Preliminary Drainage Report
North Bay at Lake Woodmoor
El Paso County, Colorado

Prepared for:
Lake Woodmoor Holdings, LLC
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Prepared by:
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Kiowa Project No. 15073.2

June 3, 2022

PCD Project No. PUDSP-22-008

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STATEMENTS AND APPROVALS

ENGINEER'S STATEMENT:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

Kiowa Engineering Corporation, 1604 South 21st Street, Colorado Springs, Colorado 80904

__________________________________ __________________

Christopher J. Castelli, P.E. (PE #38842) Date
For and on Behalf of Kiowa Engineering Corporation

DEVELOPER'S STATEMENT:

I, the Developer, have read and will comply with all of the requirements specified in this drainage report and plan.

By: __________________________________ __________________

Steve Rossoll, Director of Development Services Date
Lake Woodmoor Holdings, LLC

Print Name: ______________________________

Address: Lake Woodmoor Holdings, LLC
9540 Federal Drive, Suite 200
Colorado Springs, Colorado 80921

EL PASO COUNTY:

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 & 2, El Paso County Engineering Criteria Manual, and Land Development Code, as amended.

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__________________________________ __________________

Jennifer Irvine, P.E. Date
Interim El Paso County Engineer/ECM Administrator

I. GENERAL LOCATION AND DESCRIPTION

North Bay at Lake Woodmoor will be developed as a multi-family residential subdivision located in the Woodmoor area of El Paso County near Monument, Colorado. The subject property is located to the south of Deer Creek Road and approximately 400 feet east of Woodmoor Drive. The site is located in the southeast portion of Section 11, Township 11 South, Range 67 West of the 6th Principal Meridian, in El Paso County, Colorado. The site is bounded to the north by Deer Creek Road, to the west by the Cove at Woodmoor Condominiums, to the east by single family residences of the Woodmoor development and to the south by Lake Woodmoor. The property covers approximately 7.23 acres and is currently undeveloped. A vicinity map of the site is shown on Figure 1 included in the Appendix.

The existing vegetative cover within the property consists primarily of smooth brome (Bromus inermis), a non-native grass commonly used for re-vegetation in good condition throughout the site. There are a few coniferous trees scattered across the site, with a denser tree cover along the south and east property boundaries. There are riparian shrubs within the creek in the northeast corner of the property and deciduous trees and wetlands along the south property boundary at Lake Woodmoor. The existing ground slopes within the property range from approximately 2 to 38 percent. Soils within the west one third of the subject site are classified to be within Hydrologic Soil Group B (Pring coarse sandy loam #71), and soils within the east two thirds of the subject site are classified to be within Hydrologic Soil Group D (Alamosa loam #1) as shown in the El Paso County Custom Soil Resource Report. Excerpts from the report are included in the Appendix. Hydrologic Soil Groups B and D were used (where appropriate in accordance with the soil report) for the purposes of computing the existing and proposed hydrology for the site.

The Lake Fork Dirty Woman Creek (Lake Fork) enters the site in the northeast corner, and continues in a southerly direction through the middle of the site to Lake Woodmoor. Not only does the Lake Fork receive runoff from the entire site, but also from offsite basins to the north, west and east of the site. The Lake Fork conveys flow south to Lake Woodmoor, then continues south crossing Lake Woodmoor Drive to the Dirty Woman Creek main branch. Dirty Woman Creek is a tributary to Monument Creek.

There are no active irrigation ditches or facilities within or adjacent to the site.

Existing utilities adjacent to the site include three Woodmoor Water and Sanitation District (District) water lines (two potable water and one raw water), one District sanitary sewer line, an underground electric line and two telephone lines within the Deer Creek Road right-of-way. There is an existing District well (Well Site No. 5) just to the west of the property. There are several existing utilities within the site, including a water line that runs south from Deer Creek Road through the middle of the site, a water line that runs east from Deer Creek Road to a fire hydrant, sanitary sewer lines located near the south and east property boundaries that run to/from an existing lift station in the southeast corner of the site, and an underground electric line near the east property boundary from Deer Creek Road to the lift station. Near the northeast corner of the property, there is a concrete headwall and 24-inch CMP that diverts creek flow approximately 240 linear feet southwest along the north property boundary to a CMP manhole, where it combines with a 24-inch CMP culvert that crosses Deer Creek Road. The 24-inch CMP continues south approximately 340 linear feet to a concrete structure at the north end of Lake Woodmoor. There is also a 12-inch PVC raw water drainline that runs parallel to the north-south 24-inch CMP and daylights at the same concrete structure at Lake Woodmoor.

Were any previous drainage reports for this area, other than DBPS, used for reference?

MAJOR DRAINAGE BASINS AND SUBBASINS

The site lies within the Dirty Woman Creek drainage basin. The site presently drains southwest and southeast by sheet flow to the Lake Fork, which drains southerly to Lake Woodmoor (Sub-basins EX-1 through EX-3). The existing drainage patterns for the site are shown on Sheet DP1 included in Appendix H.

There is currently offsite runoff that enters the site from the east. Offsite Sub-basin OS-1 conveys runoff west by sheet flow from the Woodmoor residential development to the east property boundary (DP 1), where it sheet flows southwest across the east portion of the site to the Lake Fork tributary. Offsite Sub-basin OS-2 conveys runoff by sheet flow from the Woodmoor Oaks residential subdivision north of the site to a swale along the north side of Deer Creek Road. The swale terminates at a 24-inch CMP just east of Burning Oak Way that captures flow from Sub-basin OS-2 (DP 4) and conveys it south across Deer Creek Road to the north property boundary at a CMP manhole. Runoff from Sub-basin OS-2 is combined with diverted Lake Fork tributary flows at the CMP manhole (see existing utilities discussion in the General Location and Description section), and continues south in a 24-inch CMP to Lake Woodmoor. Offsite Sub-basin OS-3 conveys runoff southeast by sheet flow and gutter flow from a portion of the The Cove at Woodmoor Condominiums development to the west property boundary (DP 6). Sub-basin OS-3 runoff is then combined with runoff from Sub-basin EX-2 and is conveyed southeast by sheet flow to the Lake Fork tributary.

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discussion.

The reports and plans that were reviewed in the process of preparing this drainage report are included in the References section. The North Bay at Lake Woodmoor area was studied as a part of the *Dirty Woman and Crystal Creeks Drainage Basin Planning Study (DBPS).* The portion of the Lake Fork tributary that is within the North Bay at Lake Woodmoor property (identified as “Reach LFDW-A-25” in the DBPS) is shown to be stabilized with a series of grade control (check) structures. Creek improvements will be constructed in conjunction with the North Bay at Lake Woodmoor improvements, so the development of the property will not adversely impact any improvements or drainageways downstream. Refer to the Drainage Facility Design section for additional discussion of the creek improvements.

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The subject property limits are shown on Flood Insurance Rate Map (FIRM) 08041C0276 F (with an effective date of March 17, 1997). The FIRM was subsequently revised to reflect a Letter of Map Revision (LOMR) dated November 9, 1998. The FIRM showing the project site and the Letter of Map Change (LOMC) outlining the edits to the Lake Fork Dirty Woman Creek Base Flood Elevations per the approved LOMR are included in Appendix A and Appendix G. The middle approximately one third of the property is located within a FEMA regulated floodplain based on Flood Insurance Rate Map 08041C0276 F. The current FEMA floodplain and floodway limits (as shown on the effective FIRM) are shown on Sheet DP1. Under proposed conditions, the property will be developed within the current floodplain and floodway, and creek flows are proposed to be conveyed through the site with a 100-year capacity storm sewer system. A Conditional Letter of Map Revision (CLOMR) that reflects the proposed design and a Letter of Map Revision (LOMR) that reflects the as-constructed conditions are therefore required for this project. The current FEMA floodplain and floodway limits and proposed condition floodplain limits are shown on Sheet DP2 included in Appendix H. Sheet DP2 also shows that finished floor elevations of all habitable/insurable structures will be located outside of the proposed 100-year floodplain.

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DRAINAGE DESIGN CRITERIA

Hydrologic and hydraulic calculations for the site were performed using the methods outlined in the *El Paso County Drainage Criteria Manual* (DCM). Topography for the site was compiled using a two-foot contour interval and is presented on the drainage plans. The hydrologic calculations were made for the existing and proposed site conditions. The drainage plans present the drainage patterns for the site, including the sub-basins. The peak flow rates for the sub-basins were estimated using the Rational Method. The 5-year (Minor Storm) and 100-year (Major Storm) recurrence intervals were determined. The one-hour rainfall depth was determined from Table 6-2 of the *Drainage Criteria Manual*. These depths are shown in the runoff calculations spreadsheet. The peak flow data generated using the rational method was used to verify street capacities and to size inlets and storm sewers within the development. The drainage basin area, time of concentration, and rainfall intensity were determined for each of the sub-basins within the property. As discussed in the General Location and Description section, Hydrologic Soil Groups B and D were used (where appropriate in accordance with the soil report) for the purposes of computing the existing and proposed hydrology for the site. For existing conditions, runoff coefficients for the on-site basins were determined using historic, packed gravel and pavement land uses. The land uses for the proposed development will be paved streets, roofs and lawns. Runoff coefficients for the offsite basins were determined using residential with a density of approximately 2 lots per acre for Sub-basin OS-1 and 1 lot per acre for Sub-basin OS-2. The land uses for offsite Sub-basin OS-3 were pavement and historic/lawns.

The sizing of the onsite hydraulic structures was made using the methods outlined in both the El Paso County and City of Colorado Springs Drainage Criteria Manuals. Colorado Department of Transportation (CDOT) Type R curb inlets, Type C and Type D grated inlets and a Stormceptor will be used within the site. The hydraulic capacities of the Type R curb inlets were determined using the MHFD-Inlet spreadsheet developed by the Mile High Flood District (MHFD), and Figure 8-10 (refer to Appendix C) was utilized for the Type C and Type D grated inlet capacities.

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El Paso County Type C curbs will be used throughout the development, except between curb returns, at curb inlets and around parking areas, where a 6-inch vertical curb will be used. The MHFD-Inlet spreadsheet was used to determine the capacity of each street within the site, considering the County criteria for the Minor (5-year) and Major (100-year) Storms.

Storm sewer pipes were initially sized based on their full-flow capacity using the Manning's equation. The UDSewer program will be used to verify storm sewer pipe sizes and perform hydraulic grade line (HGL) and energy grade line (EGL) calculations for the 5-year and 100-year storm events, which will be included in the Final Drainage Report. Hydraulic calculations are provided in Appendix C for the proposed street, inlet and pipe capacities.

The UD-Culvert spreadsheet was used to determine the extent and size of riprap erosion protection for pipe outlets. These calculations are also included in Appendix C.

The on-site stormwater quality areas (rain gardens) were sized using MHFD volume calculations. The UD-Detention spreadsheet created by the MHFD will be used for each and included in the Final Drainage Report. Supporting calculations associated with the rain garden sizing are included in Appendix E. The proposed Stormceptor for the site was sized by Contech based on the drainage area and percent imperviousness of the drainage basin tributary to the Stormceptor. A detail for the Stormceptor provided by Contech is also included in Appendix E.

The storm sewer system proposed to convey 100-year creek flows through the site was analyzed using UDSewer for pipe sizing and HGL and EGL calculations. The entrance to the system was designed using the Federal Highway Administration's (FHWA) HY-8 program, and the energy dissipation basin at the outlet was evaluated and sized using FHWA HEC No. 14 guidance.

II. DRAINAGE FACILITY DESIGN

The drainage of the site will be accomplished through a combination of sheet flow, gutter flow and storm sewer flow. Curb inlets and grated inlets will be placed at low points (sump areas) throughout the site to accept the developed runoff and convey it to Lake Fork Dirty Woman Creek. Two curb inlets on a continuous grade will be required along Redbridge Point to decrease the amount of gutter flow for the minor and major storms.

Each stormwater quality area (rain garden) will include a free-draining growing media underlain by a woven geotextile fabric, an underdrain system, a riprap presedimentation forebay at each proposed storm sewer outlet and a CDOT Type D grated inlet to serve as the outlet structure. In order to control the drain time of the rain garden to the required 12-hours, there will be an orifice plate at the downstream end of the underdrain system within the outlet structure. An emergency spillway/overflow path and maintenance access will also be provided.

The proposed rain gardens and Stormceptor will be private facilities owned and maintained by the homeowner's association for the North Bay at Lake Woodmoor development.

The proposed drainage patterns for the site are shown on the Final Drainage Plan for the developed condition (Sheet DP2) provided in Appendix H. The hydrologic and hydraulic calculations are provided in Appendices B and C, refer to the Drainage Design Criteria section for additional information on the hydrologic and hydraulic calculations.

The evaluation related to the sizing of the onsite drainage improvements was carried out in accordance with the *El Paso County Drainage Criteria Manual*. The capacities of the proposed onsite facilities were calculated in accordance with the Criteria Manual.

The primary stormwater conveyance facilities will be storm sewer systems ranging in size from 18- to 24-inches conveying the on-site runoff to Lake Fork Dirty Woman Creek.

Following is a description of the on-site drainage sub-basins:

Sub-basin A is approximately 0.48 acres in area and is located at the northeast corner of the site. The basin includes a portion of the Lake Fork Dirty Woman Creek and the proposed improved inlet structure to capture the flows from the creek and route them through the site. Runoff from this basin will sheet flow to the creek and improved inlet where it will be captured by the storm sewer system.

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Sub-basin B is approximately 0.22 acres in area and is located just west of Sub-basin OS-1a. The basin accepts runoff from OS-1a and the combined runoff will sheet flow west to a 2-foot-wide concrete drain pan that will convey flow south to a grass-lined swale in Sub-basin C at Design Point 1 (DP 1).

Sub-basin C is approximately 0.56 acres in area and is located west of Sub-basins OS-1a and OS-1b, and south of Sub-basin B. This basin consists of a portion of the buildings and back yards of Lots 1-6, 9 and 10. A grass-lined swale will capture runoff from Sub-basins OS-1a, OS-1b, B and C and convey it south to a stormwater quality area (rain garden) at DP 2.

Identify as Water Quality Area #, as shown on drainage map.

Sub-basin D is approximately 1.80 acres in area and is locat middle of the site. The basin consists of Shoreditch Heights, Newham Point, all or a portion of Lots 1–16 and 27–35. Runoff from this basin will sheet flow then gutter flow to the low point at a parking area south of the intersection of Shoreditch Heights and Newham Point at DP 3. Runoff will be captured by a 10-foot Type R curb inlet, which is sized for the 100-year storm event.

Sub-basin E is approximately 0.53 acres in area and is located west of Sub-basin D and south of the intersection of Deer Creek Road and Shoreditch Heights. The basin includes a portion of Deer Creek Road and a portion of the buildings and back yards of Lots 25, 26 and 32–36. Runoff from this basin will sheet flow to a stormwater quality area (rain garden).

Identify as Water Quality Area #, as shown on dra

Sub-basin F is approximately 0.15 acres in area and is located southwest of Sub-basin E and southeast of the intersection of Deer Creek Road and Redbridge Point. The basin includes a portion of Deer Creek Road, a portion of Redbridge Point and Lots 25 and 26. Runoff from this basin will sheet flow southwest then gutter flow south to a 5-foot Type R curb inlet on a continuous grade at the northeast

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corner of Redbridge Point and Newham Point. This location is the upstream end of the 18-inch RCP Storm Sewer System B1, that will convey flows south to Water Quality Area 4.

Sub-basin G is approximately 0.20 acres in area and is located on the west side of Redbridge Point opposite Sub-basin F, between Deer Creek Road and Newham Point. The basin includes a portion of Deer Creek Road, a portion of Redbridge Point and Lots 21 through 24. Runoff from this basin will sheet flow southeast then gutter flow south to a 5-foot Type R curb inlet on a continuous grade at the southwest corner of Redbridge Point and Newham Point at DP 5. Flows captured by the curb inlet will then be conveyed south by the 18-inch RCP Storm Sewer System B1 to Water Quality Area 4.

Sub-basin H is approximately 0.48 acres in area and is located south of Deer Creek Road and west of Sub-basin G. The basin includes a portion of Deer Creek Road and a portion of the buildings and back yards of Lots 20–24. Runoff from this basin will sheet flow to a Type C grated inlet in a sump condition at a low area behind Lots 21 and 22. This inlet is located at the upstream end of Storm Sewer System B1, Lateral 1.

Sub-basin I is approximately 0.62 acres in area and is located east of Sub-basin OS-3 and south of Sub-basins G and H. The basin includes a portion of the entry drive and parking area for The Cove at Woodmoor Condominiums development, a portion of Redbridge Point and a portion of Lots 17–21. This basin will accept flows from Sub-basin OS-3 and sheet flow runoff east and south to a low point in a parking area between Lots 17 and 18. There is a 5-foot Type R curb inlet in a sump condition at this location at DP 6. The inlet will capture flows up to the 100-year storm event and convey them west to Storm Sewer System B1, via an 18-inch RCP (Storm Sewer System B1, Lateral 2).

Sub-basin J is approximately 0.20 acres in area and is located south of Sub-basin I. The basin includes a portion of The Cove Condos parking area, a portion of Lot 19 and all drainage areas directly tributary to Water Quality Area 4 (rain garden). Storm Sewer System B1 will convey runoff to Water Quality Area 4 at DP 8.

Sub-basin K is approximately 2.65 acres in area and encompasses the south portion of the site. The basin represents all drainage areas directly tributary to Lake Woodmoor, including portions of the buildings and the back yards of Lots 11–19. Runoff from this basin will sheet flow west, east and south to the lake (DP 9). Storm Sewer System D downstream of the Stormceptor (Water Quality Area 2) conveys runoff through one of the wingwalls of the 78-inch outfall structure to a riprap-lined energy dissipation basin between Lots 14 and 15.

The offsite drainage sub-basins are described in detail in the Major Drainage Basins and Subbasins section.

Lake Fork Dirty Woman Creek Improvements

Hydrology Restudy. A hydrologic study was completed to update the hydrology of the Lake Fork Basin of the Dirty Woman Creek Drainage Basin located in Unincorporated El Paso County. The previous Dirty Woman Creek and Crystal Creek Drainage Basin Planning Study (DBPS) was published in 1993. Since then, the majority of the Lake Fork Basin has been developed with primarily large lot residences in the upper portion of the basin and some higher density residential development around Lake Woodmoor. The study re-evaluated the hydrology of the Lake Fork Basin based on the final developed land use and is included on Appendix B1. The study has already been informally submitted and reviewed by the County, and is now being incorporated into this report as a formal submission for approval.

Proposed Improvements. As previously mentioned, a storm sewer system is proposed to convey 100-year creek flows through the site in lieu of the drainageway improvements (check structures) as presented in the DBPS. The DBPS states that the check structures were to be non-reimbursable

Provide an MDDP/DBPS Amendment to address the hydrology changes for the channel. The DBPS Amendment will need to be approved by Drainage Board prior to Final Plat approval.

Where does this flow come from? Map shows the DBPS flow rates.

Address how the change from 8x5 box to 78" RCP is being accomplished.

improvements (refer to Plan and Profile Sheet LF2 and Table 14 from the DBPS, Reach LFDW-A-25 included in Appendix G).

Using the revised 100-year flowrate of 520 cfs (1,107 cfs in the DBPS) … sized and analyzed using the UDSewer program. The system is an … reinforced concrete box culvert (RCB) at the upstream end to allow for sufficient clearance over an existing 12-inch sanitary sewer main in Shoreditch Heights, then will change to a 78-inch RCP for its remaining length through the site along Shoreditch Heights. At changes in direction, change in size and storm pipe lateral connections, Type I (box base) Manholes are proposed in accordance with County standards. Refer to Appendix F for hydraulic calculations for the storm sewer system and associated structures.

In order to help maximize the efficiency of the entrance condition to the pipe system, an improved inlet structure (side-tapered inlet) is proposed at the upstream end. The structure was sized using FHWA guidance and includes a major storm grate for safety considerations and debris collection. The structure is sized to allow for one foot of freeboard to the back or walk along Shoreditch Heights.

An emergency overflow structure is provided just downstream of the entrance structure, that will have enough capacity to capture the 100-year storm in the event the entrance structure is fully clogged with debris. The structure is proposed to prevent overflows from being conveyed on the surface through the site. This structure will also have a major storm grate.

At the downstream end of the pipe system, there will be an outfall structure consisting of a cast-in-place concrete headwall and wingwalls with footings and toe walls for scour protection. A Type H Riprap basin will be provided to serve as an energy dissipator and for downstream erosion protection. The size and length of the riprap basin was determined using FHWA guidance for "Energy Dissipators for Culverts and Channels", HEC No. 14.

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A. STORMWATER DETENTION AND WATER QUALITY DESIGN

Stormwater Detention

Lake Woodmoor will provide 100-year detention storage for the developed … site. The DBPS assumed a land use of residential with 2 lots per acre for the area that encompasses the North Bay at Lake Woodmoor site (refer to Appendix F, Figure 3 from the DBPS). The assumed land use would have a 25 percent imperviousness resulting in a 0.53 ac-ft detention volume requirement. This volume includes 0.49 ac-ft. of 100-year detention volume plus one half of the water quality capture volume (0.04 ac-ft). The calculated composite percent imperviousness for the proposed site is 38.4 percent. This equates to a detention volume requirement of 0.65 ac-ft, which includes 0.60 ac-ft of 100-year detention volume plus one half of the water quality capture volume (0.05 ac-ft). The net increase in detention volume to Lake Woodmoor from what was assumed in the DBPS is 0.12 ac-ft. Given the approximately 46-acre surface area of Lake Woodmoor (over 6 times larger than the proposed 7.23-acre site), the increase in detention volume would cause an increase of 0.0027 ft (0.03 in) in the lake's water surface elevation. Lake Woodmoor therefore has sufficient capacity to accept the additional runoff volume, and no improvements are recommended for the reservoir. Refer to Appendix D for detention volume calculations. The Woodmoor Water and Sanitation District (WWSD) has prepared a letter stating that they will allow the use of their facility (Lake Woodmoor) for this site's flood storage. Refer to Appendix G for a copy of the letter.

Stormwater Quality

Storm water quality measures are required as stated in the County's Drainage Criteria Manual. The selection of appropriate BMPs is based on the site's characteristics and potential pollutants. The County requires that a Four-Step Process be followed in the BMP selection process:

Step 1: Employ Runoff Reduction Practices
The proposed site includes the construction of streets, driveways, sidewalks and parking areas to the minimum widths necessary in order to minimize imperviousness while still maintaining the functionality of the site as intended, providing for adequate parking, snow management, public safety and fire access. Drainage swales are located throughout the site for runoff from parts of the site and buildings to drain through before being routed into bioretention areas and/or inlets. These landscaped and grassed areas will encourage infiltration. Site constraints limit the extent to which Low Impact Development (LID) techniques can be implemented.

Step 2: Stabilize Drainageways
The section of drainageway which courses through the site will be replaced with a storm sewer system to convey the flows. The downstream end of the storm sewer system will include a riprap lined energy dissipator to protect the area from erosion and reduce the flow velocity before draining into the lake.

Step 3: Provide Water Quality Capture Volume (WQCV)
WQCV is provided in multiple locations within the site through the use of bioretention areas and a stormceptor. The bioretention areas will be designed per County and MHFD criteria. 1 These WQ areas will include an underdrain system near the bottom of the filter media that connects to the outlet structure, where an orifice plate will control the release of the required WQCV in a 12-hour drain time. A proposed storm sewer will convey runoff released from the basin south to a storm sewer or the Lake Woodmoor. If the outlet structure becomes plugged, an emergency spillway will convey the runoff to the streets or Lake Woodmoor. The stormceptor will be designed to provide stormwater quality treatment of the runoff before discharging into the storm sewer system.

The letter received from the WWSD included in Appendix F also states that they will require the installation of permanent stormwater quality BMPs within the North Bay at Lake Woodmoor development. Also, the WWSD prefers sand filters over other forms of permanent stormwater quality BMPs.

Step 4: Consider Need for Industrial and Commercial BMPs
The proposed development is not an industrial or commercial site, so no specialized BMPs were considered.

<u>Runoff Drainage Off Site without Stormwater Quality Treatment</u>
There are portions of the proposed site at the upstream and downstream ends of the property which drain off site without water quality treatment. Those areas are within Drainage Basin A and K. Drainage Basin A is located at the upstream end of the property where the creek drains into the proposed improved inlet structure. The improvements within that basin are the inlet structure, a small trail segment and site grading. The area associated with these improvements is 0.01 acres. Drainage Basin K is located at the downstream end of the property where the storm sewer system discharges to Lake Woodmoor. The drainage basin includes the storm sewer outfall, residential home backyards and back half of the buildings; maintenance trail to the storm sewer outfall structure and sanitary sewer system; and

retaining walls. The majority of this area will be pervious. The approximate area associated with these improvements is 0.56 acres.

Runoff from these areas is not practicable to capture and drain towards a control measure. The total area is 0.57 acres, which is 7.9 percent of the total site area of 7.23 acres. The total area is less than 1.0 acres and is less than 20 percent of the total site, as allowed by the County. Therefore, these areas qualify for the "Water Quality Capture Volume (WQCV) Standard" exclusion per Section I.7.1.C.1 of the ECM.

B. DRAINAGE AND BRIDGE FEES

The site lies within the Dirty Woman Creek Drainage Basin. The current drainage basin fee associated with the Dirty Woman Creek Drainage Basin is $21,134 per impervious acre. The current bridge fee associated with the Dirty Woman Creek Drainage Basin is $1,156 per impervious acre. The North Bay at Lake Woodmoor development encompasses 7.23 acres. Table 1 details the fees due as part of this development.

III. CONCLUSIONS

North Bay at Lake Woodmoor will be a multi-family residential development covering approximately 7.23 acres. Onsite drainage will include the use of curb inlets, grated inlets and storm sewers to route runoff from the site to the Lake Fork Tributary of Dirty Woman Creek. The proposed on-site permanent BMPs are private and will be maintained by the North Bay at Lake Woodmoor Homeowners Association. The Appendix includes an update to the hydrology for the Dirty Woman and Crystal Creeks Drainage Basin Planning Study. The proposed development will include the installation of a storm sewer to convey the Creek flows through the site, therefore no on site drainageway improvements area planned. With the site discharging its runoff to a major drainageway that is immediately upstream of Lake Woodmoor, the development of the North Bay at Lake Woodmoor property will not adversely impact or deteriorate improvements or natural drainageways downstream of the property.

IV. REFERENCES

1) Drainage Basin Planning Study, Dirty Woman Creek and Crystal Creek, El Paso County, Colorado, prepared by Kiowa Engineering Corporation, dated September 1993.

2) Flood Insurance Study, El Paso County, Colorado and Incorporated Areas, prepared by the Federal Emergency Management Agency, dated August 1999.

3) El Paso County Drainage Criteria Manual (Volumes 1 and 2) and Engineering Criteria Manual, current editions.

4) City of Colorado Springs Drainage Criteria Manual, Volumes 1 and 2, May 2014.

5) Flood Insurance Rate Map, Map Number 08041C0276F, by Federal Emergency Management Agency, dated March 17, 1997.

6) Letter of Map Change, Letter of Map Revision Case Number 99-08-012P, Community Number 080059, by Federal Emergency Management Agency, dated November 9, 1998.

7) Custom Soil Resource Report for El Paso County Area, Colorado, prepared by United States Department of Agriculture Natural Resources Conservation Service, dated August 24, 2016.

