# Preliminary Drainage Report
# Skyline East
## Stillwater, Oklahoma

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**July 2015**

**Preliminary Drainage Study**
**Skyline East**

Project Location and Information

The proposed project is located in the northeast ¼ of Section 12, T19N, R2E on the open land between Jardot Road, Sunrise Avenue, and Skyline Street. There are commercial facilities to the east on Jardot Road, residential properties to the south and west, along Sunrise Avenue and Skyline Street, and Stillwater Junior High is on the west side of Skyline. Land to the north is open land.

It is proposed to construct approximately 113 single-family homes on 26 acres. The report describes the drainage and detention facilities proposed for the site. The Project Location Map provides the owners name, legal description, and information about surrounding development.

There are no blue-line creeks on the site and no FEMA floodplains on or near the site. The site on the USGS Stillwater North quad map is attached, along with the FEMA Firmette. The blue area is the remnant of a farm pond. The embankment of the pond has been breached and it no longer holds water.

Existing Drainage Map

A map of existing drainage is attached. Runoff is generally from southwest to northeast and runoff leaves the site at three locations, designated Southeast, East/Center, and North. Discharge from the Southeast and East/Center locations goes to the bar ditch on Jardot and combines with the North discharge near the northeast property corner. Offsite runoff enters the property along the south and west property lines. To the south, runoff is generally distributed along the property line as overland flow. Runoff from the homes to the west is also distributed as overland flow. Discharge from the school property and runoff within the curbs of Skyline Street is collected in a pipe and conveyed to the site through a 36-inch outfall. The outfall is located just east of the property line, about 425 feet north of Sunrise Ave.

The site and offsite map shows all of the areas draining to the property. Offsite topography was determined from the 2-meter DEM obtained from the NRCS data gateway. Areas within the site were determined using field survey data obtained for the project. An existing drainage area map, zoomed in on the site and based on the field survey data, is also attached. The following table summarizes the site and offsite areas.

Current land use for the existing site is open land, mostly grass with some trees in the vicinity of the former farm pond. There are various uses in the surrounding properties, which are summarized in Table 1. An aerial photograph is attached, showing the adjacent land uses. Easements and other features are shown on the plat map.

| Table 1<br>Existing Site and Offsite Drainage Areas | | | | |
|---|---|---|---|---|
| **Name** | **Description** | **Land Use** | **Acres** | **Sq. Mi.** |
| O/C | Offsite runoff, to center east outlet from west | 4 homes/ac | 0.27 | 0.0004 |
| O/DSP | Offsite runoff, to downstream of existing pond | 2 homes/ac | 1.12 | 0.0017 |
| O/N | Offsite runoff, through site to north outlet | School (commercial), 4 homes/ac | 6.69 | 0.0105 |
| O/PS | Offsite runoff, to existing pond from south | 2 and 4 homes/ac | 22.42 | 0.0350 |
| O/PW | Offsite runoff, to existing pond from west | 4 homes/ac, public park (open land), commercial | 17.74 | 0.0277 |
| S/C | Site – drains to center east outlet | Open land, fair condition | 7.33 | 0.0115 |
| S/DSP | Site - drains to downstream of existing pond | Open land, fair condition | 2.73 | 0.0043 |
| S/N | Site - drains to north outlet | Open land, fair condition | 10.06 | 0.0157 |
| S/P | Site - drains to existing pond | Open land, fair condition | 6.28 | 0.0098 |

Proposed Drainage Map

A map of proposed drainage areas within the site is attached. All of the drainage areas offsite – areas with an O/xx designation – are unchanged as a result of the project, so are not repeated in the table. Land use for the site areas is residential with an average of 4 homes per acre. Detention is provided in the northeast corner, which will control discharge at the North outlet such that it is equal to or less than existing conditions. A portion of the site to the north bypasses the detention, which will be designed such that the combined discharge from the facility and the bypass is less than or equal to existing. Similarly, a detention facility in the southeast corner will serve to control discharge at the Southeast outlet. The east property will be graded and have a slope length such that the discharge directly east bypassing the detention facilities will leave the property as sheet flow. The following table summarizes the proposed areas within the site.

| Table 2<br>Proposed Site Drainage Areas | | | |
|---|---|---|---|
| **Name** | **Description** | **Acres** | **Sq. Mi.** |
| SP | Area to South Detention | 7.96 | 0.0124 |
| BP-north | Area to North outlet, bypassing detention | 1.63 | 0.0025 |
| NP-W | Area discharging to North Detention from the west | 9.14 | 0.0143 |
| BP-east | Area to east side of site, bypassing detention | 1.57 | 0.0024 |
| NP-E | Area discharging to North Detention from the east | 6.11 | 0.0095 |

Discharge from the 36-inch outfall on the west side of the property will be intercepted into a pipe and conveyed to the South Detention. It is anticipated that a 48-inch pipe will be used, which will also capture a portion of the runoff from the streets.

Discharge from the O/N offsite area will be largely conveyed within the entry street that is an extension of Krayler Avenue. It is proposed to route this discharge through the North Detention.

Easements and other features are shown on the plat map.

Hydrology and Hydraulics

Existing and proposed drainage patterns and site outlets are summarized in the previous sections of this report.

Runoff from existing site and offsite areas was calculated using NRCS methods. Curve numbers were weighted according to land use and soil type and are summarized in Table 3. NRCS soils data and hydrologic soil group maps are attached. Curve numbers were assigned from the reference in the Stillwater Standard Manual for ¼-acre lots, ½ acre lots, commercial, and open space. The school property was assigned a commercial designation, with about 85 percent of impervious area. The existing site and city park were assigned the designation open space – fair condition.

Time of concentration and lag time were computed using the NRCS TR-55 method represented in Figure 1800.1. The lines in the figure can be represented with the equation $V = a\sqrt{slope}$ where "a" equals 16.1 for unpaved surfaces and 20.3 for paved surfaces. Table 4 summarizes the calculations for existing conditions.

The HEC-HMS model was used to make the calculations for the 1, 2, 5, 10, 25, 50, and 100-year events. The 24-hour rainfall depths were obtained from the standards manual and a one-minute time step was used. The stability criterion for the NRCS unit hydrograph routing is that the lag time should be greater than or equal to the time step divided by 0.29 or 3.45 minutes. If the computed lag time was less than 3.45 minutes, the area was modeled as unrouted.

Tables 5 and 6 summarize the runoff parameters for the site under proposed conditions.

The former farm pond was evaluated to determine if it served to detain discharge to any significant extent. Survey indicated that there was storage volume between elevation 927 and 929 feet with a surface area of about 1 acre at elevation 929 feet. Once discharge reaches a water elevation greater than 929 feet, it will bypass the pond on the north side. Total storage volume is about 1 acre-foot. There is low point in the south end of the berm at about elevation 927.5 feet and the berm will act as a broad-crested weir. The HEC-HMS model gave an error message for the 1-year event, indicating that the berm overtops during the event. As the total runoff volume into the pond in the 1-year event is about 6.5 acre-feet, it is safe to conclude that the pond will be overflowing

well before the peak of the event. If was therefore concluded that the former farm pond does not serve to detain the discharge on the site.

**Table 3**
**Existing Conditions Runoff Parameters**

| Name | Land Use | Sq. Ft. | SoilHSG | CN | Total Sq. Ft. | Frac*CN | Wtd CN |
|---|---|---|---|---|---|---|---|
| O/C | 1/4 acre lots | 11793 | C | 83 | 11793 | 83.0 | 83.0 |
| O/DSP | 1/2 acre lots | 48785 | D | 85 | 48785 | 85.0 | 85.0 |
| O/N | 1/4 acre lots | 60078 | C | 83 | | 17.1 | |
| O/N | Open | 29853 | B | 79 | | 8.1 | |
| O/N | School | 32880 | B | 92 | | 10.4 | |
| O/N | School | 19270 | C | 94 | | 6.2 | |
| O/N | School | 149450 | D | 95 | 291530 | 48.7 | 90.5 |
| O/PS | 1/2 acre lots | 746698 | C | 80 | | 61.2 | |
| O/PS | 1/2 acre lots | 23097 | D | 85 | | 2.0 | |
| O/PS | 1/4 acre lots | 182766 | C | 83 | | 15.5 | |
| O/PS | 1/4 acre lots | 23889 | D | 87 | 976450 | 2.1 | 80.9 |
| O/PW | 1/4 acre lots | 39310 | C | 83 | | 4.2 | |
| O/PW | 1/4 acre lots | 22585 | C | 83 | | 2.4 | |
| O/PW | 1/4 acre lots | 56711 | D | 87 | | 6.4 | |
| O/PW | Commercial | 70974 | D | 95 | | 8.7 | |
| O/PW | Open | 190543 | C | 79 | | 19.5 | |
| O/PW | Open | 243949 | D | 84 | | 26.5 | |
| O/PW | School | 95977 | C | 94 | | 11.7 | |
| O/PW | School | 52814 | D | 95 | 772861 | 6.5 | 85.9 |
| S/C | Open | 180208 | C | 79 | | 44.6 | |
| S/C | Open | 139231 | D | 84 | 319438 | 36.6 | 81.2 |
| S/DSP | Open | 119058 | D | 84 | 119058 | 84.0 | 84.0 |
| S/N | Open | 103996 | B | 69 | | 16.4 | |
| S/N | Open | 128165 | C | 79 | | 23.1 | |
| S/N | Open | 206052 | D | 84 | 438213 | 39.5 | 79.0 |
| S/P | Open | 91834 | C | 79 | | 26.5 | |
| S/P | Open | 181520 | D | 84 | 273354 | 55.8 | 82.3 |

