
Culverts and Storm Sewers[3]	**Roughness or Corrugation**	**Manning's n**
Concrete Pipe	Smooth	0.013
Concrete Boxes	Smooth	0.013
Corrugated Polyethylene	Corrugated	Per manufacturer
Smooth Polyethylene	Smooth	0.011
Polyvinyl chloride (PVC)	Smooth	0.011

GRADING PLAN



TYPE 1
(Arterial curb)



Combined Curb & Gutter (6")

STAKE MARKER LEGEND

- ⅝"x24" = 1" Galvanized Iron Pipe
- ½"x24" = 3/4" Iron Pipe
- ⅜"x24" = 1/2" Rebar w/Boudreau Cap
- ⅜"x24" = 1/2" Rebar w/Mid Kansas Engineering Cap
- ½"x24" = 1/2" Rebar w/Professional Engineering Consultants Cap
- ½"x24" = 1/2" Rebar w/Survey Cap (Set)

LEGEND

G = GAS MAIN
W = WATER MAIN
SS = SANITARY SEWER
SWS = STORM WATER SEWER
UGE = UNDER GROUND ELECTRIC
UGT = UNION GROUND TELEPHONE

- B.M. . . . . BENCH MARK
- TELE. PED . . . . . TELEPHONE PEDESTAL
- C.O. . . . . CLEAN OUT
- C.A.T.V. . . . . CABLE TELEVISION PEDESTAL
- E.B. . . . . ELECTRIC BOX
- E.M. . . . . ELECTRIC METER
- F.H. . . . . FIRE HYDRANT
- F.P. . . . . FLAG POLE
- GUY ANCHOR
- G.M. . . . . GAS METER
- G.P. . . . . GUARD POST
- L.P. . . . . LIGHT POLE
- M.B. . . . . MAIL BOX
- O.H. . . . . OBSERVATION HOLE
- PL. MKR . . . . . PIPELINE MARKER
- POWER POLE
- SIGN
- WELL . . . . . WATER WELL
- W.M. . . . . WATER METER
- W.V. . . . . WATER VALVE
- X'MR . . . . . ELECTRIC TRANSFORMER
- SS M.H. . . . . SANITARY SEWER MANHOLE
- SWS M.H. . . . . STORM WATER SEWER MANHOLE

GRADING LEGEND

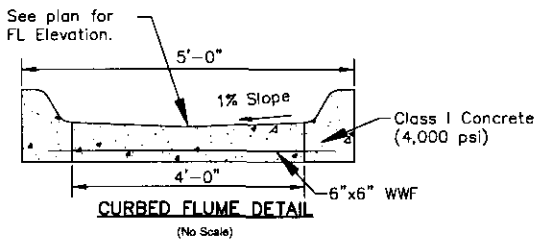
- EXISTING CONTOURS
- PROPOSED CONTOURS
- PROPOSED FLOWLINE
- PROPOSED RIDGE LINE
- PROPOSED LIMITS OF DISTURBANCE
- TA = 1327.87 MATCH EX. — EXISTING SPOT ELEVATIONS
- TC = 1317.51 FL = 1327.01 — PROPOSED SPOT ELEVATIONS

FFE = FINISHED FLOOR ELEVATION
EC = EDGE OF CONCRETE
FL = FLOWLINE
G = GROUND
HP = HIGH POINT
ME = MATCH EXISTING
SW = SIDWALK
TA = TOP OF ASPHALT
TC = TOP OF CURVE

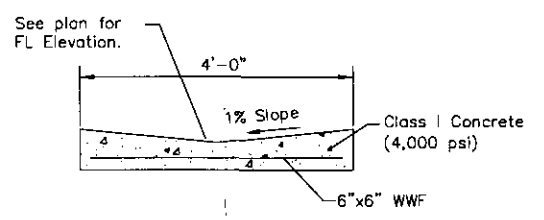
BENCHMARKS:

BM #1: A square cut in top of inlet Southwest of the intersection of W. Kellogg Dr. and S. Woodchuck Lane.
Elev.= 1328.05 (NAVD 88)

BM #2: A square cut in top of curb on the Northwest corner of the intersection of W. Irving Ave and S. Woodchuck Lane.
Elev. = 1327.60 (NAVD 88)



CURBED FLUME DETAIL
(No Scale)



V-BOTTOM FLUME DETAIL
(No Scale)

ONE CALL KANSAS
KS: 1-800-344-7233
WICHITA: 316-867-2470

UTILITIES SHOWN REPRESENT THE BEST INFORMATION AVAILABLE FOR DESIGN. ADDITIONAL UTILITIES MAY BE PRESENT ON THIS PROJECT. THE CONTRACTOR SHALL BE RESPONSIBLE FOR DETERMINING THE EXACT LOCATION, DEPTH AND SIZE OF ALL UNDERGROUND UTILITIES PRIOR TO CONSTRUCTION. THE CONTRACTOR SHALL BE LIABLE FOR ANY DAMAGE CAUSED BY THE *FAILURE TO DO SO.*

SURVEY DISCLAIMER:
TOPOGRAPHIC SURVEY USED IN PREPARING PLANS WAS PROVIDED BY GARBER SURVEYING SERVICE, (620) 665-7032, 423 WEST FIRST AVE., HUTCHINSON, KS. ENGINEER DOES NOT GUARANTEE SURVEY ELEVATIONS FOR ACCURACY. CONTRACTOR SHALL VERIFY ELEVATIONS AND NOTIFY ENGINEER OF ANY DISCREPANCIES.

REV.	DESCRIPTION	DATE

GRAPHIC SCALE
30' 0 30'
(IN FEET)
1"=30'

HALF SCALE 1" = 60'

HING ADDITION
AN ADDITION TO
WICHITA, SEDGWICK COUNTY, KS

ALEXANDER MOTORS
8027 W. KELLOGG

CERTIFIED ENGINEERING DESIGN, P.A.
CIVIL ENGINEERING SERVICES
1935 WEST MAPLE STREET
WICHITA, KANSAS 67213
PH.(316)262-8808 FAX.(316)262-1669

HARLAN DALE FORAKER LICENSED 10891 2-4-13 KANSAS PROFESSIONAL ENGINEER

PROJECT NO.: 20132089
ISSUE DATE: 03/04/13
CONTACT: L. MILLS / H. FORAKER
CHECKED BY:

PHASE 1 GRADING PLAN

3 OF 3