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  - Excerpts from Dirty Woman and Crystal Creeks Drainage Basin Planning Study
  - FEMA Letter of Map Change for Lake Fork Dirty Woman Creek LOMR
  - Woodmoor Water and Sanitation District Letter-Detention and Stormwater Quality

APPENDIX H
- Existing and Proposed Drainage Plans
  - Sheet DP1 - Drainage Plan Existing Condition
  - Sheet DP2 - Final Drainage Plan Developed Condition

APPENDIX A

Figures and Exhibits

Figure 1: Vicinity Map

Excerpts from USDA NRCS Custom Soil Resource Report

FEMA Flood Insurance Rate Map (Panel 276)

Table 1: Impervious Area and Drainage Basin & Bridge Fee Calculation

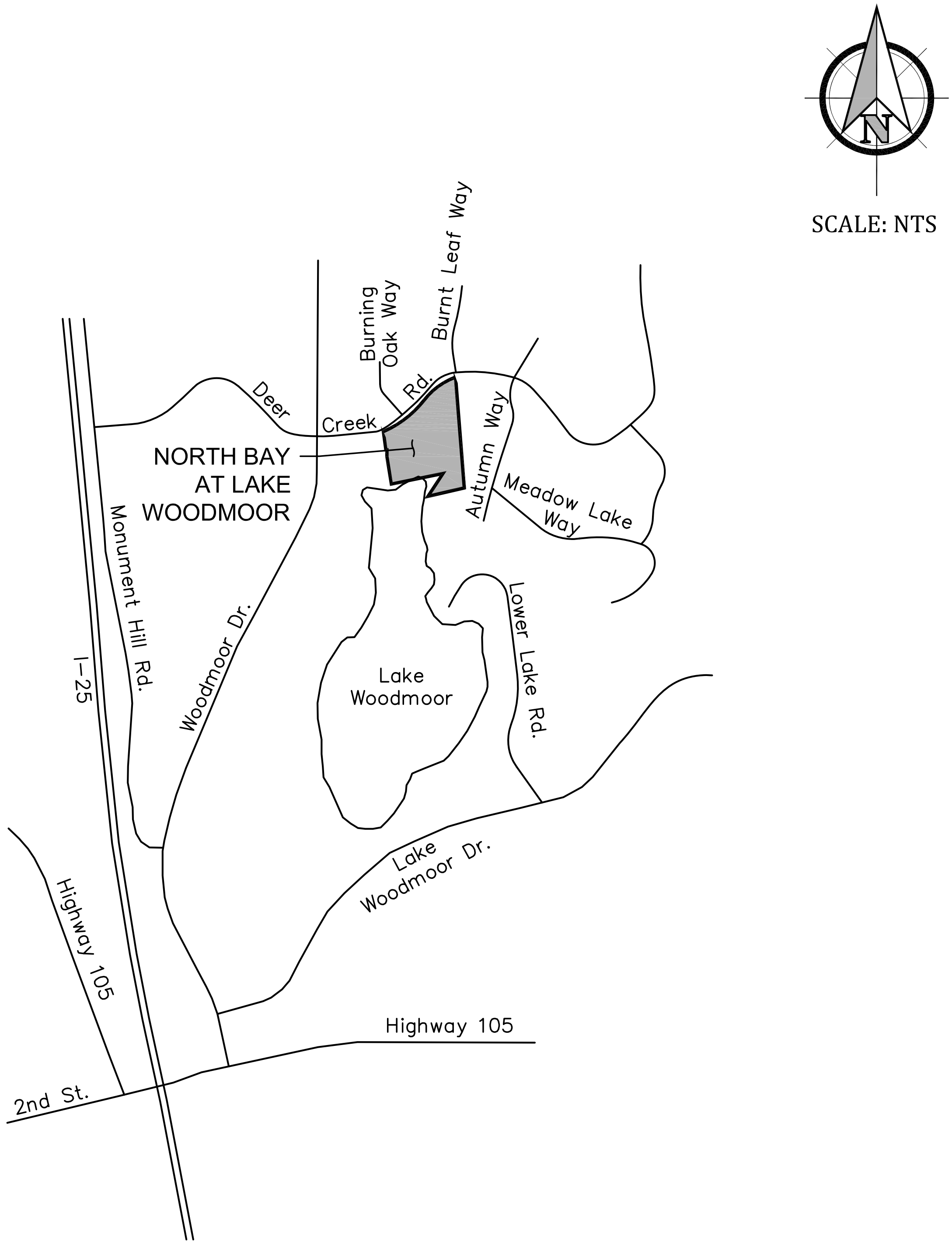


FIGURE 1

15073 Drainage Plan.dwg/Nov 03, 2016

North Bay at Lake Woodmoor

Vicinity Map

El Paso County, Colorado

PROJECT NO. 15073

Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904
(719) 630-7342

United States
Department of
Agriculture

NRCS

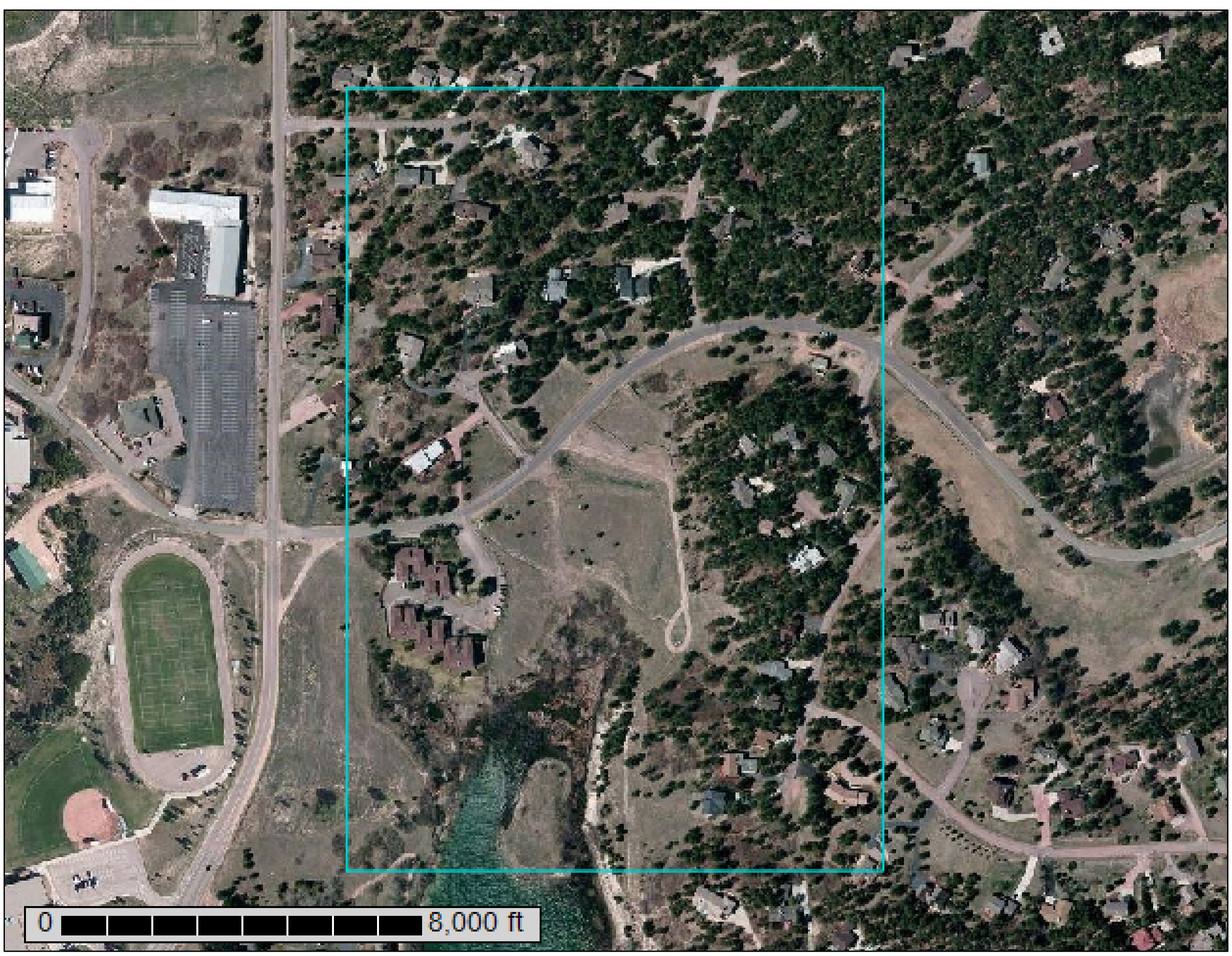
Natural
Resources
Conservation
Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

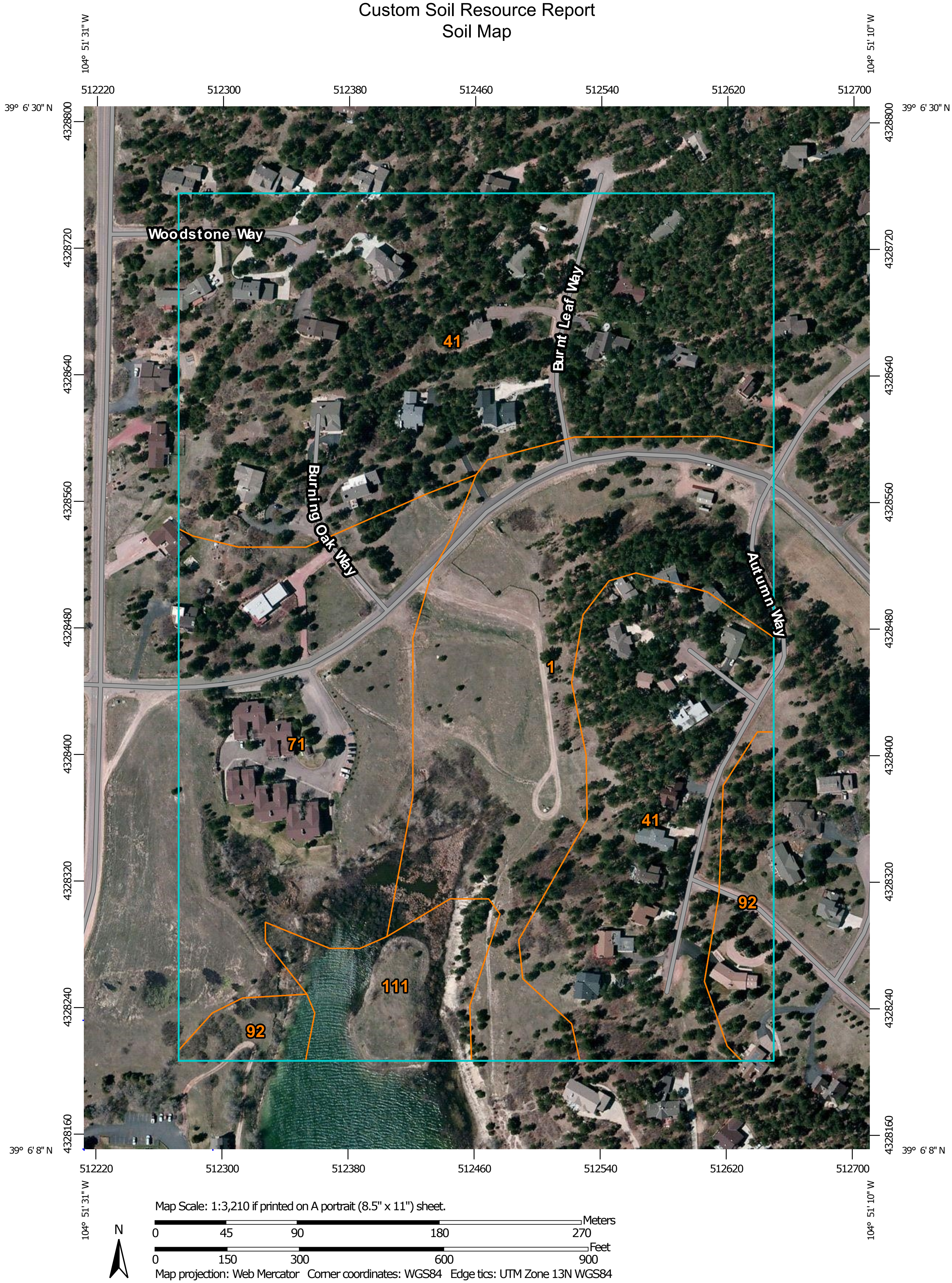
El Paso County Area, Colorado

North Bay at Lake Woodmoor



August 24, 2016

Soil Map


104° 51' 31" W
104° 51' 10" W
512220
512300
512380
512460
512540
512620
512700
39° 6' 30" N
39° 6' 8" N
4328800
4328720
4328640
4328560
4328480
4328400
4328320
4328240
4328160
Woodstone Way
Burnt Leaf Way
Burning Oak Way
Autumn Way
41
1
71
41
92
111
92
Map Scale: 1:3,210 if printed on A portrait (8.5" x 11") sheet.
Meters
0 45 90 180 270
Feet
0 150 300 600 900
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

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

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

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

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: El Paso County Area, Colorado
Survey Area Data: Version 13, Sep 22, 2015

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

Date(s) aerial images were photographed: Apr 15, 2011—Sep 22, 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.

Map Unit Legend

El Paso County Area, Colorado (CO625)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1	Alamosa loam, 1 to 3 percent slopes	11.0	21.3%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	25.1	48.9%
71	Pring coarse sandy loam, 3 to 8 percent slopes	10.4	20.3%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	2.4	4.7%
111	Water	2.4	4.8%
Totals for Area of Interest		**51.4**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

El Paso County Area, Colorado

1—Alamosa loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 3670
Elevation: 7,200 to 7,700 feet
Farmland classification: Prime farmland if irrigated and reclaimed of excess salts and sodium

Map Unit Composition

Alamosa and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Alamosa

Setting

Landform: Flood plains, fans
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 6 inches: loam
Bt - 6 to 14 inches: clay loam
Btk - 14 to 33 inches: clay loam
Cg1 - 33 to 53 inches: sandy clay loam
Cg2 - 53 to 60 inches: sandy loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 12 to 18 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Very slightly saline to strongly saline (2.0 to 16.0 mmhos/cm)
Available water storage in profile: High (about 10.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: D
Ecological site: Mountain Meadow (R048AY241CO)
Hydric soil rating: Yes

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

41—Kettle gravelly loamy sand, 8 to 40 percent slopes

Map Unit Setting

National map unit symbol: 368h
Elevation: 7,000 to 7,700 feet
Farmland classification: Not prime farmland

Map Unit Composition

Kettle and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kettle

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose

Typical profile

E - 0 to 16 inches: gravelly loamy sand
Bt - 16 to 40 inches: gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 8 to 40 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions

Hydric soil rating: Yes

71—Pring coarse sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369k
Elevation: 6,800 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Pring and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pring

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock

Typical profile

A - 0 to 14 inches: coarse sandy loam
C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: Loamy Park (R048AY222CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:

Landform: Depressions
Hydric soil rating: Yes

92—Tomah-Crowfoot loamy sands, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 36b9
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Tomah and similar soils: 50 percent
Crowfoot and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tomah

Setting

Landform: Alluvial fans, hills
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose and/or residuum weathered from arkose

Typical profile

A - 0 to 10 inches: loamy sand
E - 10 to 22 inches: coarse sand
C - 48 to 60 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Description of Crowfoot

Setting

Landform: Alluvial fans, hills
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 12 inches: loamy sand
E - 12 to 23 inches: sand
Bt - 23 to 36 inches: sandy clay loam
C - 36 to 60 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

111—Water

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

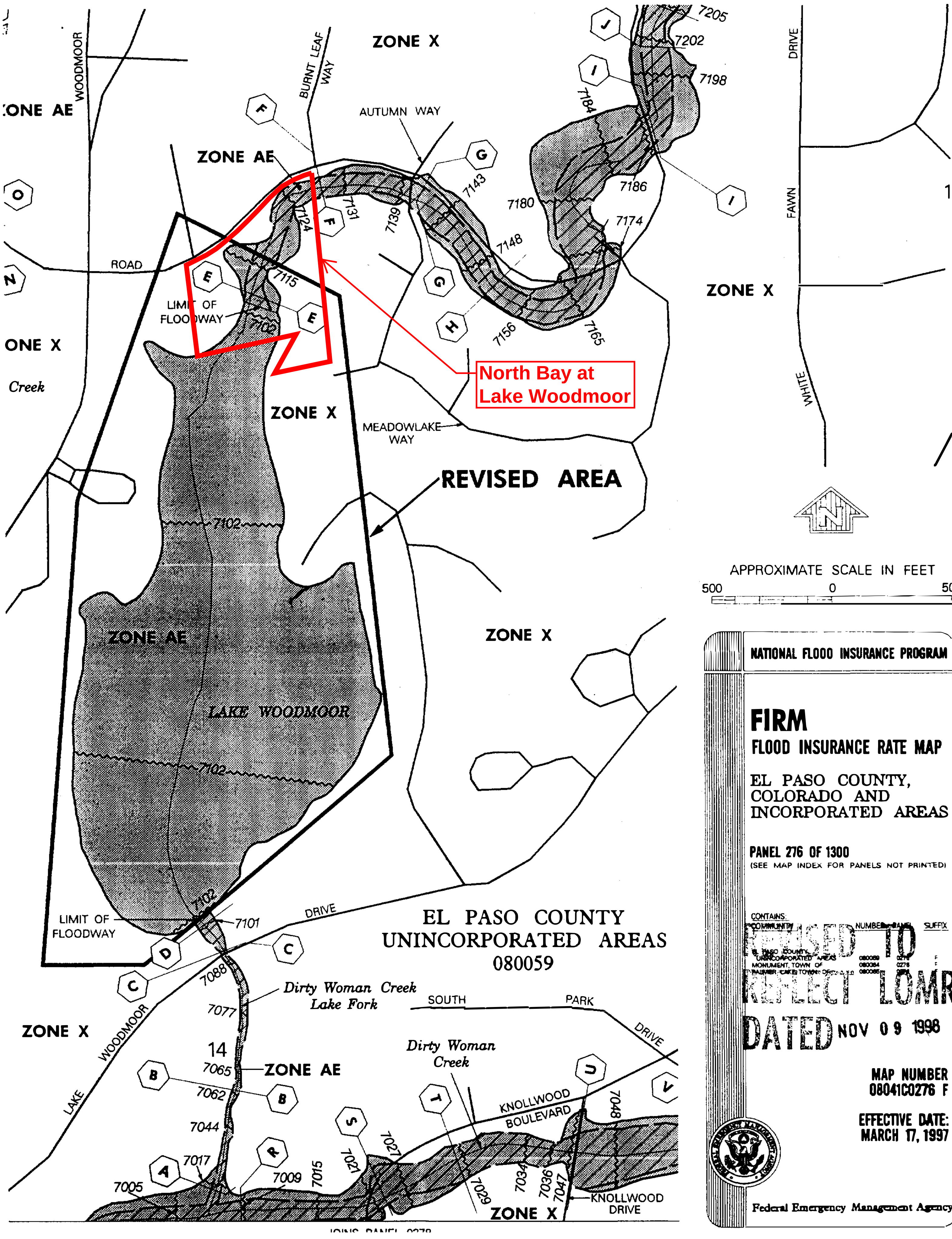

ZONE X
ZONE AE
BURNT LEAF WAY
AUTUMN WAY
WOODMOOR
ROAD
LIMIT OF FLOODWAY
North Bay at Lake Woodmoor
MEADOWLAKE WAY
REVISED AREA
LAKE WOODMOOR
Creek
DRIVE
EL PASO COUNTY
UNINCORPORATED AREAS
080059
Dirty Woman Creek
Lake Fork
SOUTH
PARK
DRIVE
LAKE WOODMOOR
KNOLLWOOD BOULEVARD
KNOLLWOOD DRIVE
Dirty Woman Creek
FAWN
WHITE
DRIVE
APPROXIMATE SCALE IN FEET
500
0
7205
7202
7198
7184
7186
7180
7174
7143
7148
7139
7131
7124
7115
7102
7156
7165
7101
7088
7077
7065
7062
7044
7017
7009
7005
7015
7021
7027
7029
7034
7036
7047
7048
14
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY, COLORADO AND INCORPORATED AREAS
PANEL 276 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)
CONTAINS:
REVISED TO REFLECT LOMR DATED NOV 09 1998
MAP NUMBER
08041C0276 F
EFFECTIVE DATE:
MARCH 17, 1997
Federal Emergency Management Agency

Table 1: Impervious Area and Drainage Basin & Bridge Fee Calculation

Dirty Woman Creek Drainage Basin

	Acreage	% Impervious	Impervious Area
Pavement/Drives/Walks	1.680 ac	100%	1.680 ac
Roofs	1.220 ac	90%	1.098 ac
Lawns/Historic	4.330 ac	0%	0.000 ac
	7.230 ac		2.778 ac

Weighted % Impervious = 38.4 %

Drainage Basin Fee and Bridge Fee Calculations			
Drainage Basin Fee =	$21,134 / ac	**Drainage Basin Fee =**	**$ 58,710.25**
Bridge Fee =	$1,156 / ac	**Bridge Fee =**	**$ 3,211.37**

Impervious Area = Acreage x (% Impervious)
Drainage Basin Fee = Impervious Area x (Drainage Basin Fee per Acre)
Bridge Fee = Impervious Area x (Bridge Fee per Acre)

Will be reviewed with Final Drainage Report.

APPENDIX B.1

Lake Fork Dirty Woman Creek DBPS Hydrology Addendum

Lake Fork of Dirty Woman Creek
Drainage Basin Planning Study
Hydrology Addendum
El Paso County, Colorado

Prepared for:
Lake Woodmoor Holdings, LLC
9540 Federal Drive, Suite 200
Colorado Springs, Colorado 80921
(719) 260-7477

Prepared by:

Kiowa
Engineering Corporation
7175 West Jefferson Avenue, Suite 2200
Lakewood, Colorado 80235

Kiowa Project No. 15073

October 25, 2021

Revised November 18, 2021

COLORADO LICENSED
STEPHEN A. BROWN
40190
PROFESSIONAL ENGINEER

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III. Basin description 1
IV. Basin delineation and mapping 2
V. Hydrology analysis 2
VI. Hydrology Model Results 4
VII. Summary 6
VIII. References 6
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I. PURPOSE AND SCOPE

The purpose of this study is to update the hydrology of the Lake Fork Basin of the Dirty Woman Creek Drainage Basin located in Unincorporated El Paso County. A vicinity map is included as Figure 1 in Appendix A. The previous Dirty Woman Creek and Crystal Creek Drainage Basin Planning Study (DBPS) was published in 1993. Since then, the majority of the Lake Fork Basin has been developed with primarily large lot residences in the upper portion of the basin and some higher density residential development around Woodmoor Lake. This study will reevaluate the hydrology of the Lake Fork Basin based on the final developed land use.

II. PAST STUDIES

Dirty Woman Creek and Crystal Creek Drainage Basin Planning Study (DBPS), by Kiowa Engineering for El Paso County Department of Public Works, 1993.

This DBPS established the existing (predevelopment) and future hydrology for the basin based on projected development and infrastructure. Hydrologic modeling for this study was developed with the HEC-1 program based on the Soil Conservation Service (SCS) Dimensionless Hydrograph Method. The Lake Fork Basin was divided into 16 subbasins which were routed by open channel elements to the outfall at Woodmoor Lake. Subbasin characteristics include area, initial abstraction, curve number (CN) and SCS lag time. Soil types consisted of primarily Type B soils with Type C soils along the drainageways. The soil types are used to determine curve numbers per Table 5-5 of the El Paso County Drainage Criteria Manual. Based on El Paso County Zoning the majority of the Lake Fork Basin at the time was shown as half-acre residential development and assigned an appropriate curve number. However, the actual development consists of lot sizes averaging closer to one acre with relatively wide, open space land dedicated to create a natural drainageway and convey storm flows through the basin to Woodmoor Lake.

Per El Paso County criteria, hydrologic models used both the 2-hour and 24-hour storms to determine the critical storm. The 24-hour storm simulation used the SCS Type IIA distribution. The 2-hour storm used the distribution per table 5-5a of the El Paso County criteria. 100-year rainfall depths for the 24-hour and 2-hour storms were 4.40 inches and 2.88 inches, respectively, per NOAA Atlas 2. The rainfall depth for the 2-hour, 10-year storm was 1.94 inches.

For the Lake Fork Basin, there was no difference between existing and future conditions peak flows in the hydrologic models.

III. BASIN DESCRIPTION

The Dirty Woman and Crystal Creek Drainage Basins are right-bank tributaries to Monument Creek in Unincorporated El Paso County, Colorado. The Lake Fork Basin is approximately 750 acres in size and a tributary of Dirty Woman Creek. Figure 8 from the 1993 DBPS shows the Lake Fork Basin location within the Dirty Woman Creek Basin (see Appendix A). The basin is characterized by relatively steep topography and drainageways that outfall to Woodmoor Lake. With the majority of the basin developed as large lot residences, the relatively dense woodland pine forest has been preserved. The drainageways are characterized by very wide and open grass meadows, many of which have been dedicated as open space.

Upper Basin Natural Drainageway

Detention Basin Along Deer Creek Road

A detention pond is located just upstream of Deer Creek Road along the Lake Fork drainageway. The pond has an area of approximately 1 acre and depth of approximately 10 feet with a 24" CMP outlet pipe. Although it is likely this pond will significantly attenuate flows during major storms, it was not included in the hydrology modeling since it is not recognized as a formal regional detention facility.

Hydrologic soil groups for the basin were determined from the USDA NRCS Soil Survey for El Paso County. This showed that the Lake Fork Basin is predominantly Type B soils with areas of Type D soils located along the drainageways. A soils map and USDA soils report are included in Appendix B.

IV. BASIN DELINEATION AND MAPPING

Hydrologic mapping for the basin was developed from the Monument USGS quadrangle map in digital format. Topographic contours from the quad map were converted to a surface in Civil 3D. The basin and subbasin delineations were then determined using the catchment function in AutoCAD Civil 3D. Tributary design points for the subbasin delineations were located to approximately coincide with those of the 1989 DBPS in an effort to provide an equivalent comparison. As seen on Figure 2 in Appendix A, the basin and subbasin delineation closely match that of the 1993 DBPS.

V. HYDROLOGY ANALYSIS

HEC-HMS version 4.8 software with the SCS hydrograph procedure was used to determine subbasin runoff and routing of channel flows through the basin. Input and output data for the model is included in Appendices C and D. USGS quadrangle maps were used to determine subbasin delineations and areas. The Lake Fork Basin was divided into 16 subbasins, which were routed by open channel elements to the outfall at Woodmoor Lake. Subbasin characteristics include area, initial abstraction, curve number (CN), and SCS lag time. Soil types consisted of primarily Type B soils with Type D soils along the drainageways. The soil type and land use areas were used to determine composite curve numbers for the subbasins per Table 5-5 of the El Paso County Drainage Criteria Manual.

Land Use and SCS Curve Numbers

SCS curve numbers for existing and future conditions models were assigned to areas according to land use per Table 5-5. The El Paso County Zoning Land Use Maps show the majority of the Lake Fork Basin as half-acre residential development (refer to Figure 7 in Appendix A). However, based on El Paso County assessor mapping of lots and Google Earth mapping, the actual development consists of lot sizes averaging closer to one acre (Table 0.5 in Appendix). Therefore, composite curve numbers for subbasins were developed using assessor lot maps and Google Earth data. Additionally, open space land and associated natural drainageways were delineated and assigned appropriate curve number values. As seen from Figures 5 and 6, existing and future conditions land use are the same with the exception of future PUD areas adjacent to Woodmoor Lake at the bottom of the basin.

The initial abstraction formula was taken from equation 6-12 of the City of Colorado Springs DCM:

$Ia = 0.1((1000/CN-10)-10)$

Channel Routing

A schematic of HEC-HMS model routing is shown on Figure 3 in the Appendix. Design points were located at major channel junctions or road crossings and approximately mirror those of the 1993 DBPS to allow for comparison of results. Runoff hydrographs for subbasins were routed through each channel link element to determine peak flows at various design points. Slope and channel lengths were determined from project mapping.

Detention

As discussed previously, no detention was included in the hydrologic modeling. The detention pond located in the lower portion of the basin immediately upstream of Dear Creek Road would likely result in significant attenuation of peak flows during major storm events. However, the facility is not recognized as a regional detention basin, and therefore was not eligible for inclusion in the hydrologic model.

Design Storms

Per City of Colorado Springs DCM criteria, hydrologic simulations used both the 2-hour and 24-hour storms to determine the critical storm. The 24-hour storm simulation used the SCS Type II distribution with 1 hour rainfall depths from NOAA Atlas 2. The 2-hour storm used the distribution per table 6-2 of the City criteria and 1-hour rainfall depths from NOAA Atlas 14. Since the basin area is greater than 1 square mile, a DARF distribution reduction was applied per Table 6-5 of City criteria. The 100-year rainfall depth for the 24-hour and 2-hour storms are 4.40 inches and 2.52 inches, respectively. The 10-year rainfall depth for the 24-hour and 2-hour storms are 3.2 and 1.46 inches, respectively.

VI. HYDROLOGY MODEL RESULTS

Existing and future conditions HEC-HMS Model results are shown in Tables A and B below. Full output tables are included in the Appendix.

Table A: Existing Conditions Peak Flows (cfs)

	Existing Conditions				
	2-Hour Storm		24-Hour Storm		
Element	100-Year Peak Flow (cfs)	10-Year Peak Flow (cfs)	100-Year Peak Flow (cfs)	10-Year Peak Flow (cfs)	Location
DP83	94	24	109	58	Upper Basin
DP91	58	15	68	36	Winding Hills Road
DP99	306	81	325	169	Woodmoor Drive
DP103	410	110	420	218	Lower Basin
DP107	472	125	459	234	Dear Creek Road
DP109	514	137	506	257	Woodmoor Lake In
DP111	573	142	558	302	Woodmoor Lake Outlet

Table B: Future Conditions Peak Flows (cfs)

	Future Conditions				
	2-Hour Storm		24-Hour Storm		
	100-Year	10-Year	100-Year	10-Year	Location
DP83	94	24	109	58	Upper Basin
DP91	58	15	68	36	Winding Hills Road
DP99	306	81	325	169	Woodmoor Drive
DP103	410	110	420	218	Lower Basin
DP107	472	125	459	234	Dear Creek Road
DP109	520	138	514	263	Woodmoor Lake In
DP111	579	144	563	306	Woodmoor Lake Outlet

As seen from Tables A and B, the 2-hour storm was the critical storm due to the higher peak flows. This is consistent with the results of the 1993 Dirty Woman Creek and Crystal Creek DBPS.

Tables C and D show existing and future conditions results comparisons to the original DBPS. As seen from the tables, peak flow rates decrease approximately 50%. This reduction is attributed primarily to increased infiltration of the lower CN values associated with larger lot sizes when compared to the original study.