| Table 4<br>Existing Time of Concentration | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | Length-ft | El. Up | El. Down | Slope | Cover | "a" | V-fps | Tc-min | Lag-min | Routing |
| S/P | 677 | 936 | 927 | 0.013 | Unpaved | 16.1 | 1.86 | 6.08 | 3.65 | UHG |
| O/PW | 954 | 958 | 940 | 0.019 | Unpaved | 16.1 | 2.21 | 7.18 | 4.31 | UHG |
| S/N | 913 | 943 | 916 | 0.030 | Unpaved | 16.1 | 2.77 | 5.50 | 3.30 | Unrouted |
| S/C | 912 | 943 | 918 | 0.027 | Unpaved | 16.1 | 2.67 | 5.70 | 3.42 | Unrouted |
| O/N | 988 | 950 | 937 | 0.013 | Paved | 20.3 | 2.33 | 7.08 | 4.25 | UHG |
| O/PS | 1302 | 967 | 930 | 0.028 | Paved | 20.3 | 3.42 | 6.34 | 3.81 | UHG |
| S/DSP | 420 | 931 | 922 | 0.021 | Unpaved | 16.1 | 2.36 | 2.97 | 1.78 | Unrouted |
| O/DSP | 278 | 936 | 929 | 0.025 | Unpaved | 16.1 | 2.55 | 1.81 | 1.09 | Unrouted |
| O/C | 69 | 946 | 944 | 0.029 | Unpaved | 16.1 | 2.75 | 0.42 | 0.25 | Unrouted |

| Table 5<br>Proposed Site Runoff Parameters | | | | | | |
|---|---|---|---|---|---|---|
| Name | Sq. Ft. | Soil HSG | CN | Total Area | Frac*CN | Wtd. CN |
| BP-east | 68291 | D | 87 | 68291 | 87.00 | 87.00 |
| BP-north | 44710 | B | 75 | | 47.32 | |
| BP-north | 26157 | D | 87 | 70868 | 32.11 | 79.43 |
| NP-E | 22262 | C | 83 | | 6.94 | |
| NP-E | 243961 | D | 87 | 266223 | 79.72 | 86.67 |
| NP-W | 58973 | B | 75 | | 11.11 | |
| NP-W | 264823 | C | 83 | | 55.21 | |
| NP-W | 74350 | D | 87 | 398146 | 16.25 | 82.56 |
| SP | 112351 | C | 83 | | 26.91 | |
| SP | 234169 | D | 87 | 346520 | 58.79 | 85.70 |

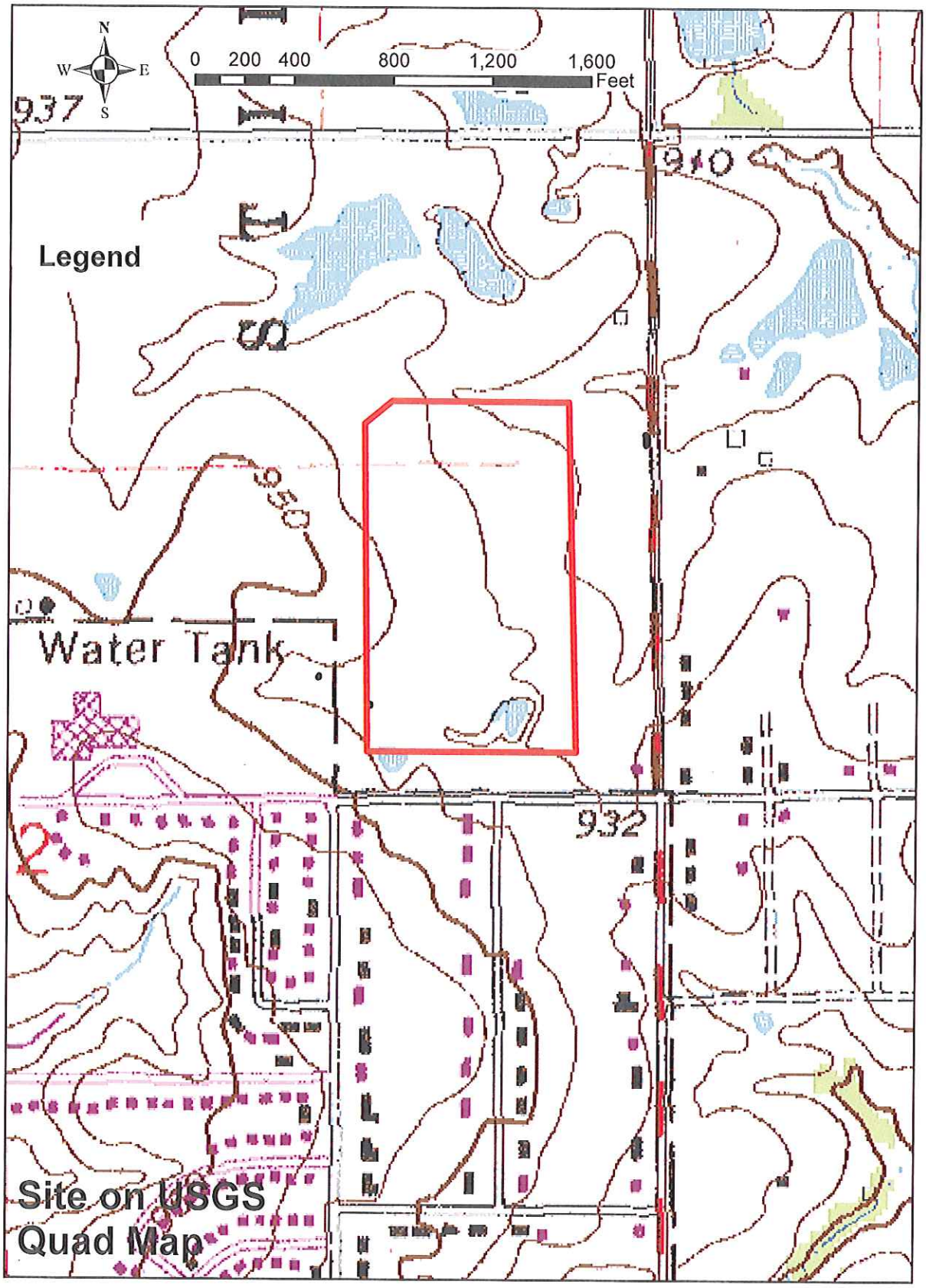
| Table 6<br>Proposed Site Time of Concentration | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | Length-ft | El. Up | El. Down | Slope | Cover | "a" | V-fps | Tc-min | Lag-min | Routing |
| SP | 983 | 937 | 926 | 0.011 | Paved | 20.3 | 2.15 | 7.63 | 4.58 | UHG |
| NP-W | 1453 | 941 | 917 | 0.017 | Paved | 20.3 | 2.61 | 9.28 | 5.57 | UHG |
| NP-E | 1094 | 922 | 919 | 0.003 | Paved | 20.3 | 1.06 | 17.14 | 10.29 | UHG |
| BP-N | 505 | 942 | 922 | 0.040 | Paved | 20.3 | 4.04 | 2.08 | 1.25 | Unrouted |
| BP-E | 52 | 929 | 922 | 0.134 | Paved | 20.3 | 7.44 | 0.12 | 0.07 | Unrouted |

| Table 7<br>Summary of Peak Discharges | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Existing Summary - Peak cfs at Each Outlet | | | | | Proposed Summary - Peak cfs at Each Outlet | | | | |
| Year | Southeast | East/Ctr | North | Total | Year | Southeast | East/Ctr | North | Total |
| 1 | 121.96 | 19.34 | 42.09 | 178.61 | 1 | 122.02 | 5.01 | 55.98 | 181.2 |
| 2 | 165.82 | 26.72 | 56.52 | 242.52 | 2 | 164.99 | 6.58 | 74.29 | 243.37 |
| 5 | 245.93 | 40.3 | 83.14 | 359.25 | 5 | 243.93 | 9.39 | 107.67 | 356.72 |
| 10 | 299.06 | 49.35 | 100.93 | 436.7 | 10 | 296.24 | 11.22 | 129.69 | 432.18 |
| 25 | 368.06 | 61.14 | 124.06 | 537.28 | 25 | 364.12 | 13.59 | 158.22 | 530.05 |
| 50 | 426.77 | 71.18 | 143.76 | 622.89 | 50 | 421.88 | 15.6 | 182.46 | 613.3 |
| 100 | 491.49 | 82.25 | 165.49 | 717.27 | 100 | 485.53 | 17.8 | 209.17 | 705.03 |

Table 7 provides a summary of the predicted peak cfs at each outlet and the HEC-HMS Global Summary tables are attached. At the southeast outlet, there is a minimal increase for the 1-year event and the predicted peak discharge is less for the remaining larger events, due to the fact that a smaller portion of the site area drains to this location under proposed conditions. However, routing the discharges through detention facility is desirable, as it will reduce the impact of concentrating the flow by piping the discharge from the 36" outfall through the site. The contours in the existing conditions map indicate that the existing discharge leaves the site as concentrated flow, so there should be no adverse impacts to downstream property.