Table C: Existing Conditions Peak Flows (cfs)

	Existing Conditions				
	2021 Update		1993 DBPS		
Element	100-Year Peak Flow (cfs)	10-Year Peak Flow (cfs)	100-Year Peak Flow (cfs)	10-Year Peak Flow (cfs)	Location
DP83	94	24	195	75	Upper Basin
DP91	58	15	112	41	Winding Hills Road
DP99	306	81	594	226	Woodmoor Drive
DP103	410	110	883	334	Lower Basin
DP107	472	125	1016	381	Dear Creek Road
DP109	514	137	1107	417	Woodmoor Lake In
DP111	573	142	1240	413	Woodmoor Lake Outlet

Table D: Future Conditions Peak Flows (cfs)

	Future Conditions				
	2021 Update		1993 DBPS		
	100-Year	10-Year	100-Year	10-Year	Location
DP83	94	24	195	75	Upper Basin
DP91	58	15	112	41	Winding Hills Road
DP99	306	81	594	226	Woodmoor Drive
DP103	410	110	883	334	Lower Basin
DP107	472	125	1016	381	Dear Creek Road
DP109	520	138	1107	417	Woodmoor Lake In
DP111	579	144	1240	413	Woodmoor Lake Outlet

VII. SUMMARY

Results of this hydrology addendum provide the basis for a reduction of peak flow rates for the Lake Fork of Dirty Woman Creek Basin. It is recommended that the revised peak discharges for the 2-hour storm as summarized in the above tables be used for the design of major drainageway facilities.

For comparison, cfs per acre was calculated for 100-year future conditions flows and compared to similar basins in the area.

Basin	100yr Future flow (cfs)	Acres	cfs/acre
1993 DWC DBPS	1108	750	1.5
2021 DWC LF addendum (current)	579	750	**0.8**
2015 Kettle Creek DBPS	4152	10502	0.4
2020 Back Squirrel DBPS Addendum	2898	7168	0.4

As seen from the comparison, results of the current study indicate flows much lower than the original 1993 DBPS, however higher but comparable to nearby basins.

VIII. REFERENCES

1) Soil Survey for El Paso County Area, NRCS website (https://websoilsurvey.nrcs.usda.gov/app/)
2) Monument Quadrangle, Colorado-El Paso CO, U.S. Geological Service, 2019.
3) Zoning Maps for El Paso County, Development Services Department, February 2020.
4) City of Colorado Springs Drainage Criteria Manual, revised January 2021.
5) Dirty Woman Creek and Crystal Creek Drainage Basin Planning Study, by Kiowa Engineering for El Paso County Department of Public Works, September 1993.

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100yr 2hr Storm
10yr 2hr Storm

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100yr 2hr Storm
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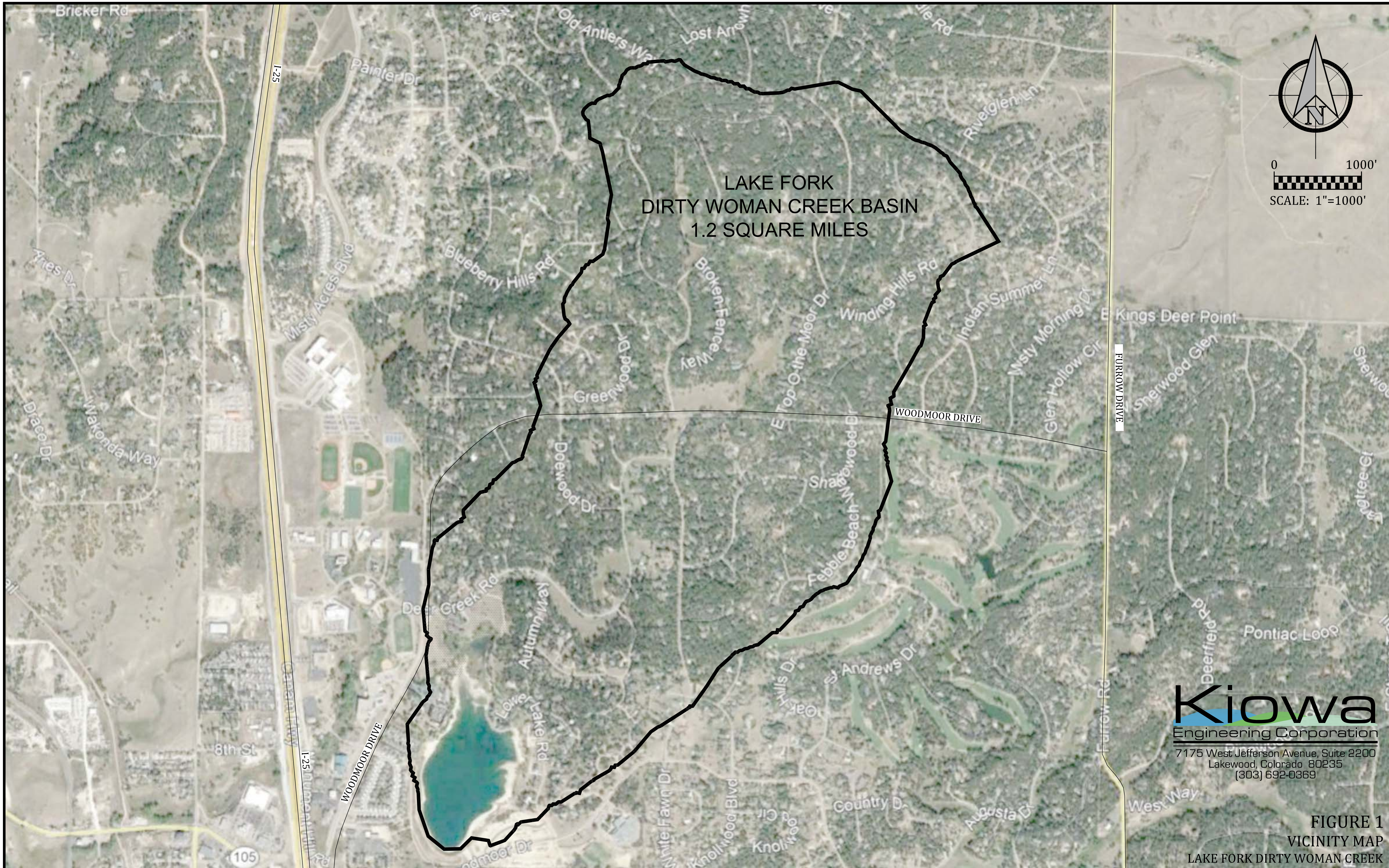
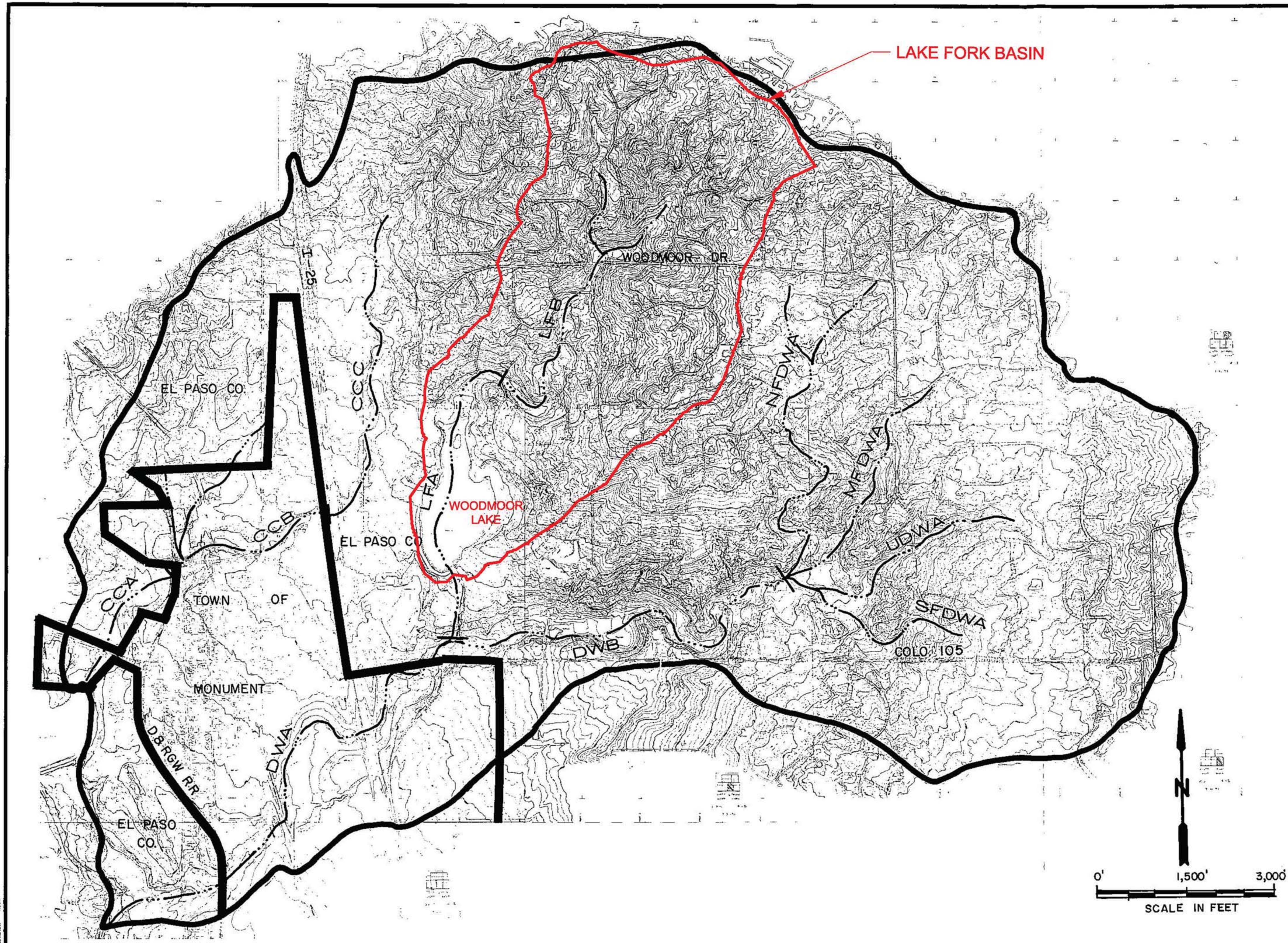


FIGURE 1
VICINITY MAP
LAKE FORK DIRTY WOMAN CREEK



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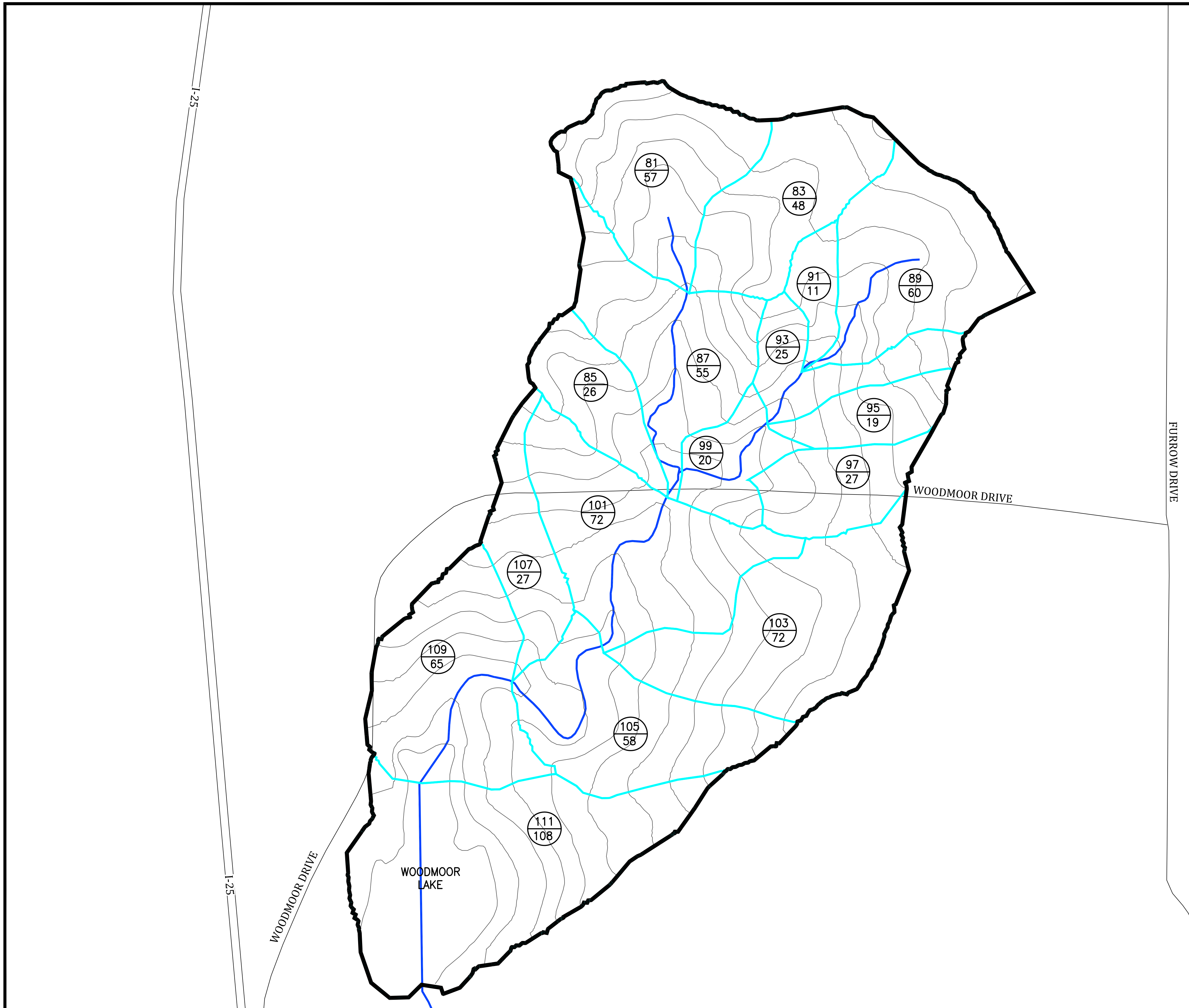
DIRTY WOMAN CREEK & CRYSTAL CREEK
DRAINAGE BASIN PLANNING STUDY
REACH DELINEATION MAP

Project No.	91-07-17
Date:	3/92
Design:	AWMc
Drawn:	EAK
Check:	
Revisions:	

FIG. 8



0 1000'
SCALE: 1"=1000'
USGS QUAD MAPPING
COUNTOUR INTERVAL = 24'

SUBBASIN
AREA
(AC)

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FIGURE 2
BASIN DELINEATION
LAKE FORK DIRTY WOMAN CREEK

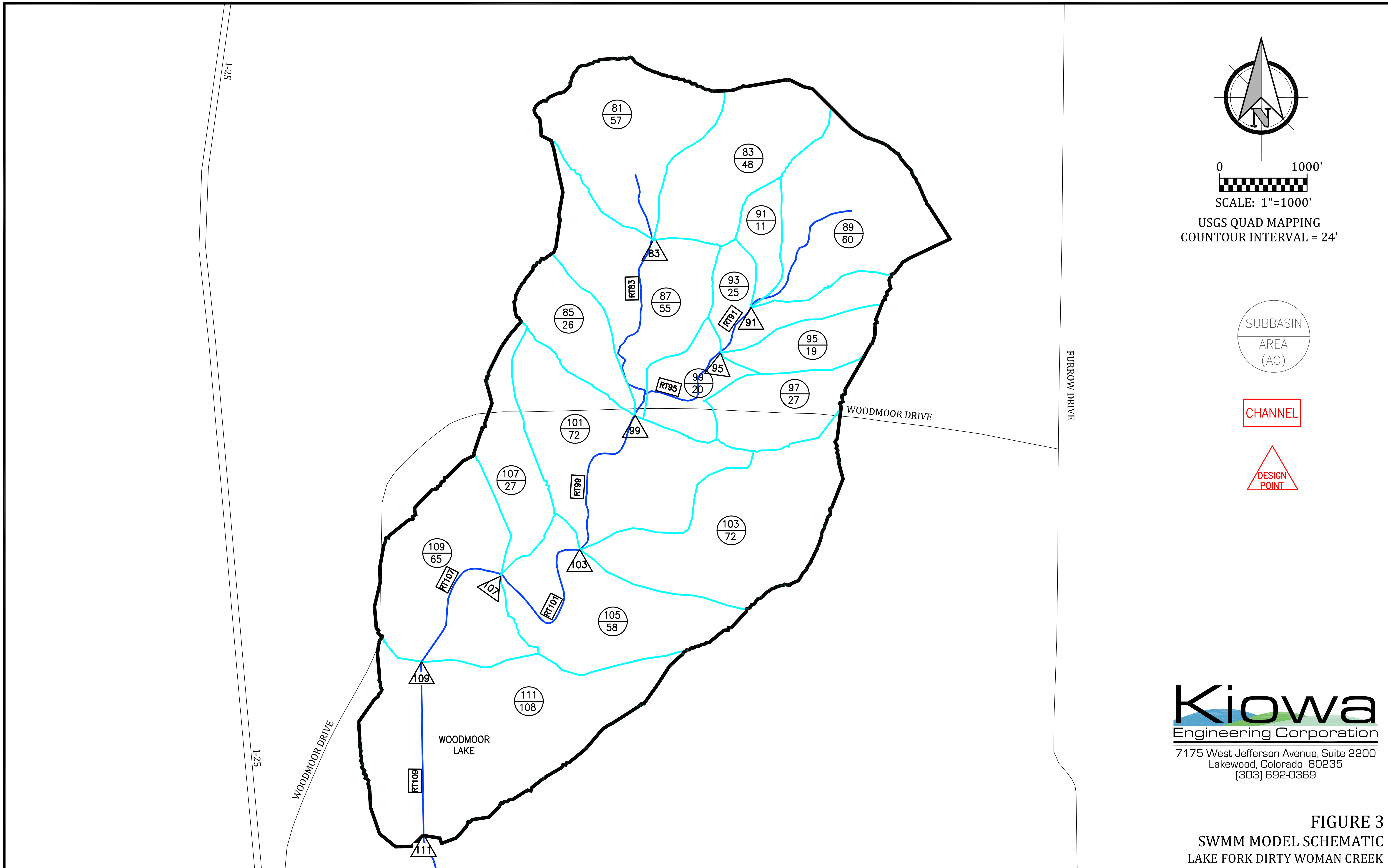

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FIGURE 3
SWMM MODEL SCHEMATIC
LAKE FORK DIRTY WOMAN CREEK

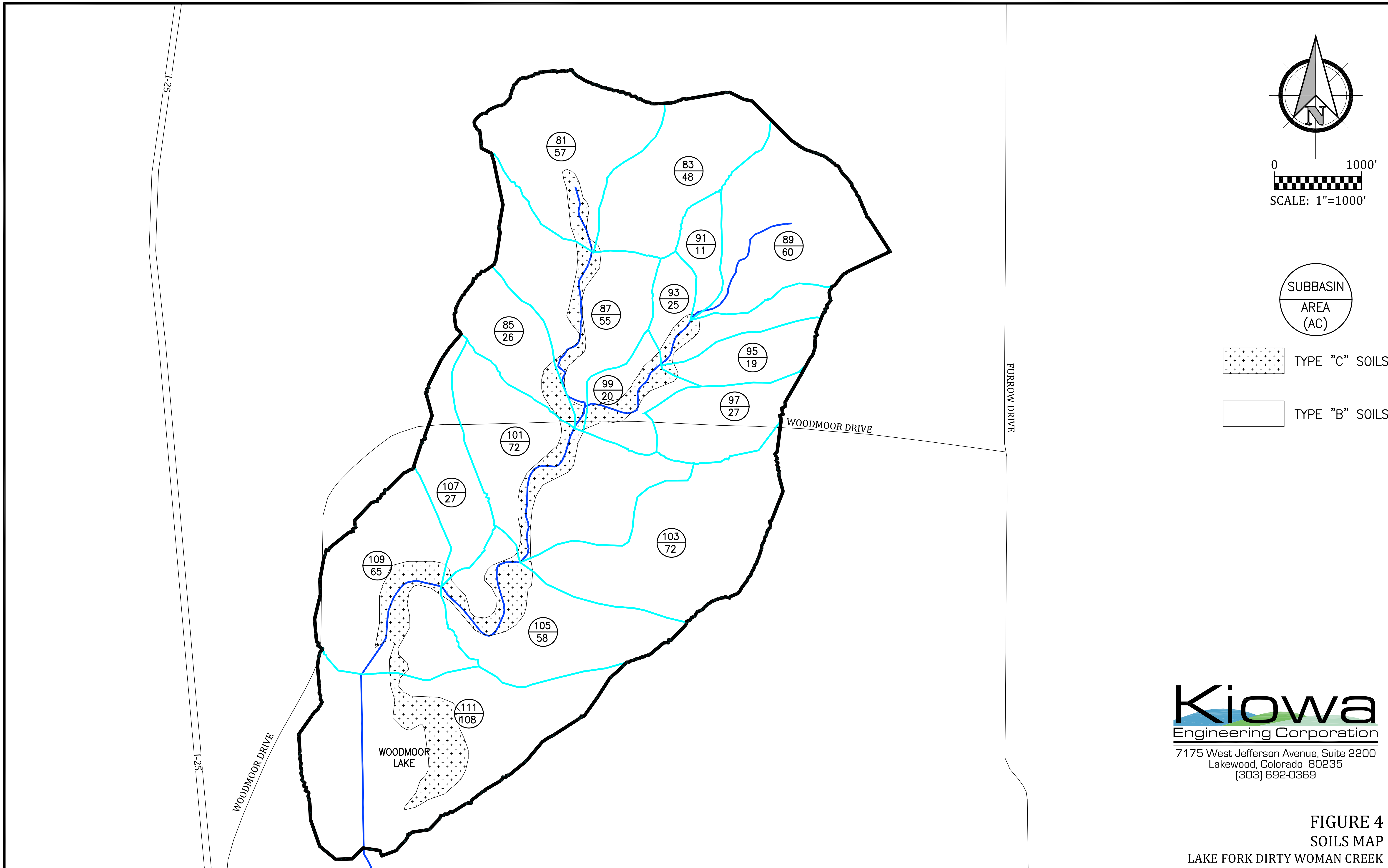
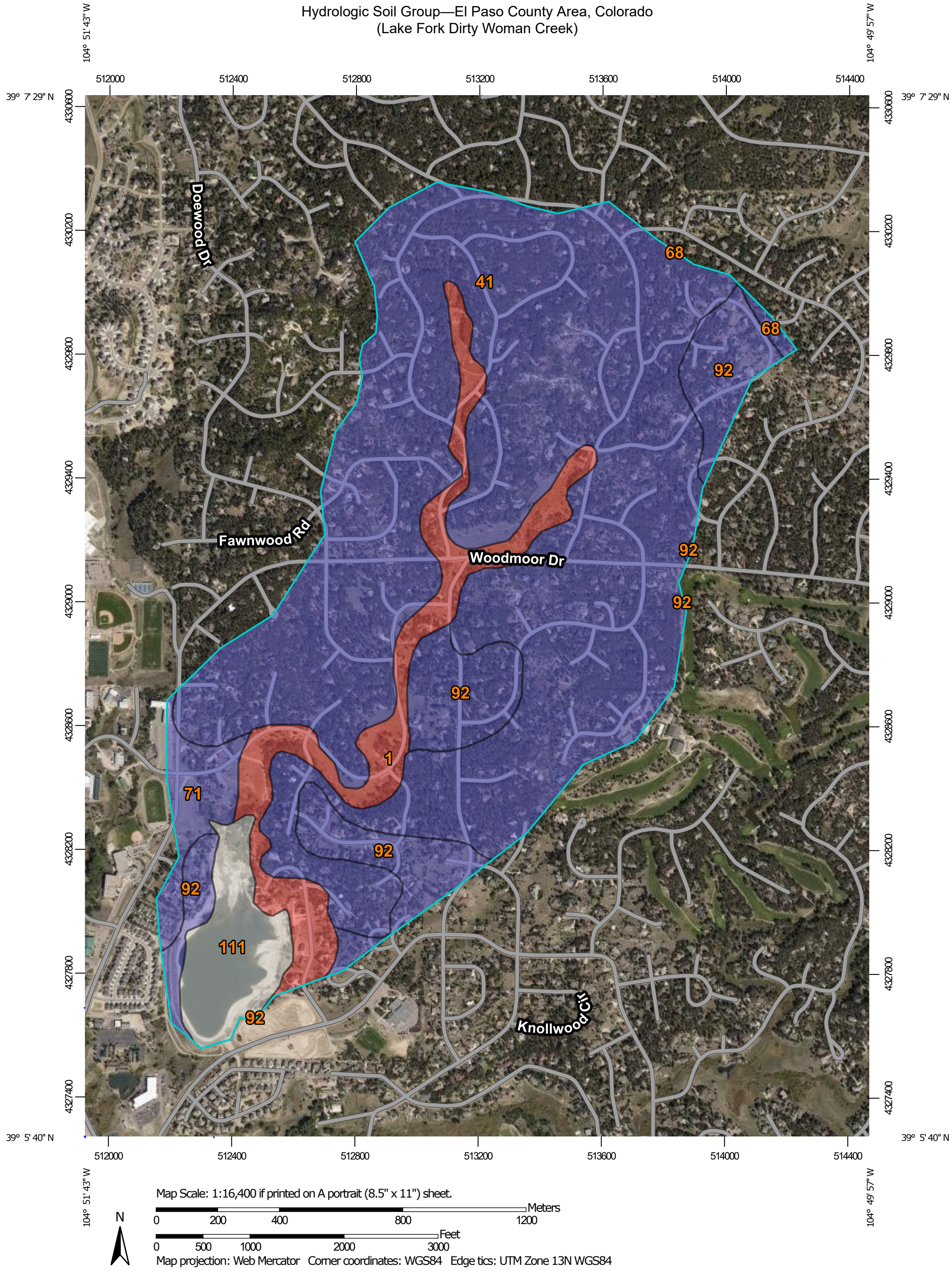


FIGURE 4
SOILS MAP
LAKE FORK DIRTY WOMAN CREEK

Hydrologic Soil Group—El Paso County Area, Colorado
(Lake Fork Dirty Woman Creek)



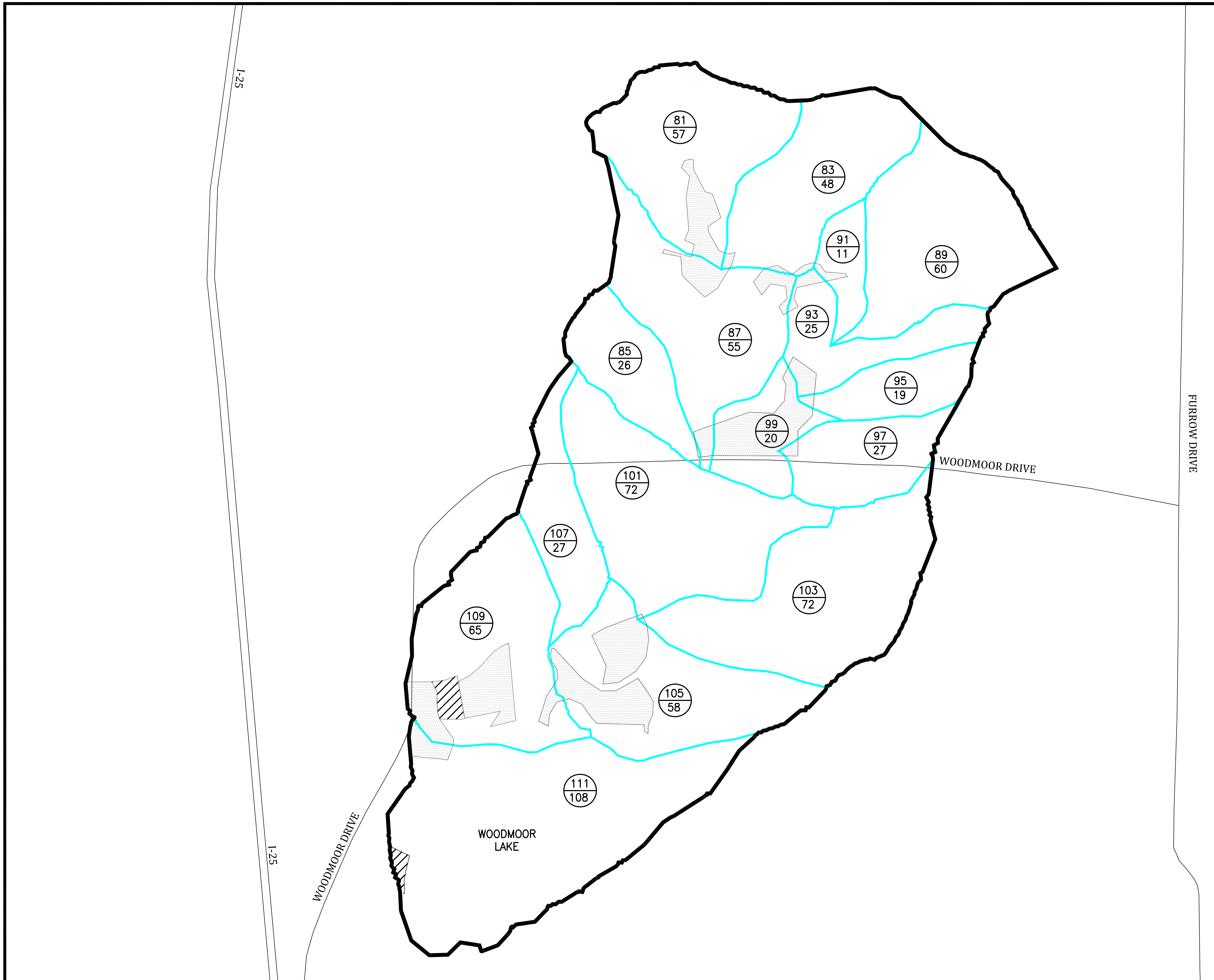
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Alamosa loam, 1 to 3 percent slopes	D	72.8	9.5%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	B	537.3	70.1%
68	Peyton-Pring complex, 3 to 8 percent slopes	B	2.5	0.3%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	22.4	2.9%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	B	92.5	12.1%
111	Water		38.9	5.1%
Totals for Area of Interest			**766.3**	**100.0%**

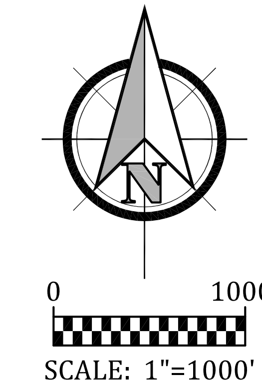
TABLE 5-5
RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL COVER COMPLEXES - URBAN AND SUBURBAN CONDITIONS 1/
(Antecedent Moisture Condition II)
(From: U.S. Dept. of Agriculture, Soil Conservation Service, 1977)

Land Use		Hydrologic Soil Group A	B	C	D
Open spaces, lawns, parks, golf courses, cemeteries, etc.					
Good condition:	grass cover on 75% or more of the area	39*	61	74	80
Fair condition:	grass cover on 50% to 75% of the area	49*	69	79	84
Commercial and Business areas (85% Impervious)		89*	92	94	95
Industrial Districts 72% Impervious)		81*	88	91	93
Residential: 2/					
Acres per Dwelling Unit	Average % Impervious 3/				
1/8 acre or less	65	77*	85	90	92
1/4 acre	38	61*	75	83	87
1/3 acre	30	57*	72	81	86
1/2 acre	25	54*	70	80	85
1 acre	20	51*	68	79	84
Paved parking lots, roofs, driveways, etc.		98	98	98	98
Streets and Roads:					
paved with curbs and storm sewers		98	98	98	98
gravel		76*	85	89	91
dirt		72*	82	87	89

1/ For a more detailed description of agricultural land use curve numbers, refer to the National Engineering Handbook (U.S. Dept. of Agriculture, Soil Conservation Service, 1972).
2/ Curve numbers are computed assuming the runoff from the house and driveway is directed towards the street with a minimum of roof water directed to lawns where additional infiltration could occur.
3/ The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

* Not to be used wherever overlot grading or filling is to occur.





SUBBASIN / AREA (AC)

OPEN SPACE (OS)

RESIDENTIAL 1 OR MORE ACRE

PUD

Land Use	CN	
	B SOIL	C SOIL
1 AC+	68	79
PUD	85	90
OPEN SPACE	61	74

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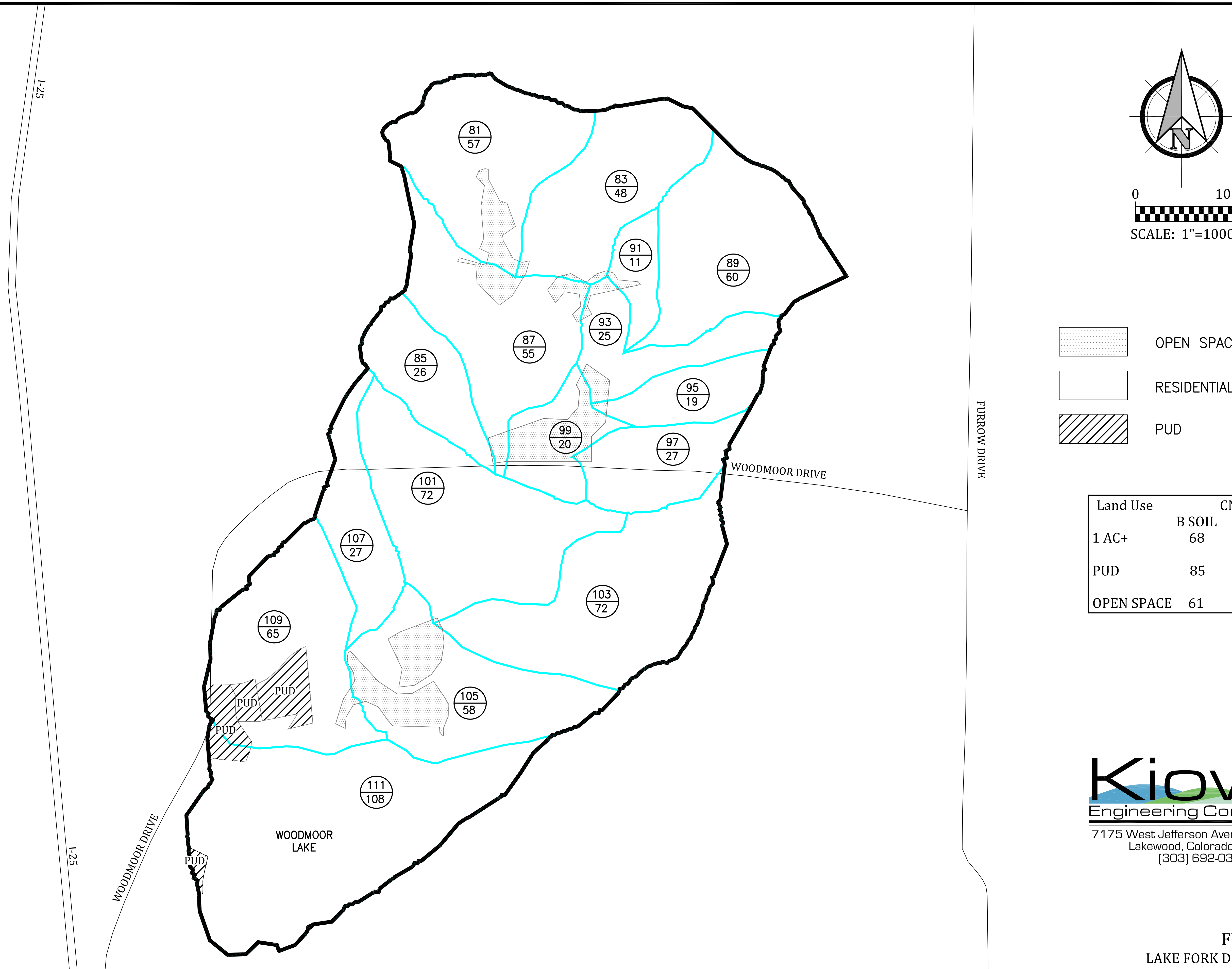
FIGURE 5
EXISTING LAND USE
LAKE FORK DIRTY WOMAN CREEK



OPEN SPACE (OS)

RESIDENTIAL 1 OR MORE ACRE

PUD

Land Use	CN B SOIL	CN C SOIL
1 AC+	68	79
PUD	85	90
OPEN SPACE	61	74

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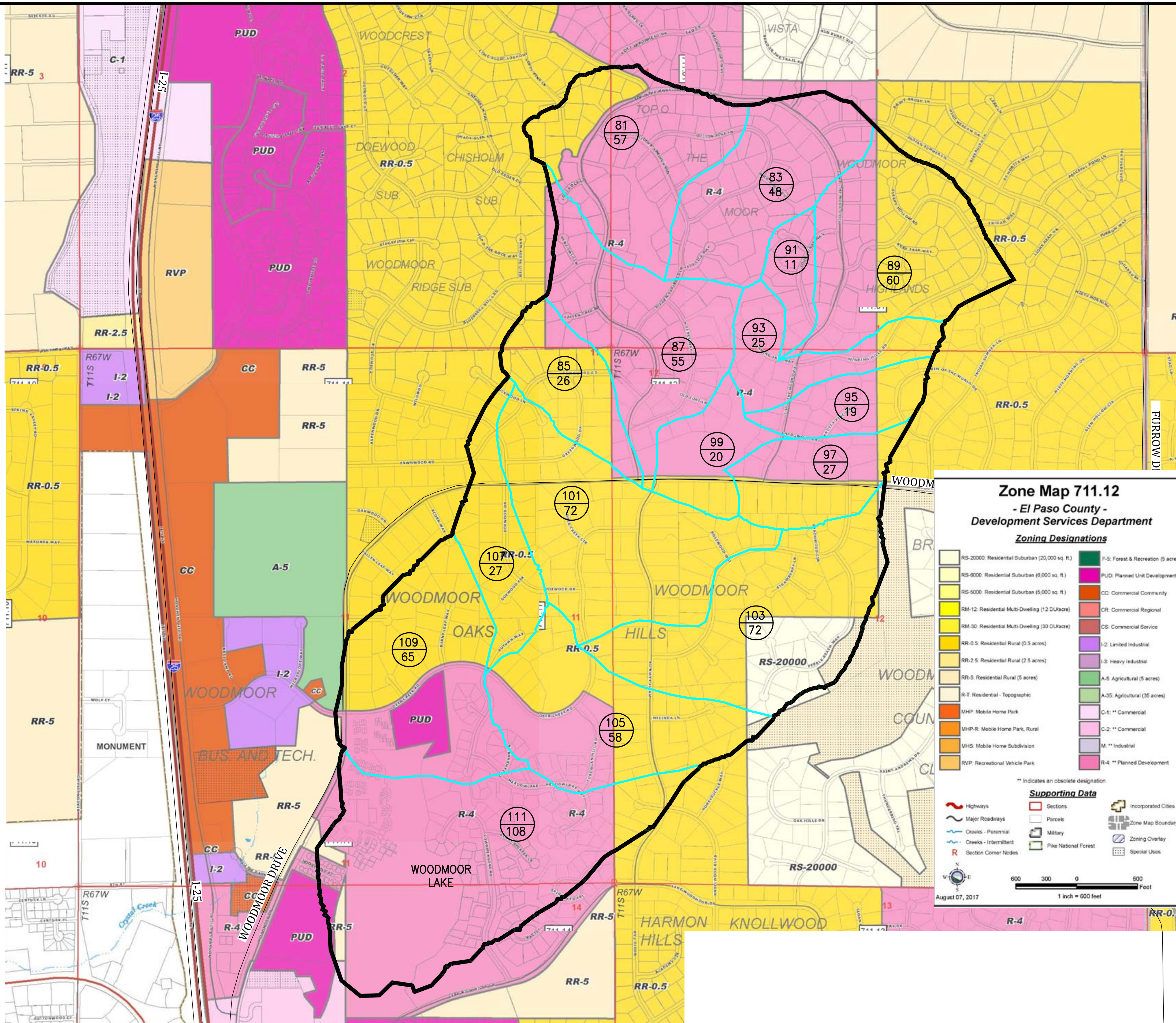
FIGURE 6
FUTURE LAND USE
LAKE FORK DIRTY WOMAN CREEK



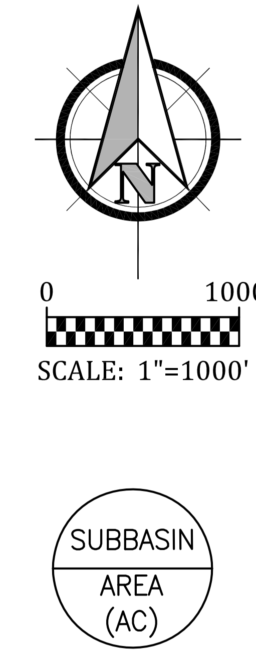


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FIGURE 7
El PASO COUNTY ZONING LAND USE
LAKE FORK DIRTY WOMAN CREEK

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Table 5 - 24 Hour Type II Storm Rainfall
NRCS Soils Report

Table 0.5

Lake Fork Basin Existing Conditions Average Lot Acreage

Basin	Area (ac)	Open Space	PUD	Lake	Net Residential Area	Lots	Average Acres/Lot
LF111	**107.8**	2.2	15.0	31.0	59.7	98	**0.6**
LF109	**65.0**	11.0	2.3	0.0	51.7	40	**1.3**
LF107	**26.5**	0.0	0.0	0.0	26.5	23	**1.2**
LF105	**57.5**	14.1	0.0	0.0	43.4	50	**0.9**
LF103	**71.9**	0.0	0.0	0.0	71.9	69	**1.0**
LF101	**72.2**	0.0	0.0	0.0	72.2	68	**1.1**
LF99	**20.4**	9.6	0.0	0.0	10.8	13	**0.8**
LF97	**26.7**	0.0	0.0	0.0	26.7	26	**1.0**
LF95	**18.7**	0.0	0.0	0.0	18.7	18	**1.0**
LF93	**24.6**	0.0	0.0	0.0	24.6	25	**1.0**
LF91	**11.3**	0.0	0.0	0.0	11.3	12	**0.9**
LF89	**60.1**	5.8	0.0	0.0	54.3	67	**0.8**
LF87	**55.4**	0.0	0.0	0.0	55.4	56	**1.0**
LF85	**25.9**	0.0	0.0	0.0	25.9	24	**1.1**
LF83	**47.9**	0.0	0.0	0.0	47.9	47	**1.0**
LF81	**56.9**	5.1	0.0	0.0	51.8	56	**0.9**
Totals	**748.8**						

Table 1
Lake Fork Basin Existing Conditions HEC-HMS Data

				1Lot/AC		0.5 Lot/AC		PUD		Open Space					
				D	B	D	B	D	B	D	B	HEC-HMS			
Basin	**Area (SF)**	**Area (ac)**	**Area (Sq Miles)**	**84**	**68**	**85**	**70**	**92**	**85**	**80**	**61**	**CN**	**Tc**	**Lag (.6Tc)**	**Abstraction**
LF111	**4697187**	**107.8**	**0.168**			**0.023**	**0.140**		**0.002**		**0.003**	**72.0**	30.2	18.1	0.388
LF109	**2830985**	**65.0**	**0.102**	**0.016**	**0.065**				**0.004**	**0.007**	**0.010**	**71.3**	24.7	14.8	0.403
LF107	**1155005**	**26.5**	**0.041**	**0.000**	**0.041**							**68.2**	35.3	21.2	0.467
LF105	**2505477**	**57.5**	**0.090**	**0.000**	**0.068**						**0.022**	**66.3**	34.4	20.7	0.509
LF103	**3132669**	**71.9**	**0.112**	**0.000**	**0.112**							**68.1**	44.3	26.6	0.469
LF101	**3144781**	**72.2**	**0.113**	**0.013**	**0.100**							**69.8**	34.9	20.9	0.433
LF99	**886749**	**20.4**	**0.032**	**0.000**	**0.017**						**0.015**	**64.6**	22.3	13.4	0.547
LF97	**1162667**	**26.7**	**0.042**		**0.042**							**68.0**	24.3	14.6	0.471
LF95	**813916**	**18.7**	**0.029**	**0.001**	**0.029**							**68.3**	24.4	14.7	0.464
LF93	**1069563**	**24.6**	**0.038**	**0.004**	**0.034**							**69.8**	25.6	15.4	0.432
LF91	**491938**	**11.3**	**0.018**		**0.018**							**68.0**	21.5	12.9	0.471
LF89	**2616838**	**60.1**	**0.094**		**0.085**						**0.009**	**67.3**	33.8	20.3	0.485
LF87	**2413762**	**55.4**	**0.087**	**0.010**	**0.076**							**69.9**	41.2	24.7	0.430
LF85	**1129789**	**25.9**	**0.041**	**0.005**	**0.035**							**70.1**	32.7	19.6	0.427
LF83	**2088220**	**47.9**	**0.075**		**0.075**							**68.0**	28.0	16.8	0.471
LF81	**2478884**	**56.9**	**0.089**	**0.002**	**0.078**						**0.008**	**67.8**	29.2	17.5	0.475
Totals	**32618429**	**748.8**	**1.170**	**0.052**	**1.118**										

CN values from AMC II Table 5-5

Table 2
Lake Fork Basin Future Conditions HEC-HMS Data

				1Lot/AC		0.5 Lot/AC		PUD		Open Space					
				D	B	D	B	D	B	D	B	HEC-HMS			
Basin	**Area (SF)**	**Area (ac)**	**Area (Sq Miles)**	**84**	**68**	**85**	**70**	**92**	**85**	**80**	**61**	**CN**	**Tc**	**Lag (.6Tc)**	**Abstraction**
LF111*	**4697187**	**107.8**	**0.168**			**0.023**	**0.138**		**0.004**		**0.003**	**72.2**	30.2	18.1	0.385
LF109*	**2830985**	**65.0**	**0.102**	**0.016**	**0.065**			**0.007**	**0.014**			**74.5**	24.7	14.8	0.343
LF107	**1155005**	**26.5**	**0.041**	**0.000**	**0.041**							**68.2**	35.3	21.2	0.467
LF105	**2505477**	**57.5**	**0.090**	**0.000**	**0.068**						**0.022**	**66.3**	34.4	20.7	0.509
LF103	**3132669**	**71.9**	**0.112**	**0.000**	**0.112**							**68.1**	44.3	26.6	0.469
LF101	**3144781**	**72.2**	**0.113**	**0.013**	**0.100**							**69.8**	34.9	20.9	0.433
LF99	**886749**	**20.4**	**0.032**	**0.000**	**0.017**						**0.015**	**64.6**	22.3	13.4	0.547
LF97	**1162667**	**26.7**	**0.042**		**0.042**							**68.0**	24.3	14.6	0.471
LF95	**813916**	**18.7**	**0.029**	**0.001**	**0.029**							**68.3**	24.4	14.7	0.464
LF93	**1069563**	**24.6**	**0.038**	**0.004**	**0.034**							**69.8**	25.6	15.4	0.432
LF91	**491938**	**11.3**	**0.018**		**0.018**							**68.0**	21.5	12.9	0.471
LF89	**2616838**	**60.1**	**0.094**		**0.085**						**0.009**	**67.3**	33.8	20.3	0.485
LF87	**2413762**	**55.4**	**0.087**	**0.010**	**0.076**							**69.9**	41.2	24.7	0.430
LF85	**1129789**	**25.9**	**0.041**	**0.005**	**0.035**							**70.1**	32.7	19.6	0.427
LF83	**2088220**	**47.9**	**0.075**		**0.075**							**68.0**	28.0	16.8	0.471
LF81	**2478884**	**56.9**	**0.089**	**0.002**	**0.078**						**0.008**	**67.8**	29.2	17.5	0.475
Totals	**32618429**	**748.8**	**1.170**	**0.052**	**1.118**										

CN values from AMC II Table 5-5
* Differ from Existing Conditions

Table 3
Lake Fork Basin HEC-HMS Routing Elements

Element	Length	US EL	Upstream DP	DS EL	Downstream DP	Slope
RT99	2094	6894	**99**	6797	**103**	0.046
RT95	1350	6923	**95**	6898	**99**	0.019
RT91	497	6964	**91**	6927	**95**	0.074
RT83	2129	6963	**83**	6897	**99**	0.031
RT109	2040	6706	**109**	6700	**111**	0.003
RT107	1638	6765	**107**	6706	**109**	0.036
RT103	2023	6797	**103**	6706	**109**	0.045
RT101	2129	6963	**83**	6893	**99**	0.033

Table 4: Rainfall Data
Lake Fork Basin
EPCO 2-hr storm distribution update Chapter 6

	DBPS NOAA Atlas 14 1 hr 100yr Depth =	2.52	DBPS NOAA Atlas 14 1 hr 10yr Depth =	1.46
	City 2Hr 100yr Distribution 0-1 miles	**100yr**	**City 2Hr 10yr Distribution**	**10yr**
min	**Fraction of Total Depth**	**CUM In**	**Fraction of Total Depth**	**CUM In**
0	0.000	0.000	0.000	0.000
5	0.014	0.035	0.014	0.020
10	0.044	0.111	0.044	0.064
15	0.076	0.192	0.076	0.111
20	0.116	0.292	0.116	0.169
25	0.176	0.444	0.176	0.257
30	0.249	0.627	0.249	0.364
35	0.396	0.998	0.396	0.578
40	0.655	1.651	0.655	0.956
45	0.756	1.905	0.756	1.104
50	0.824	2.076	0.824	1.203
55	0.866	2.182	0.866	1.264
60	0.901	2.271	0.901	1.315
65	0.934	2.354	0.934	1.364
70	0.948	2.389	0.948	1.384
75	0.962	2.424	0.962	1.405
80	0.973	2.452	0.973	1.421
85	0.984	2.480	0.984	1.437
90	0.995	2.507	0.995	1.453
95	1.006	2.535	1.006	1.469
100	1.017	2.563	1.017	1.485
105	1.026	2.586	1.026	1.498
110	1.036	2.611	1.036	1.513
115	1.046	2.636	1.046	1.527
120	1.054	2.656	1.054	1.539

Distributions DARF Adjisted for 1 to 5 square mile basins

Table 5: 24 Hour Rainfall
Lake Fork Basin

NOAA Atlas 2: 24-hr 100yr depth= 4.4

From Table 5.2 SCS 24 hour Type II distribution

hr	Fraction 24hr Depth	Cum Dist
0	0.000	0.00
	0.005	0.022
1	0.011	0.048
	0.017	0.075
2	0.023	0.101
	0.029	0.128
3	0.035	0.154
	0.041	0.180
4	0.048	0.211
	0.056	0.246
5	0.060	0.266
	0.072	0.317
6	0.080	0.352
	0.090	0.396
7	0.100	0.440
	0.110	0.484
8	0.120	0.528
	0.133	0.585
9	0.147	0.647
	0.163	0.717
10	0.181	0.796
	0.203	0.893
11	0.236	1.038
	0.283	1.245
12	0.663	2.917
	0.735	3.234
13	0.776	3.414
	0.804	3.538
14	0.825	3.630
	0.842	3.705
15	0.856	3.766
	0.869	3.824
16	0.881	3.876
	0.893	3.929
17	0.903	3.973
	0.913	4.017
18	0.922	4.057
	0.930	4.092
19	0.938	4.127
	0.946	4.162
20	0.953	4.193
	0.959	4.220
21	0.965	4.246
	0.971	4.272
22	0.977	4.299
	0.983	4.325
23	0.989	4.352
	0.995	4.378
24	0.998	4.391

NOAA Atlas 2: 24-hr 10yr depth= 3.2

From Table 5.2 SCS 24 hour Type II distribution

hr	Fraction 24hr Depth	Cum Dist
0	0.000	0.00
	0.005	0.02
1	0.011	0.04
	0.017	0.05
2	0.023	0.07
	0.029	0.09
3	0.035	0.11
	0.041	0.13
4	0.048	0.15
	0.056	0.18
5	0.060	0.19
	0.072	0.23
6	0.080	0.26
	0.090	0.29
7	0.100	0.32
	0.110	0.35
8	0.120	0.38
	0.133	0.43
9	0.147	0.47
	0.163	0.52
10	0.181	0.58
	0.203	0.65
11	0.236	0.76
	0.283	0.91
12	0.663	2.12
	0.735	2.35
13	0.776	2.48
	0.804	2.57
14	0.825	2.64
	0.842	2.69
15	0.856	2.74
	0.869	2.78
16	0.881	2.82
	0.893	2.86
17	0.903	2.89
	0.913	2.92
18	0.922	2.95
	0.930	2.98
19	0.938	3.00
	0.946	3.03
20	0.953	3.05
	0.959	3.07
21	0.965	3.09
	0.971	3.11
22	0.977	3.13
	0.983	3.15
23	0.989	3.16
	0.995	3.18
24	0.998	3.19

United States Department of Agriculture

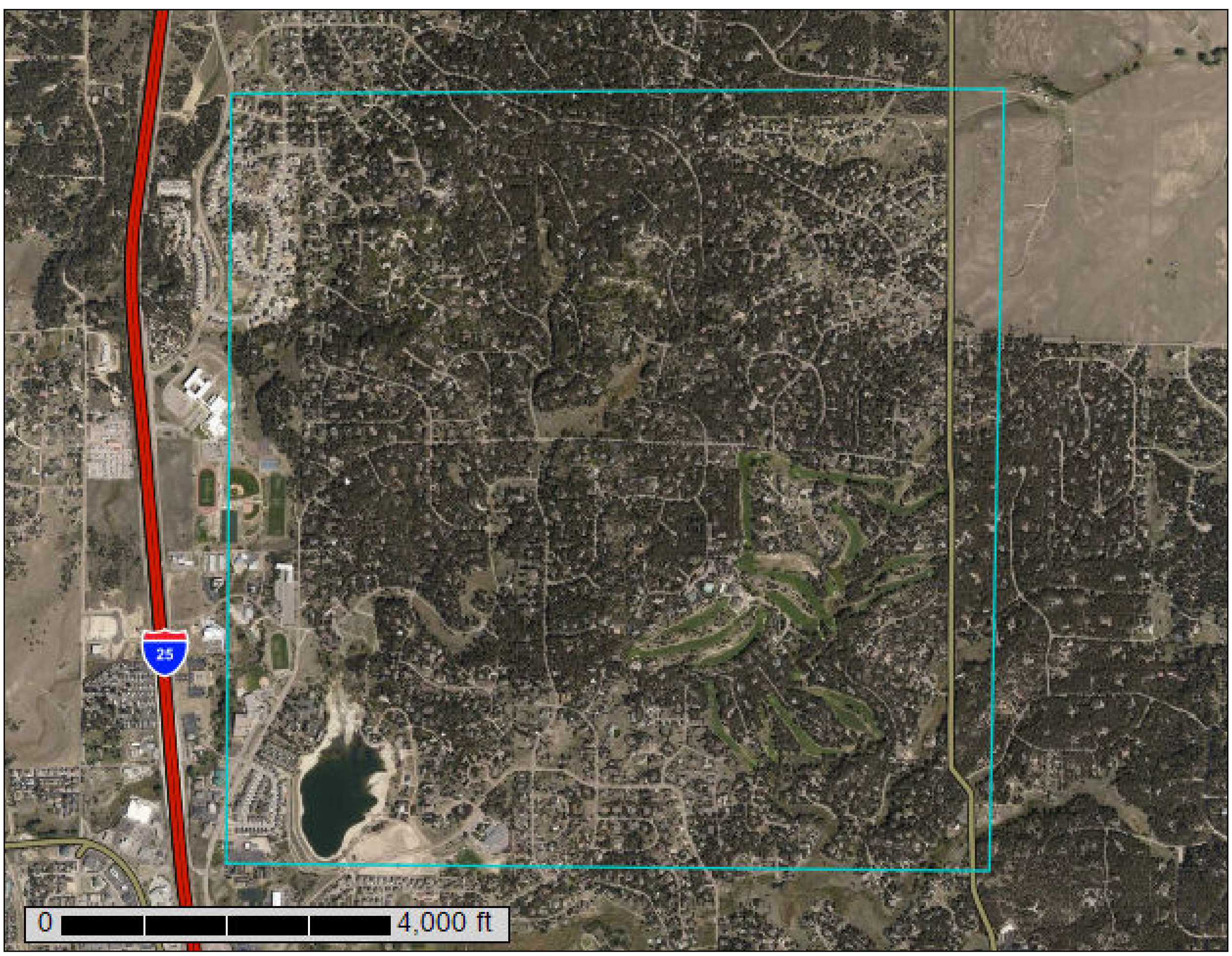
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

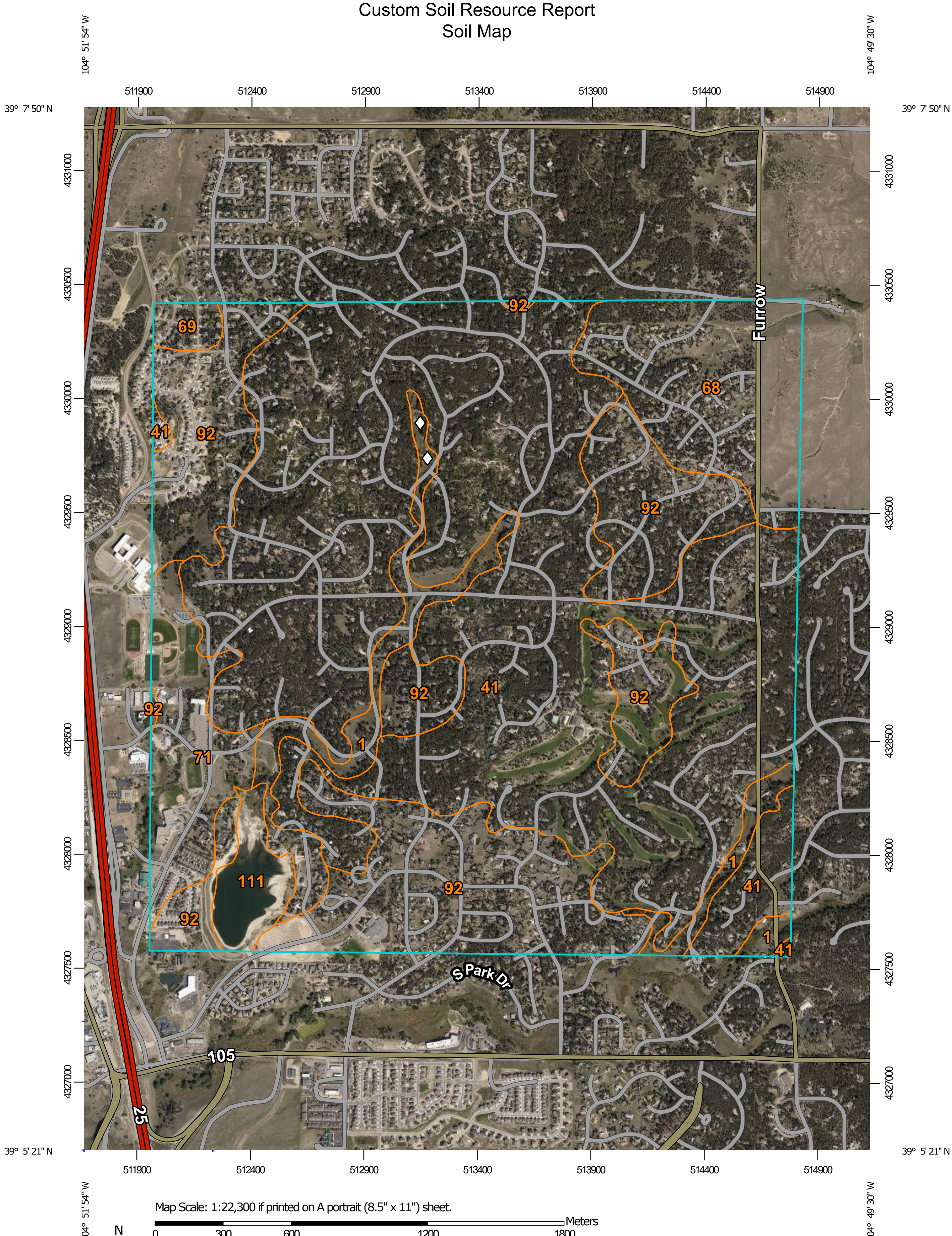
Custom Soil Resource Report for

El Paso County Area, Colorado



August 5, 2021

Soil Map



Map Scale: 1:22,300 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 300, 600, 1200, 1800