The discharge from the proposed site to the east is greatly reduced over existing conditions. Also, this discharge will be distributed over the length of the site and not concentrated near the center, as it is under existing conditions. Therefore, no adverse impacts are predicted.

There is an increase in peak discharge to the north. Detention volume and outlets will be provided where the North Detention is shown to reduce peak discharge to equal to or less than existing conditions for all events. The detention is situated such that it can discharge to the defined channel on the north property line, so there should be no additional impacts from concentrated flow.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Site on USGS
Quad Map


surance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 250 500 750 1,000 FEET

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0068F

# FIRM

FLOOD INSURANCE RATE MAP

PAYNE COUNTY, OKLAHOMA

AND INCORPORATED AREAS

PANEL 68 OF 525

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| PAYNE COUNTY, UNINCORPORATED AREAS | 400493 | 0068 | F |
| STILLWATER, CITY OF | 405380 | 0068 | F |

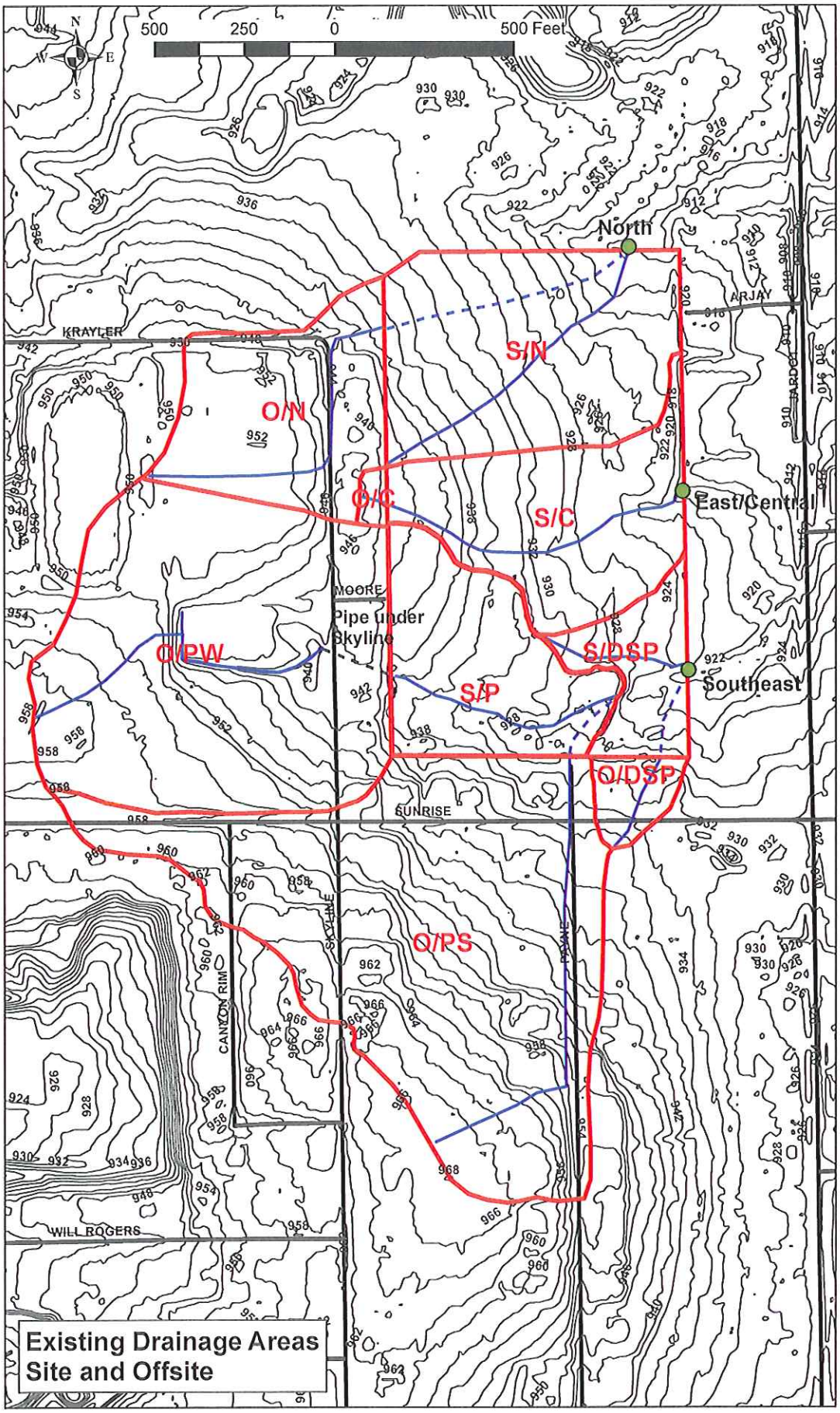
Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
40119C0068F