Feet: 0, 1000, 2000, 4000, 6000

N

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Alamosa loam, 1 to 3 percent slopes	102.0	5.1%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	1,102.4	54.6%
68	Peyton-Pring complex, 3 to 8 percent slopes	166.8	8.3%
69	Peyton-Pring complex, 8 to 15 percent slopes	14.7	0.7%
71	Pring coarse sandy loam, 3 to 8 percent slopes	102.4	5.1%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	490.5	24.3%
111	Water	39.2	1.9%
Totals for Area of Interest		**2,018.0**	**100.0%**

Map Unit Descriptions

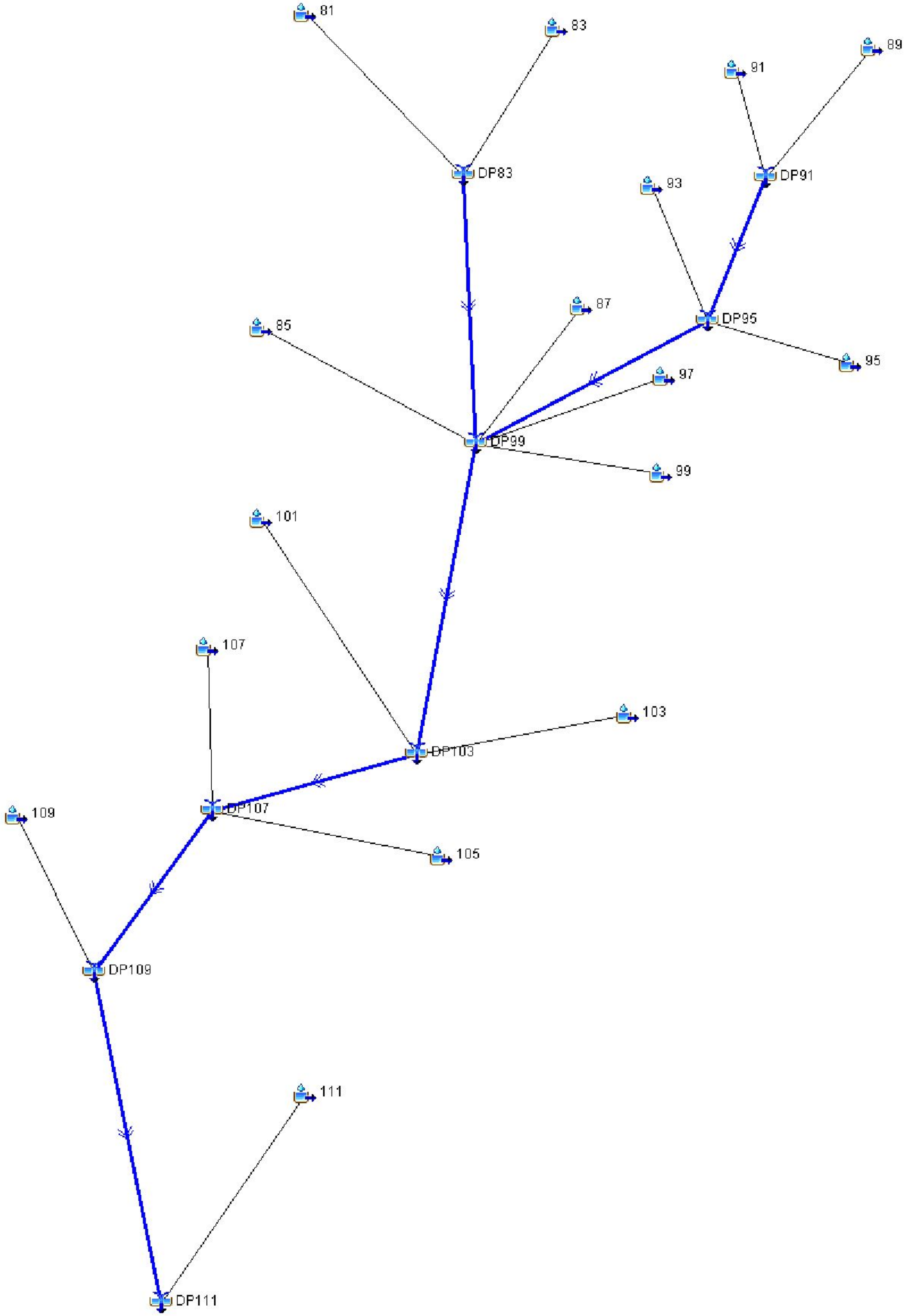
The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor

APPENDIX C: Existing Conditions HEC-HMS Parameters and Output

100yr 2hr Storm
10yr 2hr Storm


81
83
89
91
DP83
93
DP91
87
DP95
85
97
95
DP99
99
101
107
103
DP103
109
DP107
105
DP109
111
DP111

Project: DWCLF_Existing
Simulation Run: 100yr 2hr Existing
Simulation Start: 31 December 2999, 24:00
Simulation End: 1 January 3000, 02:00

HMS Version: 4.8
Executed: 22 November 2021, 16:47

Global Parameter Summary - Subbasin

Area (ft²)

Element Name	Area (ft²)
89	0.09
91	0.02
95	0.04
93	0.04
87	0.09
97	0.04
85	0.04
99	0.03
101	0.11
103	0.11
81	0.09
83	0.07
105	0.09
107	0.04
109	0.1
111	0.17

Downstream

Element Name	Downstream
89	Dp91
91	Dp91
95	Dp95
93	Dp95
87	Dp99
97	Dp99
85	Dp99
99	Dp99
101	Dp103
103	Dp103
81	Dp83
83	Dp83
105	Dp107
107	Dp107
109	Dp109
111	Dp111

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
89	0	68	0.48
91	0	68	0.47
95	0	68.3	0.46
93	0	69.8	0.43
87	0	69.9	0.43
97	0	68	0.47
85	0	70.1	0.43
99	0	65.5	0.55
101	0	69.8	0.43
103	0	68	0.47
81	0	67.8	0.47
83	0	68	0.47
105	0	66.3	0.51
107	0	68.2	0.47
109	0	71.3	0.34
111	0	72	0.39

Transform: Scs

Element Name	Lag	Unitgraph Type
89	20.3	Standard
91	12.9	Standard
95	14.7	Standard
93	15.4	Standard
87	24.7	Standard
97	14.6	Standard
85	19.6	Standard
99	13.4	Standard
101	20.9	Standard
103	26.6	Standard
81	17.5	Standard
83	16.8	Standard
105	20.7	Standard
107	21.2	Standard
109	14.8	Standard
111	18.1	Standard

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Rt99	0.56	298.76	01Jan3000, 01:05	0.6
Dp103	0.79	410.44	01Jan3000, 01:05	0.6
Dp99	0.56	306.02	01Jan3000, 01:05	0.61
Rt103	0.79	410.17	01Jan3000, 01:10	0.58
Dp95	0.2	109.25	01Jan3000, 01:00	0.64
89	0.09	48.88	01Jan3000, 01:05	0.61
Dp91	0.11	58.01	01Jan3000, 01:05	0.62
91	0.02	11.85	01Jan3000, 00:55	0.65
Rt91	0.11	57.99	01Jan3000, 01:05	0.61
95	0.04	28.01	01Jan3000, 00:55	0.65
93	0.04	24.95	01Jan3000, 01:00	0.7
Rt95	0.2	108.52	01Jan3000, 01:05	0.59
Rt83	0.16	92.35	01Jan3000, 01:05	0.6
87	0.09	45.35	01Jan3000, 01:10	0.65
97	0.04	25.81	01Jan3000, 00:55	0.64
85	0.04	24.32	01Jan3000, 01:05	0.69
99	0.03	17.64	01Jan3000, 00:55	0.56
Dp83	0.16	93.45	01Jan3000, 01:00	0.63
101	0.11	64.27	01Jan3000, 01:05	0.67

103	0.11	50.56	01Jan3000, 01:10	0.58
81	0.09	49.98	01Jan3000, 01:00	0.62
83	0.07	43.48	01Jan3000, 01:00	0.63
105	0.09	42.87	01Jan3000, 01:05	0.56
107	0.04	21.31	01Jan3000, 01:05	0.62
Dp107	0.92	471.8	01Jan3000, 01:10	0.58
Rt107	0.92	461.49	01Jan3000, 01:15	0.56
109	0.1	78.07	01Jan3000, 00:55	0.79
Dp109	1.02	514.43	01Jan3000, 01:10	0.58
Rt109	1.02	503.64	01Jan3000, 01:20	0.48
111	0.17	115.31	01Jan3000, 01:00	0.76
Dp111	1.19	572.98	01Jan3000, 01:20	0.52

Project: DWCLF_Existing
Simulation Run: 10yr 2hr Existing
Simulation Start: 31 December 2999, 24:00
Simulation End: 1 January 3000, 02:00

HMS Version: 4.8
Executed: 22 November 2021, 16:47

Global Parameter Summary - Subbasin

Area (ft^2)

Element Name	Area (ft^2)
89	0.09
91	0.02
95	0.04
93	0.04
87	0.09
97	0.04
85	0.04
99	0.03
101	0.11
103	0.11
81	0.09
83	0.07
105	0.09
107	0.04
109	0.1
111	0.17

Downstream

Element Name	Downstream
89	Dp91
91	Dp91
95	Dp95
93	Dp95
87	Dp99
97	Dp99
85	Dp99
99	Dp99
101	Dp103
103	Dp103
81	Dp83
83	Dp83
105	Dp107
107	Dp107
109	Dp109
111	Dp111

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
89	0	68	0.48
91	0	68	0.47
95	0	68.3	0.46
93	0	69.8	0.43
87	0	69.9	0.43
97	0	68	0.47
85	0	70.1	0.43
99	0	65.5	0.55
101	0	69.8	0.43
103	0	68	0.47
81	0	67.8	0.47
83	0	68	0.47
105	0	66.3	0.51
107	0	68.2	0.47
109	0	71.3	0.34
111	0	72	0.39

Transform: Scs

Element Name	Lag	Unitgraph Type
89	20.3	Standard
91	12.9	Standard
95	14.7	Standard
93	15.4	Standard
87	24.7	Standard
97	14.6	Standard
85	19.6	Standard
99	13.4	Standard
101	20.9	Standard
103	26.6	Standard
81	17.5	Standard
83	16.8	Standard
105	20.7	Standard
107	21.2	Standard
109	14.8	Standard
111	18.1	Standard

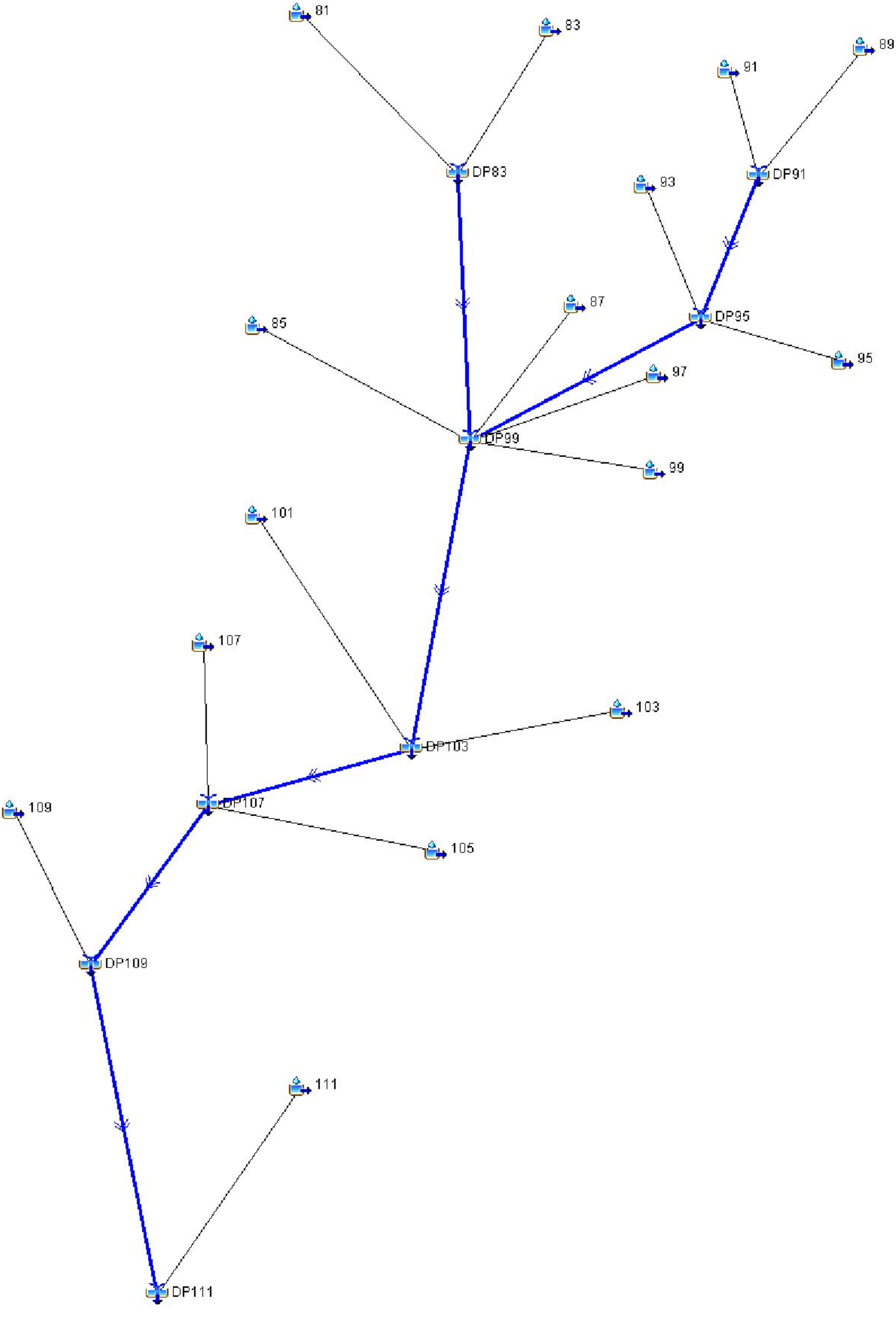
Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Rt99	0.56	80.02	01Jan3000, 01:15	0.16
Dp103	0.79	110.24	01Jan3000, 01:15	0.16
Dp99	0.56	80.97	01Jan3000, 01:10	0.17
Rt103	0.79	109.05	01Jan3000, 01:15	0.15
Dp95	0.2	28.64	01Jan3000, 01:05	0.18
89	0.09	12.67	01Jan3000, 01:10	0.17
Dp91	0.11	15.34	01Jan3000, 01:05	0.17
91	0.02	3.02	01Jan3000, 00:55	0.18
Rt91	0.11	15.11	01Jan3000, 01:10	0.17
95	0.04	7.48	01Jan3000, 01:00	0.18
93	0.04	7.02	01Jan3000, 01:00	0.2
Rt95	0.2	28.17	01Jan3000, 01:15	0.16
Rt83	0.16	24.34	01Jan3000, 01:10	0.16
87	0.09	12.77	01Jan3000, 01:10	0.19
97	0.04	6.82	01Jan3000, 01:00	0.18
85	0.04	6.91	01Jan3000, 01:05	0.2
99	0.03	4.08	01Jan3000, 01:00	0.14
Dp83	0.16	24.38	01Jan3000, 01:05	0.17
101	0.11	17.86	01Jan3000, 01:10	0.19

103	0.11	13.74	01Jan3000, 01:15	0.16
81	0.09	13.09	01Jan3000, 01:05	0.17
83	0.07	11.28	01Jan3000, 01:05	0.18
105	0.09	10.8	01Jan3000, 01:10	0.15
107	0.04	5.7	01Jan3000, 01:10	0.17
Dp107	0.92	124.52	01Jan3000, 01:15	0.15
Rt107	0.92	124.07	01Jan3000, 01:20	0.14
109	0.1	23.82	01Jan3000, 01:00	0.25
Dp109	1.02	136.84	01Jan3000, 01:20	0.15
Rt109	1.02	130.3	01Jan3000, 01:40	0.09
111	0.17	34.08	01Jan3000, 01:05	0.24
Dp111	1.19	142.06	01Jan3000, 01:40	0.11

APPENDIX D: Future Conditions HEC-HMS Parameters and Output

100yr 2hr Storm
10yr 2hr Storm


81
83
89
91
DP83
93
DP91
87
85
DP95
95
97
DP99
99
101
107
103
DP103
109
DP107
105
DP109
111
DP111

Project: DWCLF_Future_Conditions
Simulation Run: 100yr 2hr Future
Simulation Start: 31 December 2999, 24:00
Simulation End: 1 January 3000, 02:00

HMS Version: 4.8
Executed: 17 November 2021, 18:40

Global Parameter Summary - Subbasin

	Area (ft²)
Element Name	Area (ft²)
89	0.09
91	0.02
95	0.04
93	0.04
87	0.09
97	0.04
85	0.04
99	0.03
101	0.11
103	0.11
81	0.09
83	0.07
105	0.09
107	0.04
109	0.1
111	0.17

Downstream

Element Name	Downstream
89	Dp91
91	Dp91
95	Dp95
93	Dp95
87	Dp99
97	Dp99
85	Dp99
99	Dp99
101	Dp103
103	Dp103
81	Dp83
83	Dp83
105	Dp107
107	Dp107
109	Dp109
111	Dp111

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
89	0	68	0.48
91	0	68	0.47
95	0	68.3	0.46
93	0	69.8	0.43
87	0	69.9	0.43
97	0	68	0.47
85	0	70.1	0.43
99	0	65.5	0.55
101	0	69.8	0.43
103	0	68	0.47
81	0	67.8	0.47
83	0	68	0.47
105	0	66.3	0.51
107	0	68.2	0.47
109	0	74.5	0.34
111	0	72.2	0.39

Transform: Scs

Element Name	Lag	Unitgraph Type
89	20.3	Standard
91	12.9	Standard
95	14.7	Standard
93	15.4	Standard
87	24.7	Standard
97	14.6	Standard
85	19.6	Standard
99	13.4	Standard
101	20.9	Standard
103	26.6	Standard
81	17.5	Standard
83	16.8	Standard
105	20.7	Standard
107	21.2	Standard
109	14.8	Standard
111	18.1	Standard

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Rt99	0.56	298.76	01Jan3000, 01:05	0.6
Dp103	0.79	410.44	01Jan3000, 01:05	0.6
Dp99	0.56	306.02	01Jan3000, 01:05	0.61
Rt103	0.79	410.17	01Jan3000, 01:10	0.58
Dp95	0.2	109.25	01Jan3000, 01:00	0.64
89	0.09	48.88	01Jan3000, 01:05	0.61
Dp91	0.11	58.01	01Jan3000, 01:05	0.62
91	0.02	11.85	01Jan3000, 00:55	0.65
Rt91	0.11	57.99	01Jan3000, 01:05	0.61
95	0.04	28.01	01Jan3000, 00:55	0.65
93	0.04	24.95	01Jan3000, 01:00	0.7
Rt95	0.2	108.52	01Jan3000, 01:05	0.59
Rt83	0.16	92.35	01Jan3000, 01:05	0.6
87	0.09	45.35	01Jan3000, 01:10	0.65
97	0.04	25.81	01Jan3000, 00:55	0.64
85	0.04	24.32	01Jan3000, 01:05	0.69
99	0.03	17.64	01Jan3000, 00:55	0.56
Dp83	0.16	93.45	01Jan3000, 01:00	0.63
101	0.11	64.27	01Jan3000, 01:05	0.67

103	0.11	50.56	01Jan3000, 01:10	0.58
81	0.09	49.98	01Jan3000, 01:00	0.62
83	0.07	43.48	01Jan3000, 01:00	0.63
105	0.09	42.87	01Jan3000, 01:05	0.56
107	0.04	21.31	01Jan3000, 01:05	0.62
Dp107	0.92	471.8	01Jan3000, 01:10	0.58
Rt107	0.92	461.49	01Jan3000, 01:15	0.56
109	0.1	87.09	01Jan3000, 00:55	0.87
Dp109	1.02	519.98	01Jan3000, 01:10	0.59
Rt109	1.02	509.64	01Jan3000, 01:20	0.49
111	0.17	116.09	01Jan3000, 01:00	0.77
Dp111	1.19	579.4	01Jan3000, 01:20	0.53

Project: DWCLF_Future_Conditions
Simulation Run: 10yr 2hr Future
Simulation Start: 31 December 2999, 24:00
Simulation End: 1 January 3000, 02:00

HMS Version: 4.8
Executed: 17 November 2021, 18:40

Global Parameter Summary - Subbasin

Area (ft²)

Element Name	Area (ft²)
89	0.09
91	0.02
95	0.04
93	0.04
87	0.09
97	0.04
85	0.04
99	0.03
101	0.11
103	0.11
81	0.09
83	0.07
105	0.09
107	0.04
109	0.1
111	0.17

Downstream

Element Name	Downstream
89	Dp91
91	Dp91
95	Dp95
93	Dp95
87	Dp99
97	Dp99
85	Dp99
99	Dp99
101	Dp103
103	Dp103
81	Dp83
83	Dp83
105	Dp107
107	Dp107
109	Dp109
111	Dp111

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
89	0	68	0.48
91	0	68	0.47
95	0	68.3	0.46
93	0	69.8	0.43
87	0	69.9	0.43
97	0	68	0.47
85	0	70.1	0.43
99	0	65.5	0.55
101	0	69.8	0.43
103	0	68	0.47
81	0	67.8	0.47
83	0	68	0.47
105	0	66.3	0.51
107	0	68.2	0.47
109	0	74.5	0.34
111	0	72.2	0.39

Transform: Scs

Element Name	Lag	Unitgraph Type
89	20.3	Standard
91	12.9	Standard
95	14.7	Standard
93	15.4	Standard
87	24.7	Standard
97	14.6	Standard
85	19.6	Standard
99	13.4	Standard
101	20.9	Standard
103	26.6	Standard
81	17.5	Standard
83	16.8	Standard
105	20.7	Standard
107	21.2	Standard
109	14.8	Standard
111	18.1	Standard

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Rt99	0.56	80.02	01Jan3000, 01:15	0.16
Dp103	0.79	110.24	01Jan3000, 01:15	0.16
Dp99	0.56	80.97	01Jan3000, 01:10	0.17
Rt103	0.79	109.05	01Jan3000, 01:15	0.15
Dp95	0.2	28.64	01Jan3000, 01:05	0.18
89	0.09	12.67	01Jan3000, 01:10	0.17
Dp91	0.11	15.34	01Jan3000, 01:05	0.17
91	0.02	3.02	01Jan3000, 00:55	0.18
Rt91	0.11	15.11	01Jan3000, 01:10	0.17
95	0.04	7.48	01Jan3000, 01:00	0.18
93	0.04	7.02	01Jan3000, 01:00	0.2
Rt95	0.2	28.17	01Jan3000, 01:15	0.16
Rt83	0.16	24.34	01Jan3000, 01:10	0.16
87	0.09	12.77	01Jan3000, 01:10	0.19
97	0.04	6.82	01Jan3000, 01:00	0.18
85	0.04	6.91	01Jan3000, 01:05	0.2
99	0.03	4.08	01Jan3000, 01:00	0.14
Dp83	0.16	24.38	01Jan3000, 01:05	0.17
101	0.11	17.86	01Jan3000, 01:10	0.19

103	0.11	13.74	01Jan3000, 01:15	0.16
81	0.09	13.09	01Jan3000, 01:05	0.17
83	0.07	11.28	01Jan3000, 01:05	0.18
105	0.09	10.8	01Jan3000, 01:10	0.15
107	0.04	5.7	01Jan3000, 01:10	0.17
Dp107	0.92	124.52	01Jan3000, 01:15	0.15
Rt107	0.92	124.07	01Jan3000, 01:20	0.14
109	0.1	27.08	01Jan3000, 01:00	0.28
Dp109	1.02	138.44	01Jan3000, 01:20	0.16
Rt109	1.02	132	01Jan3000, 01:40	0.1
111	0.17	34.35	01Jan3000, 01:05	0.24
Dp111	1.19	143.85	01Jan3000, 01:40	0.12

APPENDIX B.2

Site Existing and Developed Condition Hydrologic Calculations

Runoff Coefficient Calculations
Time of Concentration Calculations
Runoff Calculations

North Bay at Lake Woodmoor

Existing Condition

Runoff Coefficient and Percent Impervious Calculation

Basin / DP	Basin or DP Area (DP contributing basins)		Soil Type	PV	Area 1 Land Use			GR	Area 2 Land Use			HI	Area 3 Land Use			US1	Area 4 Land Use			US2	Area 5 Land Use			Basin % Imperv	Basin Runoff Coeficient	
				% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp		C_5	C_{100}
OS-1	96,767 sf	2.22ac	B	100%		0%	0%	40%		0%	0%	2%		0%	0%	25%	2.22ac	100%	25%	20%		0%	0%	**25.0%**	**0.22**	**0.46**
OS-2	611,666 sf	14.04ac	B	100%		0%	0%	40%		0%	0%	2%		0%	0%	25%		0%	0%	20%	14.04ac	100%	20%	**20.0%**	**0.20**	**0.44**
OS-3	21,166 sf	0.49ac	B	100%	0.18ac	36%	36%	40%		0%	0%	2%	0.31ac	64%	1%	25%		0%	0%	20%		0%	0%	**37.5%**	**0.28**	**0.49**
EX-1	81,827 sf	1.88ac	D	100%	0.09ac	5%	5%	40%	0.05ac	3%	1%	2%	1.74ac	92%	2%	25%		0%	0%	20%		0%	0%	**7.8%**	**0.20**	**0.53**
EX-2	115,677 sf	2.66ac	D	100%	0.27ac	10%	10%	40%	0.06ac	2%	1%	2%	2.33ac	88%	2%	25%		0%	0%	20%		0%	0%	**12.6%**	**0.22**	**0.54**
EX-3	146,648 sf	3.37ac	D	100%	0.07ac	2%	2%	40%	0.12ac	4%	1%	2%	3.17ac	94%	2%	25%		0%	0%	20%		0%	0%	**5.5%**	**0.18**	**0.52**
DP 1	OS-1	2.22ac	B	100%		0%	0%	40%		0%	0%	2%		0%	0%	25%	2.22ac	100%	25%	20%		0%	0%	**25.0%**	**0.22**	**0.46**
DP 2	EX-1	1.88ac	D	100%	0.09ac	5%	5%	40%	0.05ac	3%	1%	2%	1.74ac	92%	2%	25%		0%	0%	20%		0%	0%	**7.8%**	**0.20**	**0.53**
DP 3	OS-1, EX-1	4.10ac	D	100%	0.09ac	2%	2%	40%	0.05ac	1%	1%	2%	1.74ac	42%	1%	25%	2.22ac	54%	14%	20%		0%	0%	**17.1%**	**0.25**	**0.55**
DP 4	OS-2	14.04ac	B	100%		0%	0%	40%		0%	0%	2%		0%	0%	25%		0%	0%	20%	14.04ac	100%	20%	**20.0%**	**0.20**	**0.44**
DP 5	OS-1, EX-1, EX-2	6.76ac	D	100%	0.36ac	5%	5%	40%	0.11ac	2%	1%	2%	4.07ac	60%	1%	25%	2.22ac	33%	8%	20%		0%	0%	**15.3%**	**0.24**	**0.54**
DP 6	OS-3	0.49ac	B	100%	0.18ac	36%	36%	40%		0%	0%	2%	0.31ac	64%	1%	25%		0%	0%	20%		0%	0%	**37.5%**	**0.28**	**0.49**
DP 6.1	OS-3	0.49ac	B	100%	0.18ac	36%	36%	40%		0%	0%	2%	0.31ac	64%	1%	25%		0%	0%	20%		0%	0%	**37.5%**	**0.28**	**0.49**
DP 7	OS-1, OS-2, OS-3, EX-1, EX-2	21.28ac	B	100%	0.53ac	3%	3%	40%	0.11ac	1%	0%	2%	4.38ac	21%	0%	25%	2.22ac	10%	3%	20%	14.04ac	66%	13%	**18.9%**	**0.19**	**0.44**
DP 8	EX-3	3.37ac	D	100%	0.07ac	2%	2%	40%	0.12ac	4%	1%	2%	3.17ac	94%	2%	25%		0%	0%	20%		0%	0%	**5.5%**	**0.14**	**0.48**
DP 9	OS-1, OS-2, OS-3, EX-1, EX-2, EX-3	24.65ac	B	100%	0.60ac	2%	2%	40%	0.23ac	1%	0%	2%	7.55ac	31%	1%	25%	2.22ac	9%	2%	20%	14.04ac	57%	11%	**17.1%**	**0.18**	**0.43**

Basin Runoff Coefficient is based on UDFCD % Imperviousness Calculation								
Runoff Coefficients and Percents Impervious								
Hydrologic Soil Type:	**B**	**Runoff Coef Calc Method**						%Imp
Land Use	Abb	%	C_2	C_5	C_{10}	C_{25}	C_{50}	C_{100}
Commercial Area	CO	95%	0.79	0.81	0.83	0.85	0.87	0.88
Drives and Walks	DR	90%	0.71	0.73	0.75	0.78	0.80	0.81
Streets - Gravel (Packed)	GR	40%	0.23	0.30	0.36	0.42	0.46	0.50
Historic Flow Analysis	HI	2%	0.03	0.08	0.17	0.26	0.31	0.36
Lawns	LA	0%	0.02	0.08	0.15	0.25	0.30	0.35
Off-site flow-Undeveloped	OF	45%	0.26	0.32	0.38	0.44	0.48	0.51
Park	PA	7%	0.05	0.12	0.20	0.29	0.34	0.39
Playground	PL	13%	0.07	0.16	0.24	0.32	0.37	0.42
Streets - Paved	PV	100%	0.89	0.90	0.92	0.94	0.95	0.96
Roofs	RO	90%	0.71	0.73	0.75	0.78	0.80	0.81
User Input 1 (2 lots/acre)	US1	25%	0.15	0.22	0.30	0.37	0.42	0.46
User Input 2 (1 lot/acre)	US2	20%	0.12	0.20	0.27	0.35	0.40	0.44

Weighted
%Imp
A
B
C
D

Equations (% Impervious Calculation):

$C_A = K_A + (1.31\, i^3 - 1.44\, i^2 + 1.135\, i - 0.12)$ [Eqn RO-6]

$C_{CD} = K_{CD} + (0.858\, i^3 - 0.786\, i^2 + 0.774\, i + 0.04)$ [Eqn RO-7]

$C_B = (C_A + C_{CD}) / 2$

I = % imperviousness/100 as a decimal (See Table RO-3)

C_A = Runoff coefficient for NRCS Type A Soils

C_B = Runoff coefficient for NRCS Type B Soils

C_{CD} = Runoff coefficient for NRCS Type C and D Soils

Correction Factors - Table RO-4

K_A = For Type A Soils

- K_A (2-yr)= 0
- K_A (5-yr)= -0.08i + 0.09
- K_A (10-yr)= -0.14i + 0.17
- K_A (25-yr)= -0.19i + 0.24
- K_A (50-yr)= -0.22i + 0.28
- K_A (100-yr)= -0.25i + 0.32

K_{CD}=For Type C & D Soils

- K_{CD} (2-yr)= 0
- K_{CD} (5-yr)= -0.10i + 0.11
- K_{CD} (10-yr)= -0.18i + 0.21
- K_{CD} (25-yr)= -0.28i + 0.33
- K_{CD} (50-yr)= -0.33i + 0.40
- K_{CD} (100-yr)= -0.39i + 0.46

North Bay at Lake Woodmoor
Existing Condition
Time of Concentration Calculation

Sub-Basin Data				Time of Concentration Estimate										Final t_c
				Initial/Overland Time (t_i)			Travel Time (t_t)						Comp.	
Basin / Design Point	Contributing Basins	Area	C_5	Length	Slope	t_i	Length	Slope	Land Type	Cv	Velocity	t_t	t_c	
OS-1		2.22ac	0.22	100lf	2.0%	12.7 min.	110lf	13.3%	NBG	10	3.7 ft/sec	0.5 min.	13.2 min.	**13.2 min.**
OS-2		14.04ac	0.20	300lf	3.0%	19.9 min.	1120lf	4.7%	GW	15	3.3 ft/sec	5.7 min.	25.6 min.	**25.6 min.**
OS-3		0.49ac	0.28	50lf	2.0%	8.4 min.	180lf	2.0%	GW	15	2.1 ft/sec	1.4 min.	9.8 min.	**9.8 min.**
EX-1		1.88ac	0.20			0.0 min.	450lf	0.8%	GW	15	1.3 ft/sec	5.6 min.	5.6 min.	**5.6 min.**
EX-2		2.66ac	0.22	20lf	2.0%	5.7 min.	390lf	6.2%	GW	15	3.7 ft/sec	1.7 min.	7.4 min.	**7.4 min.**
EX-3		3.37ac	0.18	80lf	13.0%	6.4 min.	380lf	5.8%	GW	15	3.6 ft/sec	1.8 min.	8.1 min.	**8.1 min.**
DP 1	OS-1	2.22ac	0.22	100lf	2.0%	12.7 min.	110lf	13.3%	NBG	10	3.6 ft/sec	0.5 min.	13.2 min.	**13.2 min.**
DP 2	EX-1	1.88ac	0.20			0.0 min.	450lf	0.8%	GW	15	1.3 ft/sec	5.6 min.	5.6 min.	**5.6 min.**
DP 3	OS-1, EX-1	4.10ac	0.25	100lf	2.0%	12.4 min.	405lf	7.4%	GW	15	4.1 ft/sec	1.7 min.	14.1 min.	**14.1 min.**
DP 4	OS-2	14.04ac	0.20	300lf	3.0%	19.9 min.	1120lf	4.7%	GW	15	3.3 ft/sec	5.7 min.	25.6 min.	**25.6 min.**
DP 5	OS-1, EX-1, EX-2	6.76ac	0.24	100lf	2.0%	12.5 min.	340lf	9.2%	GW	15	4.5 ft/sec	1.2 min.	13.8 min.	**13.8 min.**
DP 6	OS-3	0.49ac	0.28	50lf	2.0%	8.4 min.	180lf	2.0%	GW	15	2.1 ft/sec	1.4 min.	9.8 min.	**9.8 min.**
DP 6.1	OS-3	0.49ac	0.28	50lf	2.0%	8.4 min.	420lf	6.8%	GW	15	3.9 ft/sec	1.8 min.	10.2 min.	**10.2 min.**
DP 7	OS-1, OS-2, OS-3, EX-1, EX-2	21.28ac	0.19	300lf	3.0%	20.0 min.	1120lf	4.7%	GW	15	3.3 ft/sec	5.7 min.	25.7 min.	**25.7 min.**
DP 8	EX-3	3.37ac	0.14	80lf	13.0%	6.7 min.	380lf	5.8%	GW	15	3.6 ft/sec	1.8 min.	8.4 min.	**8.4 min.**
DP 9	OS-1, OS-2, OS-3, EX-1, EX-2, EX-3	24.65ac	0.18	300lf	3.0%	20.2 min.	1260lf	4.5%	GW	15	3.2 ft/sec	6.6 min.	26.8 min.	**26.8 min.**

Equations:

t_i (Overland) = $0.395(1.1-C_5)L^{0.5}S^{-0.333}$
C_5 = Runoff coefficient for 5-year
L = Length of overland flow (ft)
S = Slope of flow path (ft/ft)
tc Check = (L/180)+10 (Developed Cond. Only)
L = Overall Length

Velocity (Travel Time) = $CvS^{0.5}$
Cv = Conveyance Coef (see Table)
S = Watercourse slope (ft/ft)

Table RO-2

Land Surface Type	Land Type	Cv
Grassed Waterway	GW	15
Heavy Meadow	HM	2.5
Nearly Bare Ground	NBG	10
Paved Area	PV	20
Riprap (Not Buried)	RR	6.5
Short Pasture/Lawns	SP	7
Tillage/Fields	TF	5

North Bay at Lake Woodmoor

Existing Condition

Runoff Calculation

Basin / Design Point	Contributing Basins	Drainage Area	C_5	C_{100}	Time of Concentration	Rainfall Intensity i_5	Rainfall Intensity i_{100}	Runoff Q_5	Runoff Q_{100}	Basin / DP
OS-1		2.22 ac	0.22	0.46	13.2 min.	3.7 in/hr	6.2 in/hr	**1.8 cfs**	**6.3 cfs**	OS-1
OS-2		14.04 ac	0.20	0.44	25.6 min.	2.7 in/hr	4.6 in/hr	**7.5 cfs**	**28.3 cfs**	OS-2
OS-3		0.49 ac	0.28	0.49	9.8 min.	4.2 in/hr	7.0 in/hr	**0.6 cfs**	**1.7 cfs**	OS-3
EX-1		1.88 ac	0.20	0.53	5.6 min.	5.0 in/hr	8.4 in/hr	**1.9 cfs**	**8.3 cfs**	EX-1
EX-2		2.66 ac	0.22	0.54	7.4 min.	4.6 in/hr	7.7 in/hr	**2.7 cfs**	**11.0 cfs**	EX-2
EX-3		3.37 ac	0.18	0.52	8.1 min.	4.4 in/hr	7.5 in/hr	**2.8 cfs**	**13.0 cfs**	EX-3
DP 1	OS-1	2.22 ac	0.22	0.46	13.2 min.	3.7 in/hr	6.2 in/hr	**1.8 cfs**	**6.3 cfs**	DP 1
DP 2	EX-1	1.88 ac	0.20	0.53	5.6 min.	5.0 in/hr	8.4 in/hr	**1.9 cfs**	**8.3 cfs**	DP 2
DP 3	OS-1, EX-1	4.10 ac	0.25	0.55	14.1 min.	3.6 in/hr	6.1 in/hr	**3.7 cfs**	**13.6 cfs**	DP 3
DP 4	OS-2	14.04 ac	0.20	0.44	25.6 min.	2.7 in/hr	4.6 in/hr	**7.5 cfs**	**28.3 cfs**	DP 4
DP 5	~~OS~~ DP-3 ~~1~~, EX-2	6.76 ac	0.24	0.54	13.8 min.	3.6 in/hr	6.1 in/hr	**5.9 cfs**	**22.5 cfs**	DP 5
DP 6	OS-3	0.49 ac	0.28	0.49	9.8 min.	4.2 in/hr	7.0 in/hr	**0.6 cfs**	**1.7 cfs**	DP 6
DP 6.1	OS-3	0.49 ac	0.28	0.49	10.2 min.	4.1 in/hr	6.9 in/hr	**0.6 cfs**	**1.6 cfs**	DP 6.1
DP 7	DP-4, DP-5 & DP-6	21.28 ac	0.19	0.44	25.7 min.	2.7 in/hr	4.6 in/hr	**11.0 cfs**	**42.4 cfs**	DP 7
DP 8	EX-3	3.37 ac	0.14	0.48	8.4 min.	4.4 in/hr	7.4 in/hr	**2.1 cfs**	**11.9 cfs**	DP 8
DP 9	DP-7 & DP-8 EX-3	24.65 ac	0.18	0.43	26.8 min.	2.6 in/hr	4.4 in/hr	**11.8 cfs**	**47.3 cfs**	DP 9

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Equations (taken from Fig 6-5, City of Colorado Springs DCM):

i_2=-1.19 ln(T_c) + 6.035
i_5=-1.50 ln(T_c) + 7.583
i_{10}=-1.75 ln(T_c) + 8.847
i_{25}=-2.00 ln(T_c) + 10.111
i_{50}=-2.25 ln(T_c) + 11.375
i_{100}=-2.52 ln(T_c) + 12.735

Q = CiA
Q = Peak Runoff Rate (cubic feet/second)
C = Runoff coef representing a ratio of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.
i = average rainfall intensity in inches per hour
A = Drainage area in acres

P1	Inches
WQCV	0.60 in
2 yr	1.19 in
5 yr	1.50 in
10 yr	1.75 in
25 yr	2.00 in
50 yr	2.25 in
100 yr	2.52 in

North Bay at Lake Woodmoor
Runoff Coeficient and Percent Impervious Calculation

Basin / DP	Basin or DP Area (DP contributing basins)		Soil Type	PV	Area 1 Land Use			LA	Area 2 Land Use			RO	Area 3 Land Use			US1	Area 4 Land Use			US2	Area 5 LandUse			Basin % Imperv	Basin Runoff Coef	
				% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp		C_5	C_{100}
OS-1a	32,679 sf	0.75ac	AB	100%	0.00ac	0%	0%	0%		0%	0%	90%		0%	0%	25%	0.75ac	100%	25%	20%		0%	0%	**25.0%**	**0.22**	**0.46**
OS-1b	29,386 sf	0.67ac	AB	100%	0.00ac	0%	0%	0%		0%	0%	90%		0%	0%	25%	0.67ac	100%	25%	20%		0%	0%	**25.0%**	**0.22**	**0.46**
OS-1c	15,839 sf	0.36ac	AB	100%	0.00ac	0%	0%	0%		0%	0%	90%		0%	0%	25%	0.36ac	100%	25%	20%		0%	0%	**25.0%**	**0.22**	**0.46**
OS-1d	18,826 sf	0.43ac	AB	100%	0.00ac	0%	0%	0%		0%	0%	90%		0%	0%	25%	0.43ac	100%	25%	20%		0%	0%	**25.0%**	**0.22**	**0.46**
OS-2	611,666 sf	14.04ac	AB	100%	0.00ac	0%	0%	0%		0%	0%	90%		0%	0%	25%		0%	0%	20%	14.04ac	100%	20%	**20.0%**	**0.20**	**0.44**
OS-3	21,166 sf	0.49ac	AB	100%	0.18ac	36%	36%	0%	0.31ac	64%	0%	90%		0%	0%	25%		0%	0%	20%		0%	0%	**36.2%**	**0.28**	**0.49**
A	21,016 sf	0.48ac	D	100%	0.05ac	10%	10%	0%	0.44ac	90%	0%	90%		0%	0%	25%		0%	0%	20%		0%	0%	**9.6%**	**0.21**	**0.53**
B	9,477 sf	0.22ac	D	100%	0.01ac	4%	4%	0%	0.21ac	96%	0%	90%		0%	0%	25%		0%	0%	20%		0%	0%	**4.3%**	**0.18**	**0.52**
C	24,570 sf	0.56ac	D	100%	0.01ac	1%	1%	0%	0.44ac	77%	0%	90%	0.12ac	21%	19%	25%		0%	0%	20%		0%	0%	**20.4%**	**0.26**	**0.55**
D	78,600 sf	1.80ac	D	100%	0.80ac	44%	44%	0%	0.43ac	24%	0%	90%	0.58ac	32%	29%	25%		0%	0%	20%		0%	0%	**73.1%**	**0.56**	**0.70**
E	23,083 sf	0.53ac	D	100%	0.06ac	11%	11%	0%	0.37ac	70%	0%	90%	0.10ac	19%	17%	25%		0%	0%	20%		0%	0%	**28.1%**	**0.30**	**0.56**
F	6,626 sf	0.15ac	D	100%	0.05ac	31%	31%	0%	0.07ac	44%	0%	90%	0.04ac	25%	23%	25%		0%	0%	20%		0%	0%	**53.7%**	**0.42**	**0.61**
G	8,514 sf	0.20ac	AB	100%	0.11ac	58%	58%	0%	0.02ac	11%	0%	90%	0.06ac	30%	27%	25%		0%	0%	20%		0%	0%	**85.7%**	**0.67**	**0.76**
H	20,721 sf	0.48ac	AB	100%	0.06ac	13%	13%	0%	0.33ac	69%	0%	90%	0.08ac	17%	16%	25%		0%	0%	20%		0%	0%	**29.0%**	**0.24**	**0.47**
I	27,187 sf	0.62ac	AB	100%	0.40ac	63%	63%	0%	0.13ac	20%	0%	90%	0.10ac	16%	15%	25%		0%	0%	20%		0%	0%	**78.1%**	**0.57**	**0.68**
J	8,746 sf	0.20ac	AB	100%	0.05ac	27%	27%	0%	0.14ac	71%	0%	90%	0.004ac	2%	2%	25%		0%	0%	20%		0%	0%	**29.0%**	**0.24**	**0.47**
K	115,648 sf	2.65ac	D	100%	0.08ac	3%	3%	0%	2.44ac	92%	0%	90%	0.13ac	5%	5%	25%		0%	0%	20%		0%	0%	**7.6%**	**0.20**	**0.53**
WQ1	B, C	0.78ac	D	100%	0.02ac	2%	2%	0%	0.65ac	83%	0%	90%	0.12ac	15%	14%	25%		0%	0%	20%		0%	0%	**16.0%**	**0.24**	**0.54**
WQ2	D	1.80ac	D	100%	0.80ac	44%	44%	0%	0.43ac	24%	0%	90%	0.58ac	32%	29%	25%		0%	0%	20%		0%	0%	**73.1%**	**0.56**	**0.70**
WQ3	E	0.53ac	D	100%	0.06ac	11%	11%	0%	0.37ac	70%	0%	90%	0.10ac	19%	17%	25%		0%	0%	20%		0%	0%	**28.1%**	**0.30**	**0.56**
WQ4	F - J	1.65ac	AB	100%	0.68ac	41%	41%	0%	0.69ac	42%	0%	90%	0.29ac	17%	16%	25%		0%	0%	20%		0%	0%	**56.6%**	**0.39**	**0.55**

Basin Runoff Coefficient is based on % Imperviousness Calculation

Based on Table 6-6: Runoff Coefficients for Rational Method from City of Colo Springs DCM

Runoff Coefficients and Percents Impervious

Hydrologic Soil Type:	**AB**	**Runoff Coef Method**			%Imp	
Land Use	Abb	%	C_5	C_{10}	C_{100}	Weighted
Commercial Area	CO	95%	0.81	0.83	0.88	%Imp
Drives and Walks	DR	100%	0.90	0.92	0.96	A
Streets - Gravel (Packed)	GR	80%	0.59	0.63	0.70	AB
Historic Flow Analysis	HI	2%	0.09	0.17	0.36	CD
Lawns	LA	0%	0.08	0.15	0.35	D
Off-site flow-Undeveloped	OF	45%	0.32	0.38	0.51	
Park	PA	7%	0.12	0.20	0.39	
Streets - Paved	PV	100%	0.90	0.92	0.96	
Roofs	RO	90%	0.73	0.75	0.81	
User Input 1 (2 lots/acre)	US1	25%	0.22	0.30	0.46	
User Input 2 (1 lot/acre)	US2	20%	0.20	0.27	0.44	

Project Name

Time of Concentration Calculation

Sub-Basin Data				Time of Concentration Estimate										Min. Tc in Urban		
				Initial/Overland Time (t_i)			Travel Time (t_t)					Comp.		Tc Check (urban)		
Basin / Design Point	**Contributing Basins**	**Area**	**C_5**	Length	Slope	t_i	Length	Slope	Land Type	Cv	Velocity	t_t	t_c	Total Length	t_c Check	**Final t_c**
OS-1a		0.75ac	0.22	100lf	2.0%	12.7 min.	110lf	13.3%	NBG	10	3.6 ft/sec	0.5 min.	13.2 min.			**13.2 min.**
OS-1b		0.67ac	0.22	100lf	2.0%	12.7 min.	110lf	13.3%	NBG	10	3.6 ft/sec	0.5 min.	13.2 min.			**13.2 min.**
OS-1c		0.36ac	0.22	100lf	2.0%	12.7 min.	110lf	13.3%	NBG	10	3.6 ft/sec	0.5 min.	13.2 min.			**13.2 min.**
OS-1d		0.43ac	0.22	100lf	2.0%	12.7 min.	110lf	13.3%	NBG	10	3.6 ft/sec	0.5 min.	13.2 min.			**13.2 min.**
OS-2		14.04ac	0.20	300lf	3.0%	19.9 min.	1120lf	4.7%	GW	15	3.3 ft/sec	5.7 min.	25.6 min.			**25.6 min.**
OS-3		0.49ac	0.28	50lf	2.0%	8.4 min.	180lf	2.0%	GW	15	2.1 ft/sec	1.4 min.	9.9 min.			**9.9 min.**
A		0.48ac	0.21	80lf	11.0%	6.6 min.	120lf	1.0%	GW	15	1.5 ft/sec	1.3 min.	7.9 min.	200lf	11.1 min.	**7.9 min.**
B		0.22ac	0.18	50lf	12.5%	5.1 min.	163lf	4.4%	PV	20	4.2 ft/sec	0.6 min.	5.8 min.	213lf	11.2 min.	**5.8 min.**
C		0.56ac	0.26	25lf	2.0%	6.1 min.	220lf	3.7%	GW	15	2.9 ft/sec	1.3 min.	7.4 min.	245lf	11.4 min.	**7.4 min.**
D		1.80ac	0.56	20lf	2.0%	3.5 min.	460lf	2.6%	PV	20	3.2 ft/sec	2.4 min.	5.9 min.	480lf	12.7 min.	**5.9 min.**
E		0.53ac	0.30	50lf	2.0%	8.3 min.	90lf	7.8%	GW	15	4.2 ft/sec	0.4 min.	8.6 min.	140lf	10.8 min.	**8.6 min.**
F		0.15ac	0.42	20lf	2.0%	4.4 min.	162lf	1.3%	PV	20	2.3 ft/sec	1.2 min.	5.6 min.	182lf	11.0 min.	**5.6 min.**
G		0.20ac	0.67	20lf	2.0%	2.8 min.	188lf	1.3%	PV	20	2.3 ft/sec	1.4 min.	5.0 min.	208lf	11.2 min.	**5.0 min.**
H		0.48ac	0.24	20lf	2.0%	5.6 min.	134lf	2.6%	GW	15	2.4 ft/sec	0.9 min.	6.5 min.	154lf	10.9 min.	**6.5 min.**
I		0.62ac	0.57	30lf	5.4%	3.0 min.	240lf	3.2%	PV	20	3.6 ft/sec	1.1 min.	5.0 min.	270lf	11.5 min.	**5.0 min.**
J		0.20ac	0.24	50lf	2.7%	8.0 min.	55lf	19.0%	GW	15	6.5 ft/sec	0.1 min.	8.1 min.	105lf	10.6 min.	**8.1 min.**
K		2.65ac	0.20	50lf	27.0%	3.9 min.	290lf	11.7%	SP	7	2.4 ft/sec	2.0 min.	5.9 min.	340lf	11.9 min.	**5.9 min.**

Equations:

t_i (Overland) = $0.395(1.1-C_5)L^{0.5} S^{-0.333}$

C_5 = Runoff coefficient for 5-year

L = Length of overland flow (ft)

S = Slope of flow path (ft/ft)

tc Check = (L/180)+10 (Developed Cond. Only)

L = Overall Length

Velocity (Travel Time) = $CvS^{0.5}$

Cv = Conveyance Coef (see table)

S = Watercourse slope (ft/ft)

Table 6-7: Conveyance Coef (City CS DCM, Vol 1)

Type of Land Surface	Land Type	Cv
Grassed Waterway	GW	15
Heavy Meadow	HM	2.5
Nearly Bare Ground	NBG	10
Paved Area	PV	20
Riprap (Not Buried)	RR	6.5
Short Pasture/Lawns	SP	7
Tillage/Fields	TF	5

North Bay at Lake Woodmoor
Runoff Calculation

Design Storm: **5 Year**

		Direct Runoff							Total Runoff				Street/Chan		Pipe			Travel Time			
Street	Design Point	Area Designation	Area	C	T_c	C*A (acre)	i (in/hr)	Q	T_c	Sum C*A	i (in/hr)	Q	Slope	Q	Q	Slope	Pipe Size	L (ft)	Vel (ft/s)	T_t	Remarks
		A	0.48 ac	0.21	7.9min	0.10	4.5	0.5 cfs													
		OS-1a	0.75 ac	0.22	13.2min	0.17	3.7	0.6 cfs										70'	3.5	0.3min	To DP1
		B	0.22 ac	0.18	5.8min	0.04	4.9	0.2 cfs													
	DP1	OS-1a, B	0.97 ac						13.6min	0.21	3.7	0.8 cfs									
		OS-1b	0.67 ac	0.22	13.2min	0.15	3.7	0.6 cfs										80'	3.5	0.4min	To DP2
		C	0.56 ac	0.26	7.4min	0.15	4.6	0.7 cfs													
	DP2	OS-1a,OS-1b,B,C	2.21 ac						13.6min	0.51	3.7	1.9 cfs									
		D	1.80 ac	0.56	5.9min	1.01	4.9	5.0 cfs													
		OS-1c	0.36 ac	0.22	13.2min	0.08	3.7	0.3 cfs										250'	4.5	0.9min	To DP3
	DP3	OS-1c, D	2.17 ac						5.9min	1.09	4.9	5.4 cfs									
		E	0.53 ac	0.30	8.6min	0.16	4.4	0.7 cfs							0.7 cfs	1.0%	18-in	46'	6	0.1min	To DP4
		OS-2	14.04 ac	0.20	25.6min	2.77	2.7	7.5 cfs													
	DP4.a	OS-2, E	14.57 ac						25.6min	2.92	2.7	8.0 cfs									
		F	0.15 ac	0.42	5.6min	0.06	5.0	0.3 cfs							0.3 cfs	1.0%	18-in	76'	6	0.2min	To DP5
		G	0.20 ac	0.67	5.0min	0.13	5.2	0.7 cfs													
		H	0.48 ac	0.24	6.5min	0.12	4.8	0.6 cfs													
	DP5	F, G, H	0.82 ac						6.5min	0.31	4.8	1.5 cfs			1.5 cfs	1.0%	18-in	98'	6	0.3min	To DP7
		OS-3	0.49 ac	0.28	9.9min	0.14	4.2	0.6 cfs										180'	3.6	0.8min	To DP6
		I	0.62 ac	0.57	5.0min	0.36	5.2	1.8 cfs													
	DP6	OS-3, I	1.11 ac						10.7min	0.49	4.0	2.0 cfs			2.0 cfs	1.0%	18-in	47'	6	0.1min	To DP7
	DP7	DP5, DP6	1.93 ac						10.7min	0.80	4.0	3.2 cfs			3.2 cfs	1.0%	18-in	200'	6	0.6min	To DP8
		J	0.20 ac	0.24	8.1min	0.05	4.4	0.2 cfs													
	DP8	DP7, J	2.13 ac						11.2min	0.85	4.0	3.4 cfs									
		OS-1d	0.43 ac	0.22	13.2min	0.10	3.7	0.4 cfs										220'	4.5	0.8min	To DP9
		K	2.65 ac	0.20	5.9min	0.52	4.9	2.6 cfs													
	DP9	OS-1d, K	3.09 ac						14.1min	0.62	3.6	2.2 cfs									

Include Basin A at this design point.

Equations (taken from Fig 6-5, City of Colorado Springs DCM):

$i_2 = -1.19 \ln(T_c) + 6.035$

$i_5 = -1.50 \ln(T_c) + 7.583$

$i_{10} = -1.75 \ln(T_c) + 8.847$

$i_{100} = -2.52 \ln(T_c) + 12.735$

Q = CiA

Q = Peak Runoff Rate (cubic feet/second)

C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.

i = average rainfall intensity in inches per hour

A = Drainage area in acres

Use DP-4 for basin OS-2, to match existing conditions and change DP-4 to DP4.a in proposed conditions.