EFFECTIVE DATE
MAY 16, 2007

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov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Pipe under Skyline
KRAYLER
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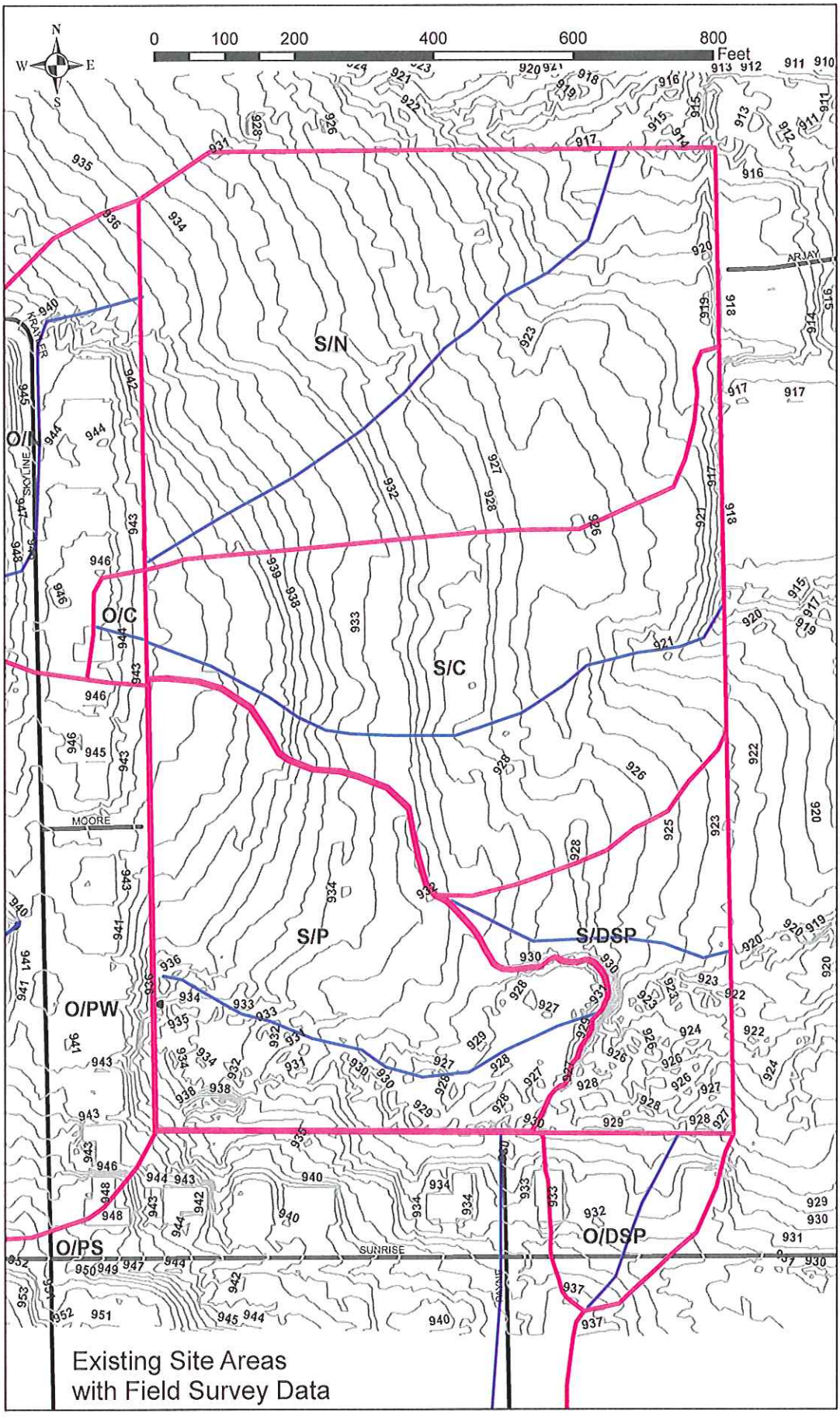
MOORE
SUNRISE
SKYLINE
CANYON RIM
WILL ROGERS
Existing Drainage Areas
Site and Offsite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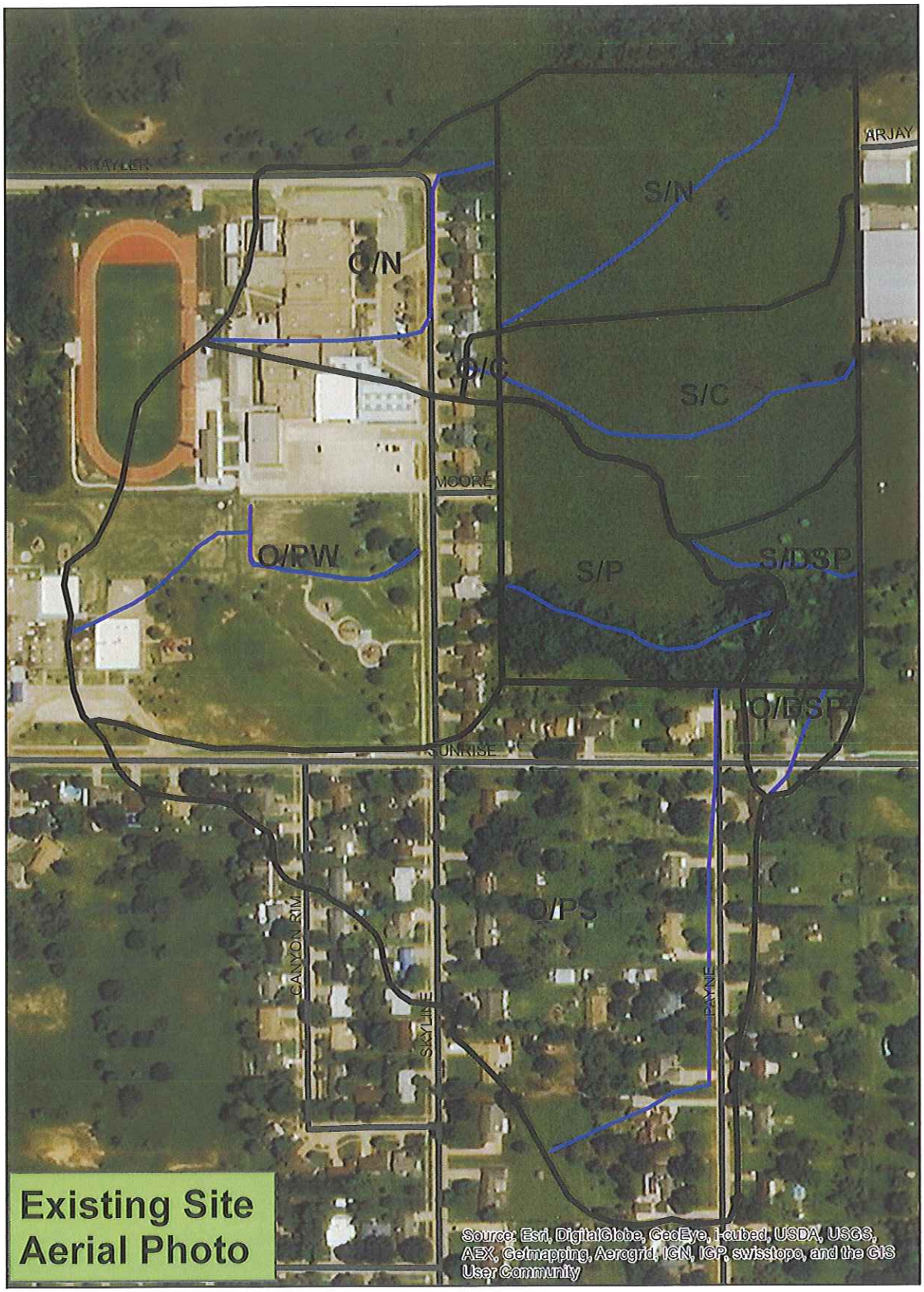
SKYLINE
MOORE
SUNRISE
ARJAY
Existing Site Areas
with Field Survey Data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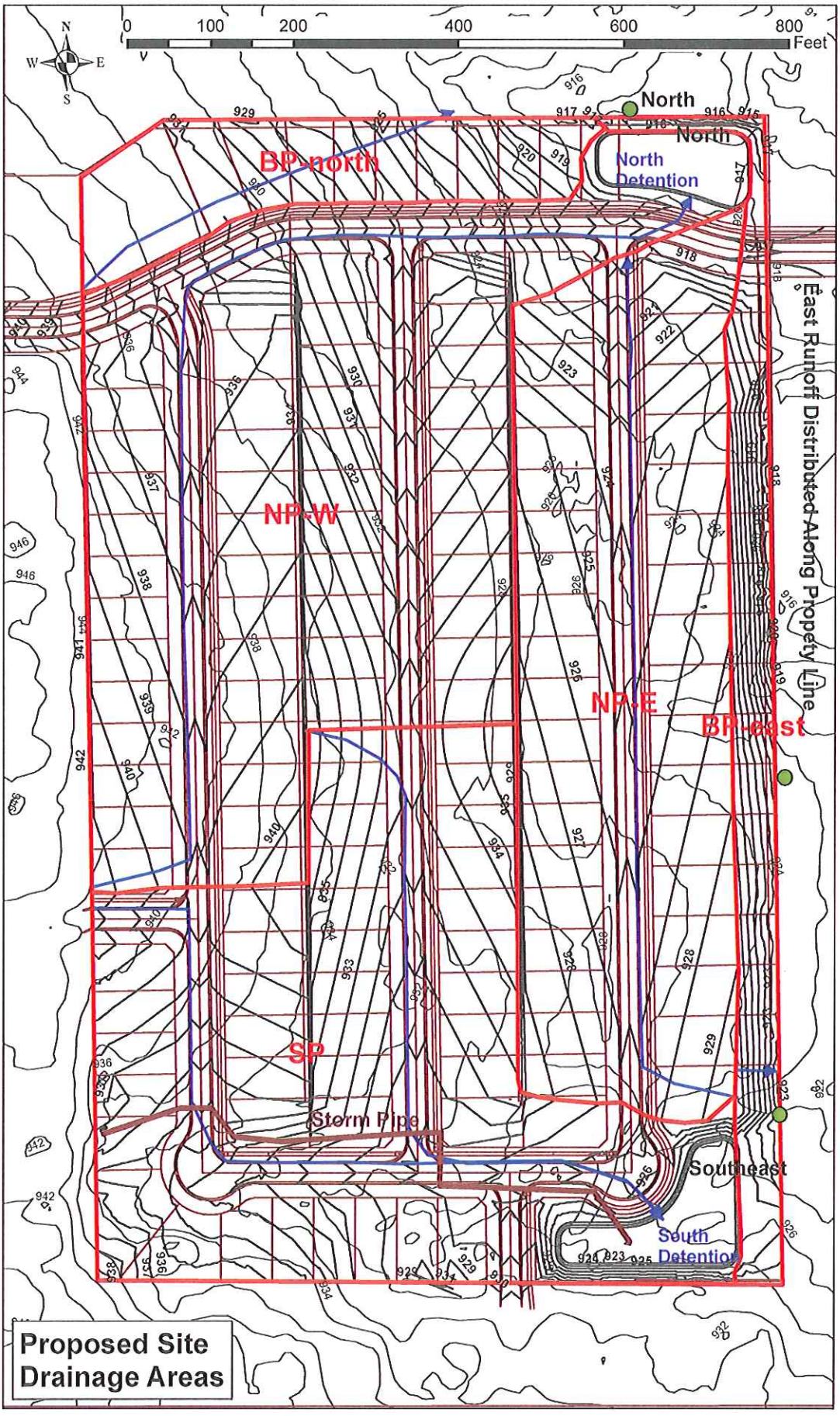