North Bay at Lake Woodmoor
Runoff Calculation

Design Storm: **100 Year**

		Direct Runoff							**Total Runoff**				**Street/Chan**		**Pipe**			**Travel Time**			
Street	**Design Point**	Area Designation	Area	C	T_c	C*A (acre)	i (in/hr)	Q	T_c	Sum C*A	i (in/hr)	Q	Slope	Q	Q	Slope	Pipe Size	L (ft)	Vel (ft/s)	T_t	Remarks
		A	0.48 ac	0.53	7.9min	0.26	7.5	1.9 cfs													
		OS-1a	0.75 ac	0.46	13.2min	0.34	6.2	2.1 cfs										70'	3.5	0.3min	To DP1
		B	0.22 ac	0.52	5.8min	0.11	8.3	0.9 cfs													
	DP1	OS-1a, B	0.97 ac						13.6min	0.45	6.2	2.8 cfs									
		OS-1b	0.67 ac	0.46	13.2min	0.31	6.2	1.9 cfs										80'	3.5	0.4min	To DP2
		C	0.56 ac	0.55	7.4min	0.31	7.7	2.4 cfs													
	DP2	OS-1a,OS-1b,B,C	2.21 ac						13.6min	1.07	6.2	6.6 cfs									
		D	1.80 ac	0.70	5.9min	1.26	8.3	10.4 cfs													
		OS-1c	0.36 ac	0.46	13.2min	0.17	6.2	1.0 cfs										250'	4.5	0.9min	To DP3
	DP3	OS-1c, D	2.17 ac						5.9min	1.42	8.3	11.7 cfs									
		E	0.53 ac	0.56	8.6min	0.30	7.3	2.2 cfs							2.2 cfs	1.0%	18-in	46'	6	0.1min	To DP4
		OS-2	14.04 ac	0.44	25.6min	6.19	4.6	28.3 cfs													
	DP4	OS-2, E	14.57 ac						25.6min	6.49	4.6	29.6 cfs									
		F	0.15 ac	0.61	5.6min	0.09	8.4	0.8 cfs							0.8 cfs	1.0%	18-in	76'	6	0.2min	To DP5
		G	0.20 ac	0.76	5.0min	0.15	8.7	1.3 cfs													
		H	0.48 ac	0.47	6.5min	0.22	8.0	1.8 cfs													
	DP5	F, G, H	0.82 ac						6.5min	0.46	8.0	3.7 cfs			3.7 cfs	1.0%	18-in	98'	6	0.3min	To DP7
		OS-3	0.49 ac	0.49	9.9min	0.24	7.0	1.6 cfs										180'	3.6	0.8min	To DP6
		I	0.62 ac	0.68	5.0min	0.43	8.7	3.7 cfs													
	DP6	OS-3, I	1.11 ac						10.7min	0.66	6.8	4.5 cfs			4.5 cfs	1.0%	18-in	47'	6	0.1min	To DP7
	DP7	DP5, DP6	1.93 ac						10.7min	1.13	6.8	7.6 cfs			7.6 cfs	1.0%	18-in	200'	6	0.6min	To DP8
		J	0.20 ac	0.47	8.1min	0.09	7.5	0.7 cfs													
	DP8	DP7, J	2.13 ac						11.2min	1.22	6.6	8.1 cfs									
		OS-1d	0.43 ac	0.46	13.2min	0.20	6.2	1.2 cfs										220'	4.5	0.8min	To DP9
		K	2.65 ac	0.53	5.9min	1.39	8.3	11.5 cfs													
	DP9	OS-1d, K	3.09 ac						14.1min	1.59	6.1	9.7 cfs									

Equations (taken from Fig 6-5, City of Colorado Springs DCM):

$i_2=-1.19 \ln(T_c) + 6.035$

$i_5=-1.50 \ln(T_c) + 7.583$

$i_{10}=-1.75 \ln(T_c) + 8.847$

$i_{100}=-2.52 \ln(T_c) + 12.735$

Q = CiA

Q = Peak Runoff Rate (cubic feet/second)

C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.

i = average rainfall intensity in inches per hour

A = Drainage area in acres

See comments on previous sheet

APPENDIX B.3

Supporting Hydrologic Tables and Figures

Table 6-6. Runoff Coefficients for Rational Method
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

* For buried riprap, select C_v value based on type of vegetative cover.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \qquad \text{(Eq. 6-10)}$$

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional “calibration” of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

For Colorado Springs and much of the Fountain Creek watershed, the 1-hour depths are fairly uniform and are summarized in Table 6-2. Depending on the location of the project, rainfall depths may be calculated using the described method and the NOAA Atlas maps shown in Figures 6-6 through 6-17.

Table 6-2. Rainfall Depths for Colorado Springs

Return Period	1-Hour Depth	6-Hour Depth	24-Hour Depth
2	1.19	1.70	2.10
5	1.50	2.10	2.70
10	1.75	2.40	3.20
25	2.00	2.90	3.60
50	2.25	3.20	4.20
100	2.52	3.50	4.60

Where Z= 6,840 ft/100

These depths can be applied to the design storms or converted to intensities (inches/hour) for the Rational Method as described below. However, as the basin area increases, it is unlikely that the reported point rainfalls will occur uniformly over the entire basin. To account for this characteristic of rain storms an adjustment factor, the Depth Area Reduction Factor (DARF) is applied. This adjustment to rainfall depth and its effect on design storms is also described below. The UDFCD UD-Rain spreadsheet, available on UDFCD's website, also provides tools to calculate point rainfall depths and Intensity-Duration-Frequency curves[2] and should produce similar depth calculation results.

2.2 Design Storms

Design storms are used as input into rainfall/runoff models and provide a representation of the typical temporal distribution of rainfall events when the creation or routing of runoff hydrographs is required. It has long been observed that rainstorms in the Front Range of Colorado tend to occur as either short-duration, high-intensity, localized, convective thunderstorms (cloud bursts) or longer-duration, lower-intensity, broader, frontal (general) storms. The significance of these two types of events is primarily determined by the size of the drainage basin being studied. Thunderstorms can create high rates of runoff within a relatively small area, quickly, but their influence may not be significant very far downstream. Frontal storms may not create high rates of runoff within smaller drainage basins due to their lower intensity, but tend to produce larger flood flows that can be hazardous over a broader area and extend further downstream.

- **Thunderstorms**: Based on the extensive evaluation of rain storms completed in the Carlton study (Carlton 2011), it was determined that typical thunderstorms have a duration of about 2 hours. The study evaluated over 300,000 storm cells using gage-adjusted NEXRAD data, collected over a 14-year period (1994 to 2008). Storms lasting longer than 3 hours were rarely found. Therefore, the results of the Carlton study have been used to define the shorter duration design storms.

  To determine the temporal distribution of thunderstorms, 22 gage-adjusted NEXRAD storm cells were studied in detail. Through a process described in a technical memorandum prepared by the City of Colorado Springs (City of Colorado Springs 2012), the results of this analysis were interpreted and normalized to the 1-hour rainfall depth to create the distribution shown in Table 6-3 with a 5 minute time interval for drainage basins up to 1 square mile in size. This distribution represents the rainfall

APPENDIX C

Hydraulic Calculations

Street Capacity Calculations
Inlet Capacity Calculations
Pipe Sizing Calculations
Pipe Outlet Erosion Protection Calculations
Swale Capacity Calculations

MHFD-Inlet, Version 5.01 (April 2021)

INLET MANAGEMENT

Worksheet Protected

Flows do not match DP 3 flows

Which DP &/or inlet structure?

INLET NAME	Inlet 8 (DP 3)	Shoreditch Hts	Inlet 2 (Basin F)	Inlet 4 (Basin G)	Inlet 5 (DP 6)	Redbridge Pt
Site Type (Urban or Rural)	URBAN	URBAN	URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET	STREET	STREET	STREET
Hydraulic Condition	In Sump	On Grade	On Grade	On Grade	In Sump	On Grade
Inlet Type	CDOT Type R Curb Opening		CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	

USER-DEFINED INPUT

User-Defined Design Flows						
Minor Q_{Known} (cfs)	2.7	2.7	0.3	0.7	2.0	2.0
Major Q_{Known} (cfs)	5.8	5.8	0.8	1.3	4.5	4.5
Bypass (Carry-Over) Flow from Upstream						
Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0	0.0	0.0	0.0
Watershed Characteristics						
Subcatchment Area (acres)						
Percent Impervious						
NRCS Soil Type						
Watershed Profile						
Overland Slope (ft/ft)						
Overland Length (ft)						
Channel Slope (ft/ft)						
Channel Length (ft)						
Minor Storm Rainfall Input						
Design Storm Return Period, T_r (years)						
One-Hour Precipitation, P_1 (inches)						
Major Storm Rainfall Input						
Design Storm Return Period, T_r (years)						
One-Hour Precipitation, P_1 (inches)						

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**2.7**	**2.7**	**0.3**	**0.7**	**2.0**	**2.0**
Major Total Design Peak Flow, Q (cfs)	**5.8**	**5.8**	**0.8**	**1.3**	**4.5**	**4.5**
Minor Flow Bypassed Downstream, Q_b (cfs)	N/A		0.0	0.0	N/A	
Major Flow Bypassed Downstream, Q_b (cfs)	N/A		0.0	0.0	N/A	

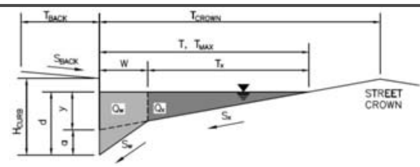
MHFD-Inlet, Version 5.01 (April 2021)

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

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

Project: North Bay at Lake Woodmoor

Inlet ID: Shoreditch Hts



Gutter Geometry:				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =			ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =			
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.5		ft
Gutter Width	W =	1.17		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.010		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.5	13.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	3.24	3.24	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	1.2	1.2	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	0.88	0.88	inches
Water Depth at Gutter Flowline	d =	4.12	4.12	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	12.3	12.3	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.255	0.255	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	4.2	4.2	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	1.4	1.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**5.6**	**5.6**	**cfs**
Flow Velocity within the Gutter Section	V =	1.4	1.4	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.5	0.5	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	21.3	21.3	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	20.1	20.1	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.158	0.158	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	15.5	15.5	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	14.3	14.3	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	2.9	2.9	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	17.2	17.2	cfs
Average Flow Velocity Within the Gutter Section	V =	1.9	1.9	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.9	0.9	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**17.2**	**17.2**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	6.00	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	1.88	1.88	inches

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**5.6**	**17.2**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

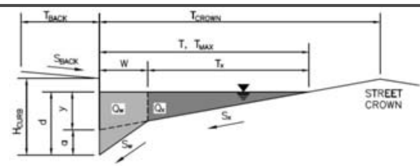
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

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

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

Project: **North Bay at Lake Woodmoor**

Inlet ID: **Redbridge Pt**



Gutter Geometry:				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =			ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =			
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	12.0		ft
Gutter Width	W =	1.17		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.030		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	12.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	2.88	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	1.2	1.2	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	0.88	0.88	inches
Water Depth at Gutter Flowline	d =	3.76	3.76	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	10.8	10.8	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.289	0.289	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	5.1	5.1	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	2.1	2.1	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**7.2**	**7.2**	**cfs**
Flow Velocity within the Gutter Section	V =	2.3	2.3	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.7	0.7	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	21.3	21.3	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\ TH}$ =	20.1	20.1	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.158	0.158	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\ TH}$	$Q_{X\ TH}$ =	26.8	26.8	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	23.4	23.4	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	5.0	5.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	28.4	28.4	cfs
Average Flow Velocity Within the Gutter Section	V =	3.3	3.3	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.6	1.6	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.74	0.74	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**21.2**	**21.2**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	5.37	5.37	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	1.61	1.61	inches

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**7.2**	**21.2**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

MHFD-Inlet, Version 5.01 (April 2021)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	Inlet 8 (DP 3)	Shoreditch Hts	Inlet 2 (Basin F)	Inlet 4 (Basin G)	Inlet 5 (DP 6)	Redbridge Pt
Site Type (Urban or Rural)	URBAN	URBAN	URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET	STREET	STREET	STREET
Hydraulic Condition	In Sump	On Grade	On Grade	On Grade	In Sump	On Grade
Inlet Type	CDOT Type R Curb Opening		CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	

USER-DEFINED INPUT

User-Defined Design Flows						
Minor Q_{Known} (cfs)	2.7	2.7	0.3	0.7	2.0	2.0
Major Q_{Known} (cfs)	5.8	5.8	0.8	1.3	4.5	4.5
Bypass (Carry-Over) Flow from Upstream						
Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0	0.0	0.0	0.0
Watershed Characteristics						
Subcatchment Area (acres)						
Percent Impervious						
NRCS Soil Type						
Watershed Profile						
Overland Slope (ft/ft)						
Overland Length (ft)						
Channel Slope (ft/ft)						
Channel Length (ft)						
Minor Storm Rainfall Input						
Design Storm Return Period, T_r (years)						
One-Hour Precipitation, P_1 (inches)						
Major Storm Rainfall Input						
Design Storm Return Period, T_r (years)						
One-Hour Precipitation, P_1 (inches)						

CALCULATED OUTPUT

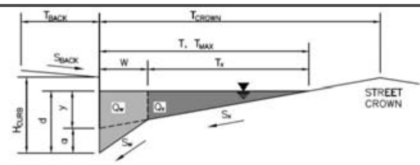
Minor Total Design Peak Flow, Q (cfs)	**2.7**	**2.7**	**0.3**	**0.7**	**2.0**	**2.0**
Major Total Design Peak Flow, Q (cfs)	**5.8**	**5.8**	**0.8**	**1.3**	**4.5**	**4.5**
Minor Flow Bypassed Downstream, Q_b (cfs)	N/A		0.0	0.0	N/A	
Major Flow Bypassed Downstream, Q_b (cfs)	N/A		0.0	0.0	N/A	

MHFD-Inlet, Version 5.01 (April 2021)

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

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

Project: North Bay at Lake Woodmoor
Inlet ID: Inlet 8 (DP 3)



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	30.0	ft
Gutter Width	W =	1.17	ft
Street Transverse Slope	S_X =	0.010	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.0	30.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread

		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.16	3.60	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	1.2	1.2	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.02	1.02	inches
Water Depth at Gutter Flowline	d =	3.18	4.62	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	16.8	28.8	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.222	0.123	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth

		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	41.5	41.5	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\ TH}$ =	40.3	40.3	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.086	0.086	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\ TH}$	$Q_{X\ TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

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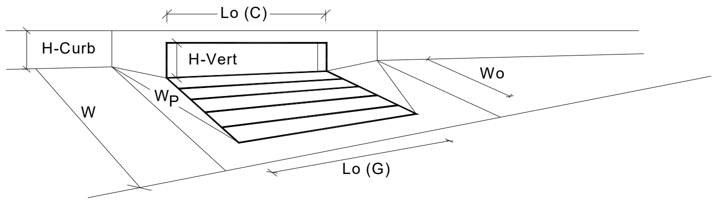
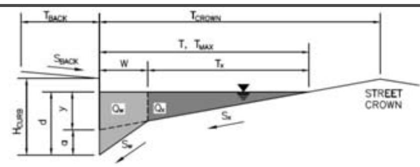


		MINOR	MAJOR	
Design Information (Input) — CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	3.6	6.0	inches
Grate Information		MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	1.17	1.17	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Grate Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate Capacity as a Weir (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	N/A	N/A	cfs
Interception with Clogging	Q_{wa} =	N/A	N/A	cfs
Grate Capacity as a Orifice (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	N/A	N/A	cfs
Interception with Clogging	Q_{oa} =	N/A	N/A	cfs
Grate Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	N/A	N/A	cfs
Interception with Clogging	Q_{ma} =	N/A	N/A	cfs
Resulting Grate Capacity (assumes clogged condition)	**Q_{Grate} =**	**N/A**	**N/A**	**cfs**
Curb Opening Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.25	1.25	
Clogging Factor for Multiple Units	Clog =	0.06	0.06	
Curb Opening as a Weir (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	3.0	10.4	cfs
Interception with Clogging	Q_{wa} =	2.8	9.8	cfs
Curb Opening as an Orifice (based on Modified HEC22 Method)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	15.4	19.5	cfs
Interception with Clogging	Q_{oa} =	14.4	18.3	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	6.3	13.3	cfs
Interception with Clogging	Q_{ma} =	5.9	12.4	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	**Q_{Curb} =**	**2.8**	**9.8**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	10.00	10.00	feet
Resultant Street Flow Spread (based on street geometry from above)	T =	21.5	41.5	ft.>T-Crown
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	1.4	inches
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.20	0.40	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.34	0.57	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.75	0.93	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**2.8**	**9.8**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	2.7	5.8	cfs

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

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

Project: **North Bay at Lake Woodmoor**
Inlet ID: **Inlet 2 (Basin F)**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	12.0	ft
Gutter Width	W =	1.17	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.013	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	12.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	2.88	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	1.2	1.2	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	0.88	0.88	inches
Water Depth at Gutter Flowline	d =	3.76	3.76	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	10.8	10.8	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.289	0.289	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	3.4	3.4	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	1.4	1.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**4.8**	**4.8**	**cfs**
Flow Velocity within the Gutter Section	V =	1.5	1.5	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.5	0.5	

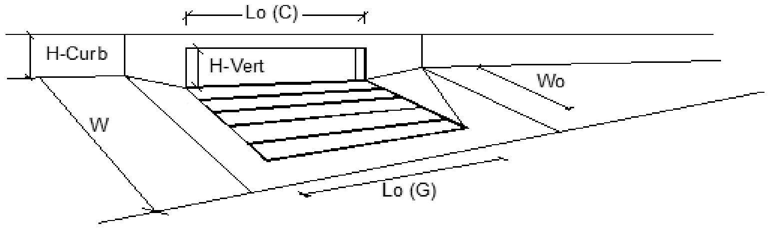
Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	21.3	21.3	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\ TH}$ =	20.1	20.1	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.158	0.158	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\ TH}$	$Q_{X\ TH}$ =	17.9	17.9	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	15.6	15.6	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	3.4	3.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	19.0	19.0	cfs
Average Flow Velocity Within the Gutter Section	V =	2.2	2.2	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.1	1.1	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**19.0**	**19.0**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	6.00	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	2.24	2.24	inches

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**4.8**	**19.0**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)

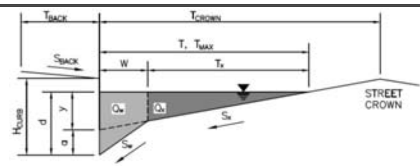


Design Information (Input) — CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	0.3	0.8	cfs
Water Spread Width	T =	3.4	5.7	ft
Water Depth at Flowline (outside of local depression)	d =	1.7	2.2	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.839	0.595	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.0	0.3	cfs
Discharge within the Gutter Section W	Q_w =	0.3	0.5	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.11	0.16	sq ft
Velocity within the Gutter Section W	V_W =	2.3	2.9	fps
Water Depth for Design Condition	d_{LOCAL} =	4.7	5.2	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.252	0.185	ft/ft
Required Length L_T to Have 100% Interception	L_T =	2.02	3.85	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	2.02	3.85	ft
Interception Capacity	Q_i =	0.3	0.8	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	4.50	4.50	ft
Actual Interception Capacity	**Q_a =**	**0.3**	**0.8**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.0**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.3**	**0.8**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100**	**100**	**%**

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

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

Project: **North Bay at Lake Woodmoor**
Inlet ID: **Inlet 4 (Basin G)**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	12.0	ft
Gutter Width	W =	1.17	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.013	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	12.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	2.88	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	1.2	1.2	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	0.88	0.88	inches
Water Depth at Gutter Flowline	d =	3.76	3.76	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	10.8	10.8	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.289	0.289	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	3.4	3.4	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	1.4	1.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**4.7**	**4.7**	**cfs**
Flow Velocity within the Gutter Section	V =	1.5	1.5	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.5	0.5	

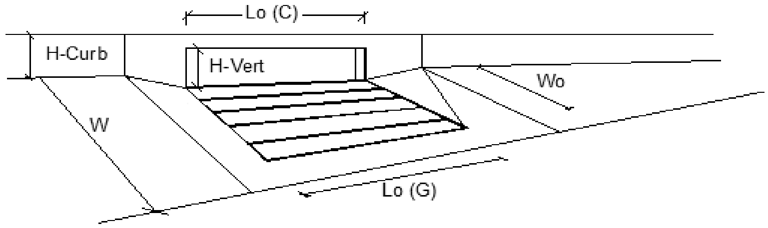
Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	21.3	21.3	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	20.1	20.1	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.158	0.158	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	17.7	17.7	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	15.4	15.4	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	3.3	3.3	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	18.7	18.7	cfs
Average Flow Velocity Within the Gutter Section	V =	2.1	2.1	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.1	1.1	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	1.00	1.00	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**18.7**	**18.7**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	6.00	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	2.24	2.24	inches

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**4.7**	**18.7**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)

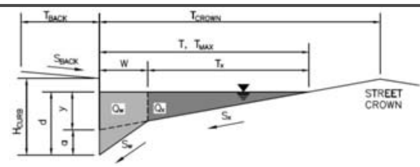


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening	CDOT Type R Curb Opening	
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	0.7	1.3	cfs
Water Spread Width	T =	5.4	7.1	ft
Water Depth at Flowline (outside of local depression)	d =	2.2	2.6	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.624	0.490	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.3	0.7	cfs
Discharge within the Gutter Section W	Q_w =	0.4	0.6	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.15	0.19	sq ft
Velocity within the Gutter Section W	V_W =	2.8	3.3	fps
Water Depth for Design Condition	d_{LOCAL} =	5.2	5.6	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o-GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**
Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.192	0.155	ft/ft
Required Length L_T to Have 100% Interception	L_T =	3.52	5.33	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	3.52	5.00	ft
Interception Capacity	Q_i =	0.7	1.3	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	4.50	4.50	ft
Actual Interception Capacity	**Q_a =**	**0.7**	**1.3**	**cfs**
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	**Q_b =**	**0.0**	**0.0**	**cfs**
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.7**	**1.3**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100**	**96**	**%**

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

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

Project: **North Bay at Lake Woodmoor**
Inlet ID: **Inlet 5 (DP 6)**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	12.0	ft
Gutter Width	W =	1.17	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

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

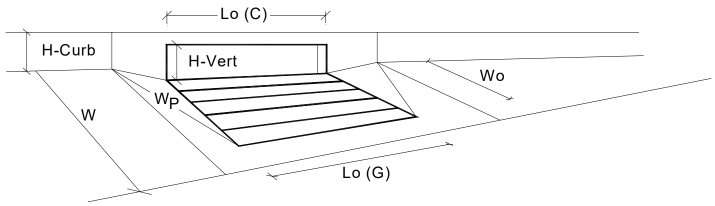
Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	2.88	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	1.2	1.2	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	0.88	0.88	inches
Water Depth at Gutter Flowline	d =	3.76	3.76	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	10.8	10.8	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.289	0.289	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	21.3	21.3	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\ TH}$ =	20.1	20.1	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.158	0.158	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\ TH}$	$Q_{X\ TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)

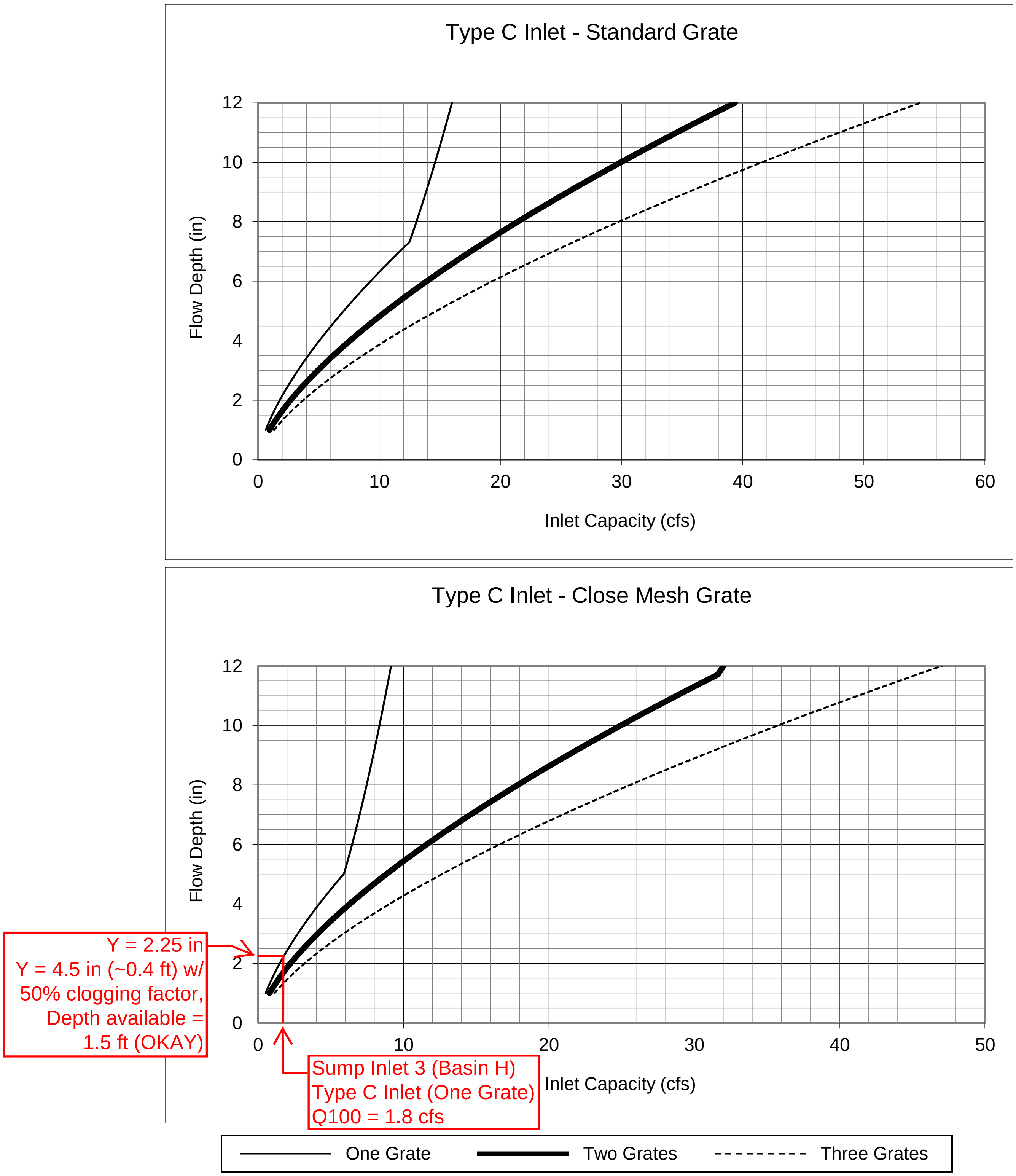


Design Information (Input)	CDOT Type R Curb Opening	MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	3.8	6.0	inches
Grate Information		MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	1.17	1.17	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.22	0.40	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.48	0.77	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**2.3**	**5.9**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	2.0	4.5	cfs

Figure 8-10. Inlet Capacity Chart Sump Conditions, Area (Type C) Inlet



Notes:

1. The standard inlet parameters must apply to use these charts.

North Bay at Lake Woodmoor
Pipe Diameter Calculations

Pipe #	100yr Flow	Design Flow	Contributing Flows	Manning 'n'	Pipe Slope	Calculated Pipe Diameter	**Pipe Diameter**	Minimum Slope of Pipe	Full Pipe Flow Velocity	Head above Pipe Flowline	H	Pipe Inlet Control Capacity	**Mannings Pipe Capacity**	Capacity Check
S10	6.6 cfs	6.6 cfs	DP 2	0.013	**5.0%**	11-inch	**18-inch**	0.40%	13.3 ft/sec	2.5 ft	1.8 ft	12.2 cfs	**23.6 cfs**	OK
S20a	11.7 cfs	11.7 cfs	DP 3	0.013	**5.0%**	14-inch	**18-inch**	1.25%	13.3 ft/sec	2.5 ft	1.8 ft	12.2 cfs	**23.6 cfs**	OK
S20b	11.7 cfs	11.7 cfs	DP 3	0.013	**5.0%**	14-inch	**18-inch**	1.25%	13.3 ft/sec	2.5 ft	1.8 ft	12.2 cfs	**23.6 cfs**	OK
S30	2.2 cfs	2.2 cfs	Basin E	0.013	**3.0%**	8-inch	**18-inch**	0.04%	10.3 ft/sec	2.5 ft	1.8 ft	12.2 cfs	**18.2 cfs**	OK
S31a	29.6 cfs	29.6 cfs	DP 4	0.013	**1.8%**	24-inch	**24-inch**	1.72%	9.7 ft/sec	5.0 ft	4.0 ft	32.8 cfs	**30.4 cfs**	OK
S31b	29.6 cfs	29.6 cfs	DP 4	0.013	**1.8%**	24-inch	**24-inch**	1.72%	9.7 ft/sec	5.0 ft	4.0 ft	32.8 cfs	**30.4 cfs**	OK
S31c	29.6 cfs	29.6 cfs	DP 4	0.013	**1.8%**	24-inch	**24-inch**	1.72%	9.7 ft/sec	5.0 ft	4.0 ft	32.8 cfs	**30.4 cfs**	OK
S40a	0.8 cfs	0.8 cfs	Basin F	0.013	**1.0%**	7-inch	**18-inch**	0.01%	6.0 ft/sec	2.5 ft	1.8 ft	12.2 cfs	**10.5 cfs**	OK
S40b	0.8 cfs	0.8 cfs	Basin F	0.013	**1.0%**	7-inch	**18-inch**	0.01%	6.0 ft/sec	2.5 ft	1.8 ft	12.2 cfs	**10.5 cfs**	OK
S41	1.8 cfs	1.8 cfs	Basin H	0.013	**1.0%**	9-inch	**18-inch**	0.03%	6.0 ft/sec	2.5 ft	1.8 ft	12.2 cfs	**10.5 cfs**	OK
S42	3.7 cfs	3.7 cfs	DP 5	0.013	**1.0%**	12-inch	**18-inch**	0.13%	6.0 ft/sec	2.5 ft	1.8 ft	12.2 cfs	**10.5 cfs**	OK
S43	4.5 cfs	4.5 cfs	DP 6	0.013	**1.0%**	13-inch	**18-inch**	0.18%	6.0 ft/sec	2.5 ft	1.8 ft	12.2 cfs	**10.5 cfs**	OK
S44a	7.6 cfs	7.6 cfs	DP 7	0.013	**1.0%**	16-inch	**18-inch**	0.53%	6.0 ft/sec	2.5 ft	1.8 ft	12.2 cfs	**10.5 cfs**	OK
S44b	7.6 cfs	7.6 cfs	DP 7	0.013	**1.0%**	16-inch	**18-inch**	0.53%	6.0 ft/sec	2.5 ft	1.8 ft	12.2 cfs	**10.5 cfs**	OK
S44c	7.6 cfs	7.6 cfs	DP 7	0.013	**1.0%**	16-inch	**18-inch**	0.53%	6.0 ft/sec	2.5 ft	1.8 ft	12.2 cfs	**10.5 cfs**	OK
S45	8.1 cfs	8.1 cfs	DP 8	0.013	**1.0%**	16-inch	**18-inch**	0.59%	6.0 ft/sec	2.5 ft	1.8 ft	12.2 cfs	**10.5 cfs**	OK

Equations:

Pipe Dia=$((2.16Qn)/(S^{0.5}))^{0.375}$
- Q = Discharge in cubic feet per second
- n = Manning's roughness coefficient
  - RCP=0.013, CMP=0.024, HDPE (smooth)=0.012
- S = Slope of the pipe
- R_h = Hydraulic Radius

Flow Velocity = $(1.49/n)R_h^{2/3} S^{1/2}$

Pipe Capacity = $(1.49/n)AR_h^{2/3} S^{1/2}$
- A = Cross-sectional area of pipe
- A=p $(D^2/4)$
- D = Inside Diameter of Pipe

$R_h = A_w/W_p$
- $A_w = p(d^2/4)$
  - A_w = Water Cross Sectional Area
  - d = Water (Flow) Depth Within Pipe
- W_p = pd (For Capacity Calculation)
  - W_p=Wetted Perimeter of Pipe

Orifice Equation:

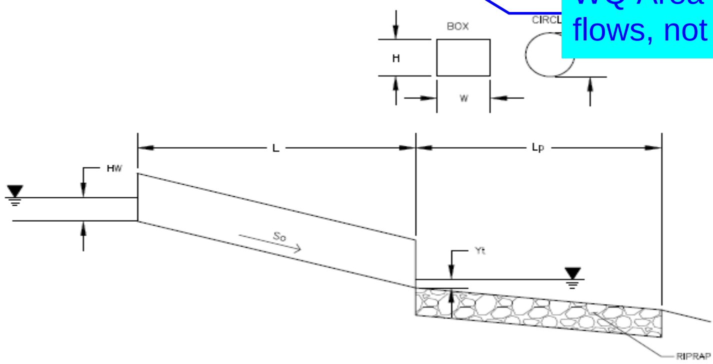
$Q = CA(2gH)^{0.5}$
- C = Orifice coefficient (dimensionless)
  - C = 0.65
- A = Cross-sectional area of opening, in sf
- g = Gravitational accel constant, 32.2 ft/sec^2
- H = Head above centerline of pipe, ft

Pipe sizing will be reviewed with Final Drainage Report

Determination of Culvert Headwater and Outlet Protection

Project: North Bay at Lake Woodmoor
Basin ID: 18" RCP (Pipe No. S45, DP 8)

WQ Area 4 release flows, not DP-8.