CANYON RIM
SKYLINE
PAYNE
Existing Site
Aerial Photo
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community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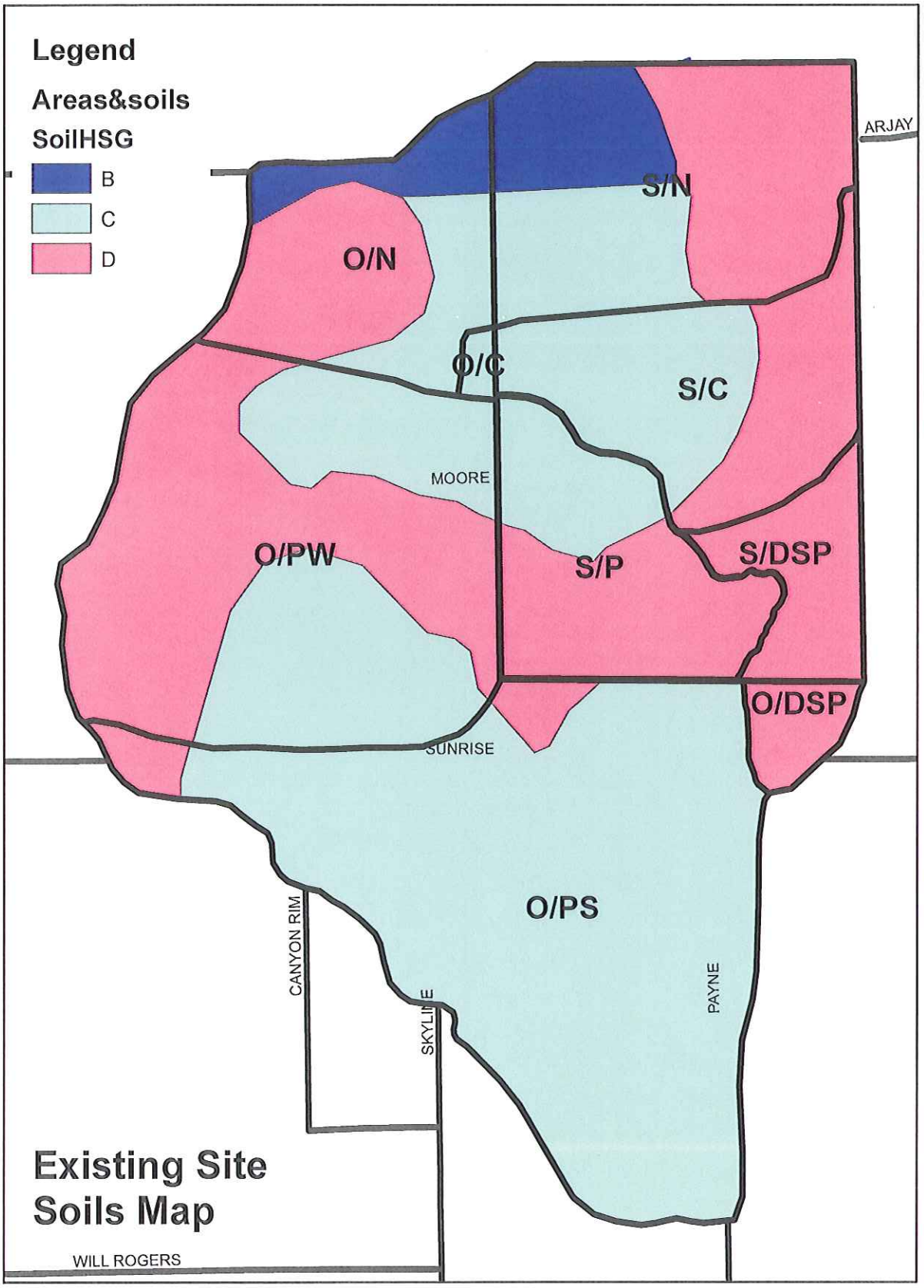
Storm Pipe
Southeast
South Detention
East Runoff Distributed Along Property Line
Proposed Site Drainage Areas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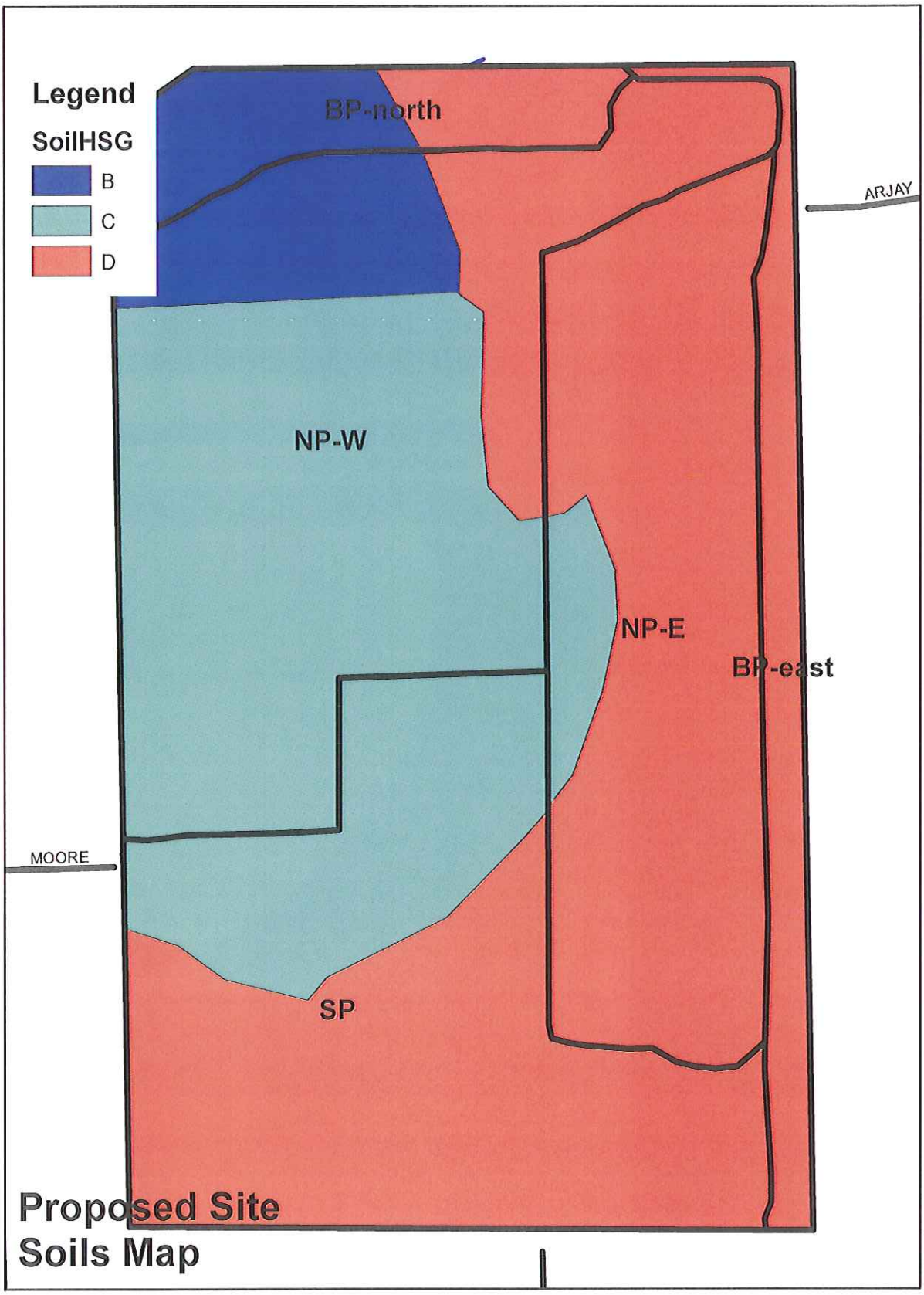
CANYON RIM
SKYLINE
PAYNE
WILL ROGERS
Existing Site
Soils Map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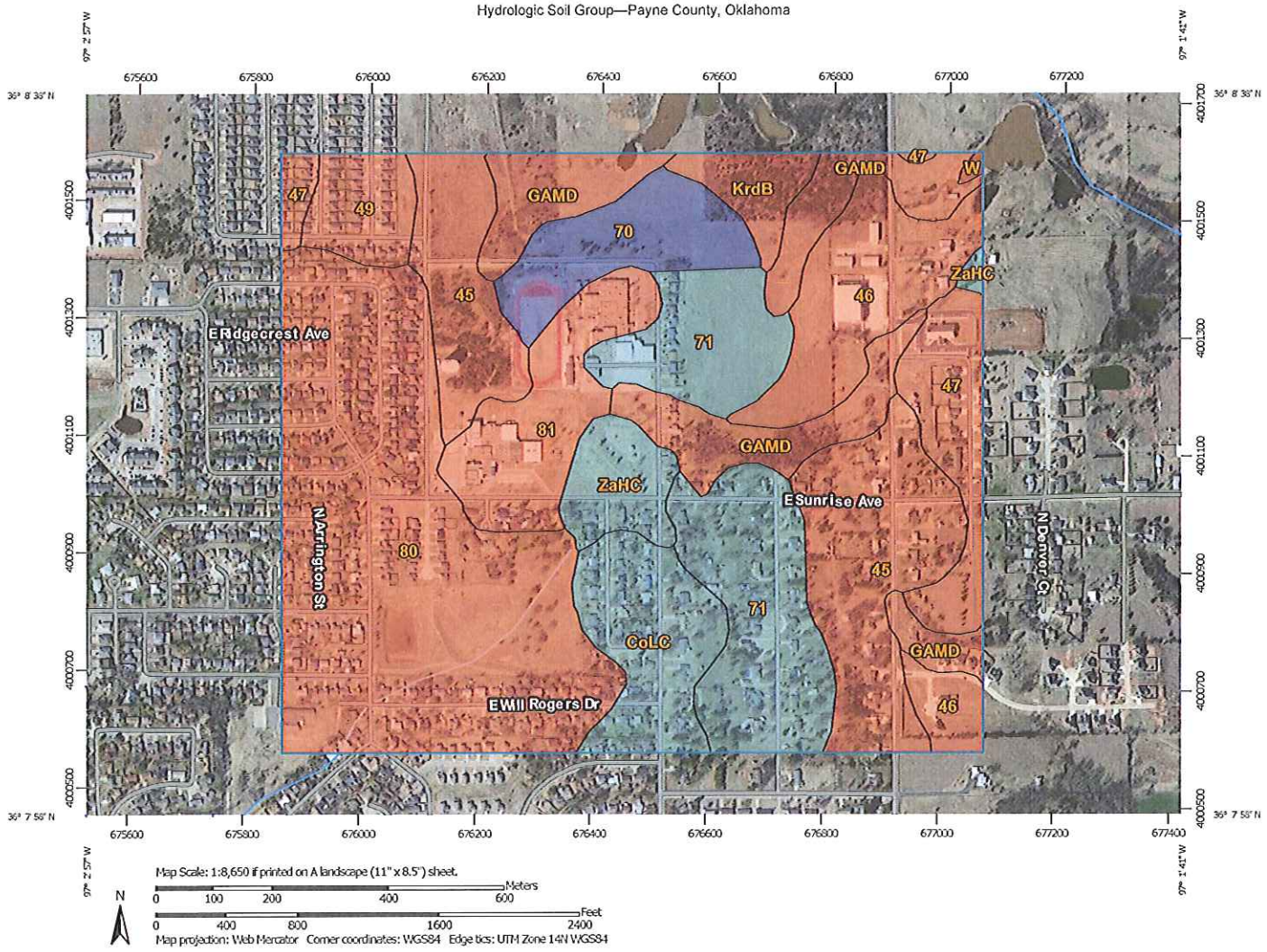
MOORE
SP
Proposed Site
Soils Map

Hydrologic Soil Group—Payne County, Oklahoma




Map Scale: 1:8,650 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 400 800 1600 2400

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

## MAP LEGEND

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

**Soils**

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

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

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

**Water Features**
- Streams and Canals

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

**Background**
- Aerial Photography

## MAP INFORMATION

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

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 map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Payne County, Oklahoma
Survey Area Data: Version 13, Sep 18, 2014

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

Date(s) aerial images were photographed: Feb 28, 2011—Mar 23, 2011

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 — Payne County, Oklahoma (OK119) | | | | |
|---|---|---|---|---|
| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
| 45 | Renfrow silt loam, 1 to 3 percent slopes | D | 41.7 | 13.6% |
| 46 | Renfrow silt loam, 3 to 5 percent slopes | D | 24.1 | 7.9% |
| 47 | Renfrow loam, 3 to 5 percent slopes, eroded | D | 15.6 | 5.1% |
| 49 | Renfrow and Grainola soils, 3 to 8 percent slopes, severely eroded | D | 7.9 | 2.6% |
| 70 | Zaneis loam, 3 to 5 percent slopes | B | 15.0 | 4.9% |
| 71 | Zaneis loam, 3 to 5 percent slopes, eroded | C | 38.4 | 12.5% |
| 80 | Renfrow-Urban land complex, 1 to 5 percent slopes | D | 81.5 | 26.6% |
| 81 | Huska silt loam, 1 to 3 percent slopes | D | 18.6 | 6.1% |
| CoLC | Coyle-Lucien complex, 1 to 5 percent slopes | C | 17.6 | 5.7% |
| GAMD | Grainola-Ashport-Mulhall complex, 0 to 8 percent slopes | D | 31.3 | 10.2% |
| KrdB | Kirkland silt loam, 1 to 3 percent slopes | D | 5.8 | 1.9% |
| W | Water | D | 0.4 | 0.1% |
| ZaHC | Zaneis-Huska complex, 1 to 5 percent slopes | C | 9.1 | 2.9% |
| **Totals for Area of Interest** | | | **307.0** | **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

HEC-HMS Global Summary

| 1-year | Existing | | | | | Proposed | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | Sq.Mi. | Peak cfs | Time | Vol, in | | Name | Sq.Mi. | Peak cfs | Time | Vol, in |
| O/PS | 0.03503 | 49.94 | 27Jul2015, 11:58 | 1.3824 | | O/PS | 0.035 | 49.9 | 27Jul2015, 11:58 | 1.3824 |
| O/PW | 0.02772 | 48.58 | 27Jul2015, 11:58 | 1.7385 | | O/PW | 0.0277 | 48.55 | 27Jul2015, 11:58 | 1.7385 |
| S/P | 0.00981 | 15.07 | 27Jul2015, 11:57 | 1.4769 | | SP | 0.0124 | 21.35 | 27Jul2015, 11:58 | 1.723 |
| Existing Pond | 0.07256 | 113.49 | 27Jul2015, 11:58 | 1.5312 | | South Pond | 0.0751 | 119.79 | 27Jul2015, 11:58 | 1.57 |
| S/DSP | 0.00427 | 7.88 | 27Jul2015, 11:53 | 1.5989 | | O/DSP | 0.0017 | 3.27 | 27Jul2015, 11:53 | 1.6726 |
| O/DSP | 0.00175 | 3.37 | 27Jul2015, 11:53 | 1.6726 | | Southeast | 0.0768 | 122.02 | 27Jul2015, 11:58 | 1.5722 |
| Southeast | 0.07858 | 121.96 | 27Jul2015, 11:57 | 1.538 | | NP-W | 0.0143 | 20.6 | 27Jul2015, 11:59 | 1.4966 |
| S/N | 0.01572 | 22.87 | 27Jul2015, 11:53 | 1.2621 | | NP-E | 0.0095 | 13.44 | 27Jul2015, 12:04 | 1.7968 |
| O/N | 0.01046 | 21.87 | 27Jul2015, 11:57 | 2.1175 | | O/C | 0.0004 | 0.71 | 27Jul2015, 11:53 | 1.5275 |
| North | 0.02618 | 42.09 | 27Jul2015, 11:55 | 1.6039 | | North Pond | 0.0242 | 33 | 27Jul2015, 12:00 | 1.6149 |
| S/C | 0.01146 | 18.6 | 27Jul2015, 11:53 | 1.4041 | | O/N | 0.0105 | 21.96 | 27Jul2015, 11:57 | 2.1175 |
| O/C | 0.00042 | 0.74 | 27Jul2015, 11:53 | 1.5275 | | BP-north | 0.0025 | 3.71 | 27Jul2015, 11:53 | 1.2872 |
| East/Center | 0.01188 | 19.34 | 27Jul2015, 11:53 | 1.4085 | | North Bypass | 0.013 | 24.93 | 27Jul2015, 11:57 | 1.9579 |
| Total Site | 0.11664 | 178.61 | 27Jul2015, 11:56 | 1.5396 | | North | 0.0372 | 55.98 | 27Jul2015, 11:59 | 1.7348 |
| | | | | | | BP-east | 0.0024 | 5.01 | 27Jul2015, 11:53 | 1.8267 |
| | | | | | | Total Site | 0.1164 | 181.2 | 27Jul2015, 11:58 | 1.6294 |

HEC-HMS Global Summary

| 2-year | Existing | | | | | | Proposed | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | Sq.Mi. | Peak cfs | Time | Vol, in | | Name | Sq.Mi. | Peak cfs | Time | Vol, in |
| O/PS | 0.03503 | 69.38 | 27Jul2015, 11:57 | 1.9195 | | O/PS | 0.035 | 69.32 | 27Jul2015, 11:57 | 1.9195 |
| O/PW | 0.02772 | 64.45 | 27Jul2015, 11:58 | 2.3274 | | O/PW | 0.0277 | 64.4 | 27Jul2015, 11:58 | 2.3274 |
| S/P | 0.00981 | 20.65 | 27Jul2015, 11:57 | 2.0293 | | SP | 0.0124 | 28.4 | 27Jul2015, 11:58 | 2.3099 |
| Existing Pond | 0.07256 | 154.31 | 27Jul2015, 11:57 | 2.0902 | | South Pond | 0.0751 | 161.82 | 27Jul2015, 11:58 | 2.1344 |
| S/DSP | 0.00427 | 10.61 | 27Jul2015, 11:53 | 2.1696 | | O/DSP | 0.0017 | 4.37 | 27Jul2015, 11:53 | 2.2533 |
| O/DSP | 0.00175 | 4.5 | 27Jul2015, 11:53 | 2.2533 | | Southeast | 0.0768 | 164.99 | 27Jul2015, 11:57 | 2.1371 |
| Southeast | 0.07858 | 165.82 | 27Jul2015, 11:57 | 2.0981 | | NP-W | 0.0143 | 28.2 | 27Jul2015, 11:59 | 2.0519 |
| S/N | 0.01572 | 32.32 | 27Jul2015, 11:53 | 1.7785 | | NP-E | 0.0095 | 17.8 | 27Jul2015, 12:03 | 2.3923 |
| O/N | 0.01046 | 28.03 | 27Jul2015, 11:57 | 2.7463 | | O/C | 0.0004 | 0.96 | 27Jul2015, 11:53 | 2.0878 |
| North | 0.02618 | 56.52 | 27Jul2015, 11:55 | 2.1652 | | North Pond | 0.0242 | 44.64 | 27Jul2015, 12:00 | 2.1861 |
| S/C | 0.01146 | 25.71 | 27Jul2015, 11:53 | 1.9451 | | O/N | 0.0105 | 28.13 | 27Jul2015, 11:57 | 2.7463 |
| O/C | 0.00042 | 1.01 | 27Jul2015, 11:53 | 2.0878 | | BP-north | 0.0025 | 5.22 | 27Jul2015, 11:53 | 1.8082 |
| East/Center | 0.01188 | 26.72 | 27Jul2015, 11:53 | 1.9502 | | North Bypass | 0.013 | 32.23 | 27Jul2015, 11:57 | 2.5659 |
| Total Site | 0.11664 | 242.52 | 27Jul2015, 11:56 | 2.0981 | | North | 0.0372 | 74.29 | 27Jul2015, 11:58 | 2.3188 |
| | | | | | | BP-east | 0.0024 | 6.58 | 27Jul2015, 11:53 | 2.4266 |
| | | | | | | Total Site | 0.1164 | 243.37 | 27Jul2015, 11:58 | 2.2011 |

HEC-HMS Global Summary

| 5-year | Existing | | | | | | Proposed | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | Sq.Mi. | Peak cfs | Time | Vol, in | | Name | Sq.Mi. | Peak cfs | Time | Vol, in |
| O/PS | 0.03503 | 105.4 | 27Jul2015, 11:57 | 2.9374 | | O/PS | 0.035 | 105.31 | 27Jul2015, 11:57 | 2.9374 |
| O/PW | 0.02772 | 93.09 | 27Jul2015, 11:57 | 3.4157 | | O/PW | 0.0277 | 93.02 | 27Jul2015, 11:57 | 3.4157 |
| S/P | 0.00981 | 30.88 | 27Jul2015, 11:57 | 3.0684 | | SP | 0.0124 | 41.09 | 27Jul2015, 11:58 | 3.3957 |
| Existing Pond | 0.07256 | 229.37 | 27Jul2015, 11:57 | 3.1379 | | South Pond | 0.0751 | 239.18 | 27Jul2015, 11:57 | 3.1895 |
| S/DSP | 0.00427 | 15.57 | 27Jul2015, 11:53 | 3.2339 | | O/DSP | 0.0017 | 6.35 | 27Jul2015, 11:53 | 3.3311 |
| O/DSP | 0.00175 | 6.54 | 27Jul2015, 11:53 | 3.3311 | | Southeast | 0.0768 | 243.93 | 27Jul2015, 11:57 | 3.1926 |
| Southeast | 0.07858 | 245.93 | 27Jul2015, 11:57 | 3.1474 | | NP-W | 0.0143 | 42.11 | 27Jul2015, 11:59 | 3.0947 |
| S/N | 0.01572 | 49.95 | 27Jul2015, 11:53 | 2.7672 | | NP-E | 0.0095 | 25.65 | 27Jul2015, 12:03 | 3.4889 |
| O/N | 0.01046 | 38.91 | 27Jul2015, 11:57 | 3.8862 | | O/C | 0.0004 | 1.42 | 27Jul2015, 11:53 | 3.1379 |
| North | 0.02618 | 83.14 | 27Jul2015, 11:54 | 3.2143 | | North Pond | 0.0242 | 65.83 | 27Jul2015, 12:00 | 3.2502 |
| S/C | 0.01146 | 38.81 | 27Jul2015, 11:53 | 2.9686 | | O/N | 0.0105 | 39.06 | 27Jul2015, 11:57 | 3.8862 |
| O/C | 0.00042 | 1.49 | 27Jul2015, 11:53 | 3.1379 | | BP-north | 0.0025 | 8.04 | 27Jul2015, 11:53 | 2.8034 |
| East/Center | 0.01188 | 40.3 | 27Jul2015, 11:53 | 2.9746 | | North Bypass | 0.013 | 45.29 | 27Jul2015, 11:56 | 3.678 |
| Total Site | 0.11664 | 359.25 | 27Jul2015, 11:56 | 3.1448 | | North | 0.0372 | 107.67 | 27Jul2015, 11:58 | 3.3997 |
| | | | | | | BP-east | 0.0024 | 9.39 | 27Jul2015, 11:53 | 3.5296 |
| | | | | | | Total Site | 0.1164 | 356.72 | 27Jul2015, 11:57 | 3.2658 |

HEC-HMS Global Summary

| 10-year | Existing | | | | | Proposed | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | Sq.Mi. | Peak cfs | Time | Vol, in | | Name | Sq.Mi. | Peak cfs | Time | Vol, in |
| O/PS | 0.03503 | 129.49 | 27Jul2015, 11:57 | 3.6336 | | O/PS | 0.035 | 129.38 | 27Jul2015, 11:57 | 3.6336 |
| O/PW | 0.02772 | 112.03 | 27Jul2015, 11:57 | 4.1475 | | O/PW | 0.0277 | 111.95 | 27Jul2015, 11:57 | 4.1475 |
| S/P | 0.00981 | 37.68 | 27Jul2015, 11:57 | 3.7754 | | SP | 0.0124 | 49.44 | 27Jul2015, 11:58 | 4.1261 |
| Existing Pond | 0.07256 | 279.21 | 27Jul2015, 11:57 | 3.8491 | | South Pond | 0.0751 | 290.56 | 27Jul2015, 11:57 | 3.9045 |
| S/DSP | 0.00427 | 18.84 | 27Jul2015, 11:53 | 3.9538 | | O/DSP | 0.0017 | 7.65 | 27Jul2015, 11:53 | 4.0578 |
| O/DSP | 0.00175 | 7.88 | 27Jul2015, 11:53 | 4.0578 | | Southeast | 0.0768 | 296.24 | 27Jul2015, 11:57 | 3.9079 |
| Southeast | 0.07858 | 299.06 | 27Jul2015, 11:57 | 3.8594 | | NP-W | 0.0143 | 51.36 | 27Jul2015, 11:59 | 3.8036 |
| S/N | 0.01572 | 61.81 | 27Jul2015, 11:53 | 3.4484 | | NP-E | 0.0095 | 30.82 | 27Jul2015, 12:03 | 4.2244 |
| O/N | 0.01046 | 46 | 27Jul2015, 11:57 | 4.643 | | O/C | 0.0004 | 1.73 | 27Jul2015, 11:53 | 3.8507 |
| North | 0.02618 | 100.93 | 27Jul2015, 11:54 | 3.9257 | | North Pond | 0.0242 | 79.85 | 27Jul2015, 12:00 | 3.9696 |
| S/C | 0.01146 | 47.54 | 27Jul2015, 11:53 | 3.6677 | | O/N | 0.0105 | 46.18 | 27Jul2015, 11:57 | 4.643 |
| O/C | 0.00042 | 1.81 | 27Jul2015, 11:53 | 3.8507 | | BP-north | 0.0025 | 9.93 | 27Jul2015, 11:53 | 3.4879 |
| East/Center | 0.01188 | 49.35 | 27Jul2015, 11:53 | 3.6742 | | North Bypass | 0.013 | 53.88 | 27Jul2015, 11:56 | 4.4209 |
| Total Site | 0.11664 | 436.7 | 27Jul2015, 11:56 | 3.8554 | | North | 0.0372 | 129.69 | 27Jul2015, 11:58 | 4.1273 |
| | | | | | | BP-east | 0.0024 | 11.22 | 27Jul2015, 11:53 | 4.2688 |
| | | | | | | Total Site | 0.1164 | 432.18 | 27Jul2015, 11:57 | 3.9854 |

HEC-HMS Global Summary

| 25-year | Existing | | | | | | Proposed | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | Sq.Mi. | Peak cfs | Time | Vol, in | | Name | Sq.Mi. | Peak cfs | Time | Vol, in |
| O/PS | 0.03503 | 160.89 | 27Jul2015, 11:57 | 4.5574 | | O/PS | 0.035 | 160.76 | 27Jul2015, 11:57 | 4.5574 |
| O/PW | 0.02772 | 136.52 | 27Jul2015, 11:57 | 5.1088 | | O/PW | 0.0277 | 136.42 | 27Jul2015, 11:57 | 5.1088 |
| S/P | 0.00981 | 46.52 | 27Jul2015, 11:57 | 4.7107 | | SP | 0.0124 | 60.22 | 27Jul2015, 11:58 | 5.086 |
| Existing Pond | 0.07256 | 343.93 | 27Jul2015, 11:57 | 4.7888 | | South Pond | 0.0751 | 357.25 | 27Jul2015, 11:57 | 4.848 |
| S/DSP | 0.00427 | 23.08 | 27Jul2015, 11:53 | 4.9028 | | O/DSP | 0.0017 | 9.34 | 27Jul2015, 11:53 | 5.0139 |
| O/DSP | 0.00175 | 9.61 | 27Jul2015, 11:53 | 5.0139 | | Southeast | 0.0768 | 364.12 | 27Jul2015, 11:57 | 4.8517 |
| Southeast | 0.07858 | 368.06 | 27Jul2015, 11:57 | 4.8 | | NP-W | 0.0143 | 63.37 | 27Jul2015, 11:59 | 4.7408 |
| S/N | 0.01572 | 77.33 | 27Jul2015, 11:53 | 4.3562 | | NP-E | 0.0095 | 37.49 | 27Jul2015, 12:03 | 5.1893 |
| O/N | 0.01046 | 55.13 | 27Jul2015, 11:57 | 5.6298 | | O/C | 0.0004 | 2.12 | 27Jul2015, 11:53 | 4.7923 |
| North | 0.02618 | 124.06 | 27Jul2015, 11:54 | 4.8651 | | North Pond | 0.0242 | 98.03 | 27Jul2015, 12:00 | 4.9177 |
| S/C | 0.01146 | 58.91 | 27Jul2015, 11:53 | 4.5948 | | O/N | 0.0105 | 55.34 | 27Jul2015, 11:57 | 5.6298 |
| O/C | 0.00042 | 2.23 | 27Jul2015, 11:53 | 4.7923 | | BP-north | 0.0025 | 12.4 | 27Jul2015, 11:53 | 4.3993 |
| East/Center | 0.01188 | 61.14 | 27Jul2015, 11:53 | 4.6018 | | North Bypass | 0.013 | 64.97 | 27Jul2015, 11:56 | 5.3932 |
| Total Site | 0.11664 | 537.28 | 27Jul2015, 11:56 | 4.7944 | | North | 0.0372 | 158.22 | 27Jul2015, 11:58 | 5.0839 |
| | | | | | | BP-east | 0.0024 | 13.59 | 27Jul2015, 11:53 | 5.2379 |
| | | | | | | Total Site | 0.1164 | 530.05 | 27Jul2015, 11:57 | 4.9339 |

HEC-HMS Global Summary

| 50-year | Existing | | | | | Proposed | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | Sq.Mi. | Peak cfs | Time | Vol, in | | Name | Sq.Mi. | Peak cfs | Time | Vol, in |
| O/PS | 0.03503 | 187.69 | 27Jul2015, 11:57 | 5.3583 | | O/PS | 0.035 | 187.53 | 27Jul2015, 11:57 | 5.3583 |
| O/PW | 0.02772 | 157.29 | 27Jul2015, 11:57 | 5.9358 | | O/PW | 0.0277 | 157.18 | 27Jul2015, 11:57 | 5.9358 |
| S/P | 0.00981 | 54.05 | 27Jul2015, 11:57 | 5.5197 | | SP | 0.0124 | 69.37 | 27Jul2015, 11:58 | 5.9121 |
| Existing Pond | 0.07256 | 399.03 | 27Jul2015, 11:57 | 5.6007 | | South Pond | 0.0751 | 413.98 | 27Jul2015, 11:57 | 5.6627 |
| S/DSP | 0.00427 | 26.68 | 27Jul2015, 11:53 | 5.7215 | | O/DSP | 0.0017 | 10.77 | 27Jul2015, 11:53 | 5.8375 |
| O/DSP | 0.00175 | 11.09 | 27Jul2015, 11:53 | 5.8375 | | Southeast | 0.0768 | 421.88 | 27Jul2015, 11:57 | 5.6666 |
| Southeast | 0.07858 | 426.77 | 27Jul2015, 11:57 | 5.6126 | | NP-W | 0.0143 | 73.6 | 27Jul2015, 11:59 | 5.5511 |
| S/N | 0.01572 | 90.61 | 27Jul2015, 11:53 | 5.1459 | | NP-E | 0.0095 | 43.14 | 27Jul2015, 12:03 | 6.0186 |
| O/N | 0.01046 | 62.86 | 27Jul2015, 11:57 | 6.4743 | | O/C | 0.0004 | 2.46 | 27Jul2015, 11:53 | 5.6058 |
| North | 0.02618 | 143.76 | 27Jul2015, 11:54 | 5.6766 | | North Pond | 0.0242 | 113.49 | 27Jul2015, 12:00 | 5.7355 |
| S/C | 0.01146 | 68.59 | 27Jul2015, 11:53 | 5.3982 | | O/N | 0.0105 | 63.1 | 27Jul2015, 11:57 | 6.4743 |
| O/C | 0.00042 | 2.59 | 27Jul2015, 11:53 | 5.6058 | | BP-north | 0.0025 | 14.51 | 27Jul2015, 11:53 | 5.1916 |
| East/Center | 0.01188 | 71.18 | 27Jul2015, 11:53 | 5.4055 | | North Bypass | 0.013 | 74.37 | 27Jul2015, 11:56 | 6.2276 |
| Total Site | 0.11664 | 622.89 | 27Jul2015, 11:56 | 5.6059 | | North | 0.0372 | 182.46 | 27Jul2015, 11:58 | 5.9075 |
| | | | | | | BP-east | 0.0024 | 15.6 | 27Jul2015, 11:53 | 6.0705 |
| | | | | | | Total Site | 0.1164 | 613.3 | 27Jul2015, 11:57 | 5.7519 |

HEC-HMS Global Summary

| 100-year | Existing | | | | | Proposed | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | Sq.Mi. | Peak cfs | Time | Vol, in | | Name | Sq.Mi. | Peak cfs | Time | Vol, in |
| O/PS | 0.03503 | 217.28 | 27Jul2015, 11:57 | 6.2542 | | O/PS | 0.035 | 217.09 | 27Jul2015, 11:57 | 6.2542 |
| O/PW | 0.02772 | 180.15 | 27Jul2015, 11:57 | 6.8559 | | O/PW | 0.0277 | 180.02 | 27Jul2015, 11:57 | 6.8559 |
| S/P | 0.00981 | 62.34 | 27Jul2015, 11:57 | 6.4232 | | SP | 0.0124 | 79.44 | 27Jul2015, 11:58 | 6.8313 |
| Existing Pond | 0.07256 | 459.77 | 27Jul2015, 11:57 | 6.5069 | | South Pond | 0.0751 | 476.51 | 27Jul2015, 11:57 | 6.5714 |
| S/DSP | 0.00427 | 30.64 | 27Jul2015, 11:53 | 6.6341 | | O/DSP | 0.0017 | 12.34 | 27Jul2015, 11:53 | 6.7547 |
| O/DSP | 0.00175 | 12.71 | 27Jul2015, 11:53 | 6.7547 | | Southeast | 0.0768 | 485.53 | 27Jul2015, 11:57 | 6.5755 |
| Southeast | 0.07858 | 491.49 | 27Jul2015, 11:57 | 6.5193 | | NP-W | 0.0143 | 84.88 | 27Jul2015, 11:59 | 6.4557 |
| S/N | 0.01572 | 105.29 | 27Jul2015, 11:53 | 6.0313 | | NP-E | 0.0095 | 49.37 | 27Jul2015, 12:03 | 6.9405 |
| O/N | 0.01046 | 71.36 | 27Jul2015, 11:57 | 7.4103 | | O/C | 0.0004 | 2.83 | 27Jul2015, 11:53 | 6.5135 |
| North | 0.02618 | 165.49 | 27Jul2015, 11:54 | 6.5823 | | North Pond | 0.0242 | 130.51 | 27Jul2015, 12:00 | 6.647 |
| S/C | 0.01146 | 79.28 | 27Jul2015, 11:53 | 6.2965 | | O/N | 0.0105 | 71.64 | 27Jul2015, 11:57 | 7.4103 |
| O/C | 0.00042 | 2.98 | 27Jul2015, 11:53 | 6.5135 | | BP-north | 0.0025 | 16.85 | 27Jul2015, 11:53 | 6.0795 |
| East/Center | 0.01188 | 82.25 | 27Jul2015, 11:53 | 6.3042 | | North Bypass | 0.013 | 84.71 | 27Jul2015, 11:56 | 7.1544 |
| Total Site | 0.11664 | 717.27 | 27Jul2015, 11:56 | 6.5116 | | North | 0.0372 | 209.17 | 27Jul2015, 11:58 | 6.8243 |
| | | | | | | BP-east | 0.0024 | 17.8 | 27Jul2015, 11:53 | 6.9958 |
| | | | | | | Total Site | 0.1164 | 705.03 | 27Jul2015, 11:57 | 6.6637 |