Soil Type:
Choose One:
- Sandy
- (●) Non-Sandy

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

Design Discharge	Q =	8.1	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	18	inches
Inlet Edge Type (Choose from pull-down list)		Square End Projection	
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	No =	1	
Inlet Elevation	Elev IN =	7109.07	ft
Outlet Elevation **OR** Slope	Elev OUT =	7108	ft
Culvert Length	L =	42.69	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =	7107	ft
Max Allowable Channel Velocity	V =	5	ft/s

Tailwater ELEVATION is less than outlet elevation, using 0.4 x RISE as Yt

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.60	ft
Flow Area at Max Channel Velocity	A_t =	1.62	ft^2
Culvert Cross Sectional Area Available	A =	1.77	ft^2
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	0.77	
Sum of All Losses Coefficients	k_s =	2.27	ft
Culvert Normal Depth	Y_n =	0.74	ft
Culvert Critical Depth	Y_c =	1.10	ft
Tailwater Depth for Design	d =	1.30	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	1.12	ft
Expansion Factor	1/(2*tan(Θ)) =	6.25	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	2.94	$ft^{0.5}/s$
Froude Number	Fr =	2.17	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.54	
Inlet Control Headwater	HW_I =	1.85	ft
Outlet Control Headwater	HW_O =	0.97	
Design Headwater Elevation	**HW =**	**7,110.92**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.23**	
Minimum Theoretical Riprap Size	d_{50} =	4	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	~~VL~~	Use Type L min.
Length of Protection	**L_p =**	**8**	**ft**
Width of Protection	**T =**	~~3~~	**ft** Use 5ft wide min.

Will review with Final Drainage Report along with final design of WQ facility

0.9 cfs

How is flow depth determined?

North Bay at Lake Woodmoor
Swale and Channel Capacity Calculations

Description	Design Flow	Bottom Width	Channel Side Slope		Flow Depth	Channel Slope	Manning "n"	Top Width	Channel Area	Wetted Perimeter	Hydraulic Radius	Flow Velocity	Shear Stress	Channel Flow Capacity	Swale / Channel Type
			Left	Right											
2' Concrete Pan Basin B	0.8 cfs	0.0 ft	6:1	6:1	0.17 ft	4.4%	0.013	2.0 ft	0.17 sf	2.1 ft	0.08 ft	4.6 ft/sec	0.47 psf	**0.8 cfs**	2' Concrete Pan
Water Quality Area 1 Overflow Swale	6.6 cfs	0.0 ft	36:1	36:1	0.33 ft	1.9%	0.035	23.4 ft	3.80 sf	23.4 ft	0.16 ft	1.7 ft/sec	0.39 psf	**6.6 cfs**	Grass-lined
Water Quality Area 3 Overflow Swale	2.2 cfs	2.0 ft	3:1	3:1	0.34 ft	1.70%	0.035	4.0 ft	1.03 sf	4.2 ft	0.25 ft	2.2 ft/sec	0.36 psf	**2.2 cfs**	Grass-lined

Equations:

Area (A) = $b(d)+zd^2$
b = width
d = depth

Perimeter (P) = $b+2d*(1+z^2)^{0.5}$
z = side slope
Hydraulic Radius = A/P

Velocity = $(1.49/n)R_h^{2/3}S^{1/2}$
S = Slope of the channel
n = Manning's number
R_h = Hydraulic Radius
Flow = $(1.49/n)AR_h^{2/3}S^{1/2}$

Shear Stress = 62.4*d*S
62.4 = specific weight of water (lb/ft^3)
d = flow depth (ft)
S = slope of channel

Include Froude # for swales.

Include calculations for swale in Basin C.

APPENDIX D

Detention Calculations

Detention Volume Calculations

North Bay at Lake Woodmoor
Detention Calculations

MHFD Detention Sizing

Detention Area	Total Acres	% Imperv.	Soil Group	100yr P_1	WQCV a	WQCV Z	WQCV Depth	WQCV Factor	WQCV Volume	EURV Depth	EURV Volume	K_{100}	V_{100}	**Required Detention Volume** **V100+1/2WQCV**
Detention Req. for Site (as Designed)	7.23 ac	38.4%	D	2.52in	1.0	1.0	0.18in	0.015	0.106ac-ft 4,607 cf	0.43in	0.257ac-ft 11,201 cf	0.996	0.60ac-ft 26,127 cf	**0.65 ac-ft** **28,431 cf**
Detention Req. for Site (DBPS Proposed Land Use)	7.23 ac	25.0%	D	2.52in	1.0	1.0	0.13in	0.011	0.081ac-ft 3,538 cf	0.27in	0.162ac-ft 7,046 cf	0.811	0.49ac-ft 21,285 cf	**0.53 ac-ft** **23,054 cf**
												Difference		**0.12 ac-ft** **5,376 cf**

Additional 100-yr Volume to Lake Woodmoor

WIR (Watershed Inches of Runoff) taken from Fig. EDB-2, Volume 3, Urban Storm Drainage Criteria Manual for the basin imperviousness shown.

WIR = Depth = $a*(0.91*I^3 - 1.19*I^2 + 0.78*I)$

I = % Impervious

a = Drain Time

Extended Detention Basin

a (40hr) =	1.0
a (24hr) =	0.9
a (12hr) =	0.8

WQCV Factor (Water Quality Capture Volume) = (WIR/12) x Z

Z = Volume Factor

Z (Extended Detention Basin) = 1.0

2015 USDCM

V_{100}
V_{100}+1/2WQCV
V_{100}+WQCV
V_{100}+1/2EURV

$EURV_k$ = Depth = Excess Urban Runoff Volume in watershed inshes (K = A, B or CD)

$EURV_A = 1.68\ i^{1.28}$ (USDCM, Eqn 12-1)

$EURV_B$ = 1.36 i1.08 (USDCM, Eqn 12-2)

$EURV_{CD}$ = 1.20 i1.08 (USDCM, Eqn 12-3)

Required Detention Storage Volume (Vx) = Kx A (Equation SO-1)

$K_2=P_1((0.968i^{1.458})A\%+(0.964i^{1.183})B\%+(0.962i^{1.104})CD\%)$

$K_5=P_1((0.973i^{1.368})A\%+(0.900i^{1.098}+0.082i^{0.098})B\%+(0.795i^{1.226}+0.159i^{0.226})CD\%)$

$K_{10}=P_1((0.988i^{1.237})A\%+(0.751i^{1.254}+0.174i^{0.254})B\%+(0.630i^{1.371}+0.248i^{0.371})CD\%)$

$K_{100}=P_1((0.728i^{1.258}+0.150i^{0.258})A\%+(0.364i^{1.286}+0.381i^{0.286})B\%+(0.306i^{1.286}+0.402i^{0.286})CD\%)$

K_x=(in inches)(USDCM, Eqn 12-4 and UDFCD Runoff and Detention Storage Volumes Memo 2015-03-26)

Recommended Release Rate = 90% of Predevelopment Flow

<u>Approximate effect to Lake Woodmoor from additional volume generated from North Bay at Lake Woodmoor site:</u>

Area of Lake: A = 2,010,670 sf = 46.16 ac

46.16 ac / 7.23 ac = 6.38 (Lake is over 6 times larger than site)

Additional Volume = 5,376 cf

Approximate Increase in Lake Level: 5,376 cf / 2,010,670 sf = **0.0027 ft = 0.03 in**

APPENDIX E

Water Quality Area Calculations

Volume Calculations
Emergency Spillway Calculations

Need to provide volume calculations for Water Quality Area 2. Provide a deviation for underground water quality (See Appendix I.7.3)

Include in report if soils are adequate to support rain garden facilities. Reference soils report.

North Bay at Lake Woodmoor
Detention Area Calculations

MHFD Water Quality Sizing

Detention Area	Total Acres	% Imperv.	Soil Group	100yr P_1	WQCV a	WQCV Z	WQCV Depth	WQCV Factor	WQCV Volume	V_5 See Below
WQ Area 1	0.78 ac	16.0%	D	2.52in	0.8	1.0	0.08in	0.007	0.005ac-ft 222 cf	0.02ac-ft 755 cf

WIR (Watershed Inches of Runoff) taken from Fig. EDB-2, Volume 3, Urban Storm Drainage Criteria Manual for the basin imperviousness shown.

WIR = Depth = $a*(0.91*I^3 - 1.19*I^2 + 0.78*I)$

I = % Impervious a = Drain Time

a (40hr) = 1.0	Extended Detention Basin
a (24hr) = 0.9	
a (12hr) = 0.8	

WQCV Factor (Water Quality Capture Volume) = (WIR/12) x Z

Z = Volume Factor

Z (Porous Landscape Detention) = 1.0 2015 USDCM

Water Quality Area 1 Earthwork

Elevation	Area (A)	Avg. Area	Volume	Depth	Cumulative Volume		Elev.
7122.3	310sf	Media Surface			**0cf**	**0.00ac-ft**	7122.3
7123	490sf	400sf	280cf	0.7 ft	**280cf**	**0.01ac-ft**	7123
7124	780sf	635sf	635cf	1.7 ft	**915cf**	**0.02ac-ft**	7124
7125	1,140sf	960sf	960cf	2.7 ft	**1,875cf**	**0.04ac-ft**	7125
		---	---	---	**---**	**---**	---

Average End Area Formula: V = (A1+A2)/2 x Elev Difference

			Elevation	Depth
Media Surface =			7122.30 ft	0.00 ft
WQCV =	222 cf	0.005 ac-ft	7122.86 ft	0.56 ft
5yr Volume =	755 cf	0.017 ac-ft	7123.75 ft	1.45 ft
5yr Detention Freeboard Depth =			0.05 ft	
Spillway Crest =	788 cf	0.02 ac-ft	7123.80 ft	1.50 ft
Spillway 100yr Flow Depth =	1,011 cf	0.02 ac-ft	7124.10 ft	1.80 ft
Spillway Freeboard Depth =			0.00 ft	
Top of Berm =	1,011 cf	0.02 ac-ft	7124.10 ft	1.80 ft

Minimum Filter Surface Area - Water Quality Area 1

A_F = 0.02AI = 0.02*0.78ac*43,560sf/ac*0.16 = <u>**108.6 sf**</u>

A_F = minimum surface area (flat surface area) (ft^2)

A = tributary area to the rain garden (ft^2)

I = imperviousness of area tributary to the sand filter (% expressed as a decimal)

Taken from Equation SF-2, Volume 3, Urban Storm Drainage Criteria Manual for sand filters.

MHFD Water Quality Sizing

Detention Area	Total Acres	% Imperv.	Soil Group	100yr P_1	WQCV a	Z	Depth	Factor	Volume	V_{100} See Below
WQ Area 3	0.53 ac	28.1%	D	2.52in	0.8	1.0	0.12in	0.010	0.005ac-ft 224 cf	0.03ac-ft 1,461 cf

WIR (Watershed Inches of Runoff) taken from Fig. EDB-2, Volume 3, Urban Storm Drainage Criteria Manual for the basin imperviousness shown.

WIR = Depth = $a*(0.91*I^3 -1.19*I^2 +0.78*I)$

I = % Impervious   a = Drain Time

a (40hr) = 1.0	Extended Detention Basin
a (24hr) = 0.9	
a (12hr) = 0.8	

WQCV Factor (Water Quality Capture Volume) = (WIR/12) x Z

Z = Volume Factor

Z (Porous Landscape Detention) = 1.0   2015 USDCM

Water Quality Area 3 Earthwork

Elevation	Area (A)	Avg. Area	Volume	Depth	Cumulative Volume		Elev.
7125	730sf	Media Surface			**0cf**	**0.00ac-ft**	7125
7125.2	980sf	855sf	171cf	0.2 ft	**171cf**	**0.00ac-ft**	7125.2
7125.4	1,260sf	1,120sf	224cf	0.4 ft	**395cf**	**0.01ac-ft**	7125.4
7125.7	1,700sf	1,480sf	444cf	0.7 ft	**839cf**	**0.02ac-ft**	7125.7
7126	2,260sf	1,980sf	594cf	1.0 ft	**1,433cf**	**0.03ac-ft**	7126
7126.1		1,130sf	113cf	1.1 ft	**1,546cf**	**0.04ac-ft**	7126.1
		---	---	---	**---**	**---**	---

Average End Area Formula: V = (A1+A2)/2 x Elev Difference

			Elevation	Depth
Media Surface =			7125.00 ft	0.00 ft
WQCV =	224 cf	0.005 ac-ft	7125.25 ft	0.25 ft
100yr Volume =	1,461 cf	0.034 ac-ft	7126.02 ft	1.02 ft
100yr Detention Freeboard Depth =			0.08 ft	
Spillway Crest =	1,546 cf	0.04 ac-ft	7126.10 ft	1.10 ft
Spillway 100yr Flow Depth =	N/A	#VALUE!	7126.30 ft	1.30 ft
Spillway Freeboard Depth =			1.00 ft	
Top of Berm =	N/A	#VALUE!	7127.30 ft	2.30 ft

Minimum Filter Surface Area - Water Quality Area 3

A_F = 0.02AI = 0.02*0.53ac*43,560sf/ac*0.281 = **129.7 sf**

A_F = minimum surface area (flat surface area) (ft^2)

A = tributary area to the rain garden (ft^2)

I = imperviousness of area tributary to the sand filter (% expressed as a decimal)

Taken from Equation SF-2, Volume 3, Urban Storm Drainage Criteria Manual for sand filters.

MHFD recommends a forebay if contributing area is larger than 1 acre.

MHFD Water Quality Sizing

Detention Area	Total Acres	% Imperv.	Soil Group	100yr P_1	WQCV a	WQCV Z	WQCV Depth	WQCV Factor	WQCV Volume	V_5
WQ Area 4	1.65 ac	56.6%	B	2.52in	0.8	1.0	0.18in	0.015	0.025ac-ft 1,079 cf	0.11ac-ft 4,578 cf

WIR (Watershed Inches of Runoff) taken from Fig. EDB-2, Volume 3, Urban Storm Drainage Criteria Manual for the basin imperviousness shown.

WIR = Depth = a*(0.91*I^3 -1.19*I^2 +0.78*I)

I = % Impervious a = Drain Time

a (40hr) = 1.0	Extended Detention Basin
a (24hr) = 0.9	
a (12hr) = 0.8	

WQCV Factor (Water Quality Capture Volume) = (WIR/12) x Z

Z = Volume Factor

Z (Porous Landscape Detention) = 1.0 2015 USDCM

Water Quality Area 4 Earthwork

Elevation	Area (A)	Avg. Area	Volume	Depth	Cumulative Volume		Elev.
7115.6	528sf	Media Surface			**0cf**	**0.00ac-ft**	7115.6
7116	665sf	597sf	239cf	0.4 ft	**239cf**	**0.01ac-ft**	7116
7117	1,100sf	883sf	883cf	1.4 ft	**1,121cf**	**0.03ac-ft**	7117
7118	1,620sf	1,360sf	1,360cf	2.4 ft	**2,481cf**	**0.06ac-ft**	7118
7119	2,260sf	1,940sf	1,940cf	3.4 ft	**4,421cf**	**0.10ac-ft**	7119
		---	---	---	**---**	**---**	---
		---	---	---	**---**	**---**	---

Average End Area Formula: V = (A1+A2)/2 x Elev Difference

			Elev.	Depth
Media Surface =			7115.60 ft	0.00 ft
WQCV =	1,079 cf	0.02 ac-ft	7116.95 ft	1.35 ft
Water Quality Freeboard Depth =			0.75 ft	
Spillway Crest =	2,073 cf	0.05 ac-ft	7117.70 ft	2.10 ft
Spillway 100yr Flow Depth =	2,481 cf	0.06 ac-ft	7118.00 ft	2.40 ft
Spillway Freeboard Depth =			1.00 ft	
Top of Berm =	4,421 cf	0.10 ac-ft	7119.00 ft	3.40 ft

Does not appear that a large enough bottom area has been provided for this design.

Minimum Filter Surface Area - Water Quality Area 4

A_F = 0.02AI = 0.02*1.65ac*43,560sf/ac*0.566 = **813.1 sf**

A_F = minimum surface area (flat surface area) (ft^2)

A = tributary area to the rain garden (ft^2)

I = imperviousness of area tributary to the sand filter (% expressed as a decimal)

Taken from Equation SF-2, Volume 3, Urban Storm Drainage Criteria Manual for sand filters.

Emergency Spillway Calculation

Water Quality Area	100-yr Flow	Water Surf Elev	Crest Elev	Crest Length	Z	C	Flow Depth (H)	**Calc'd Flow**	Check
1	6.6 cfs	7,124.1	7,123.8	6 ft	33:1	3.0	0.30 ft	6.9 cfs	OK
3	2.2 cfs	7,126.3	7,126.1	8 ft	3:1	3.0	0.20 ft	2.3 cfs	OK
4	8.1 cfs	7,118.0	7,117.7	16 ft	4:1	3.0	0.30 ft	8.4 cfs	OK

Broad Crested Weir Equation (USDCM Eqn 12-20 and 12-21):

$Q = CLH^{1.5} + 2x((2/5)CZH^{5/2})$

H = Head above weir crest, in ft

C = Weir coefficient, C = 3.0 (most cases)

Z = Side slope (horizontal:vertical)

L = Length of weir at Crest, in ft. Not including sideslopes.

Figure 13-12c. Emergency Spillway Protection

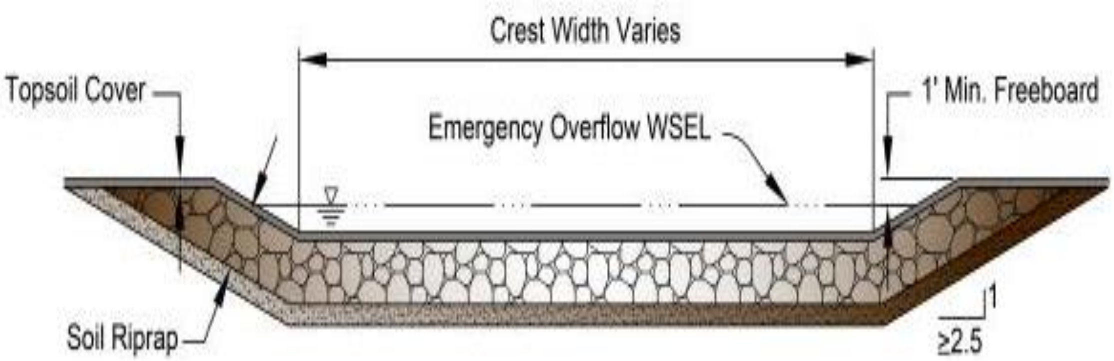
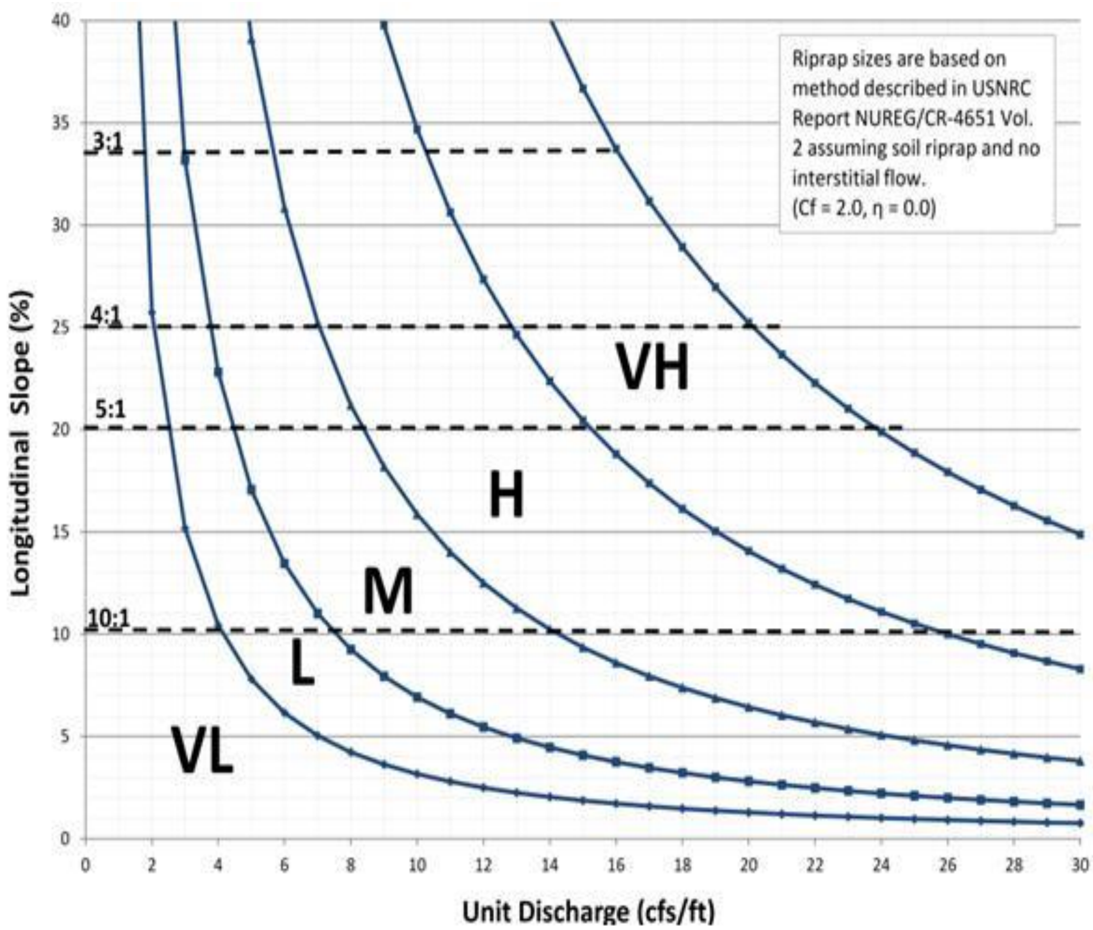
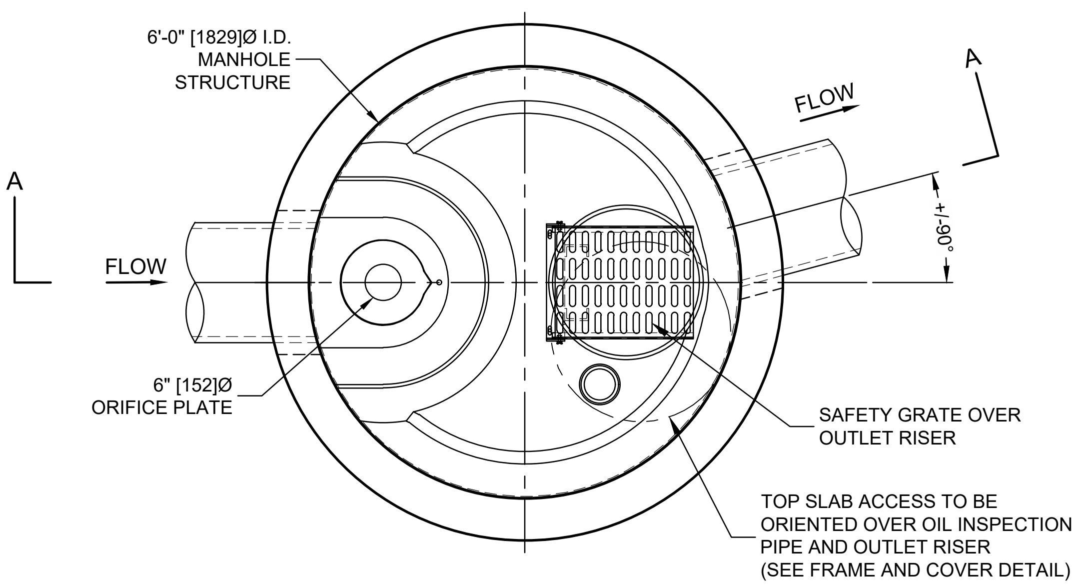
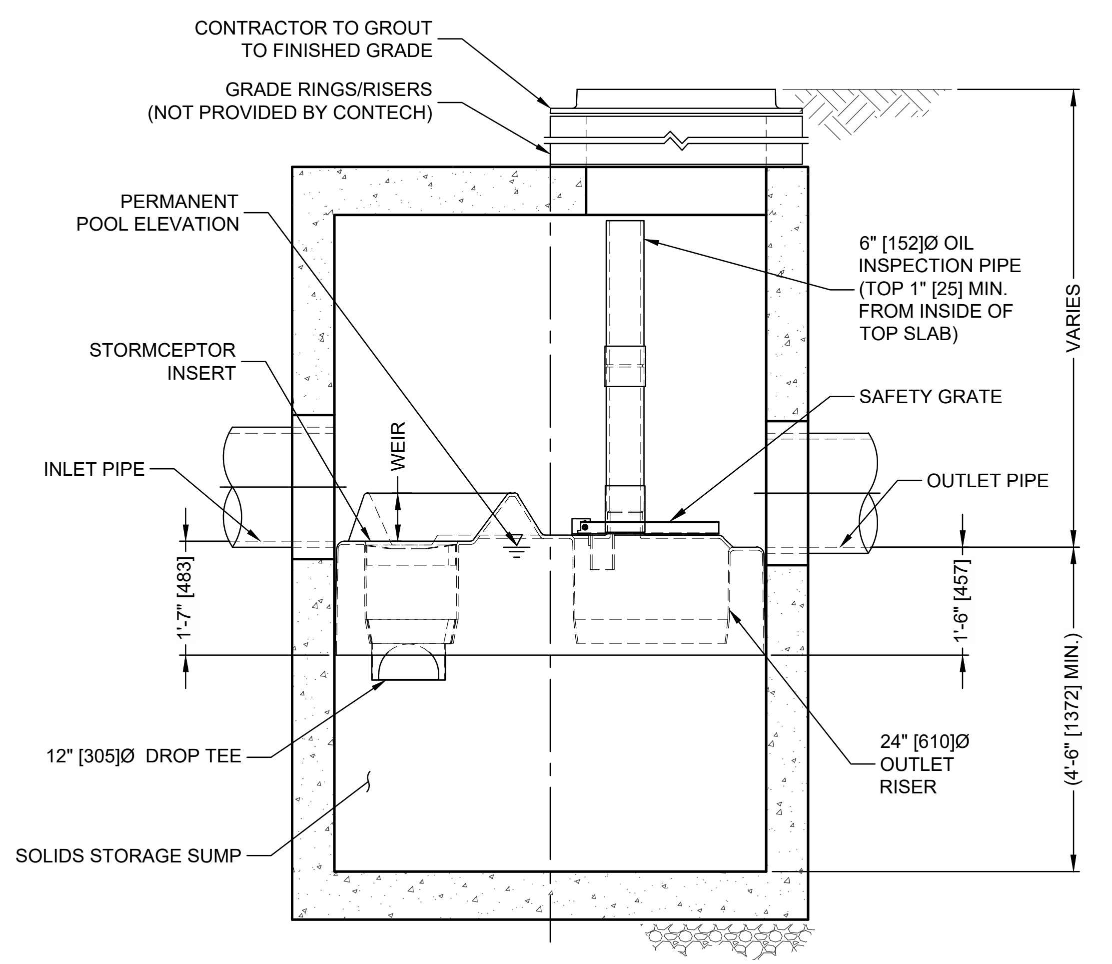


Figure 13-12d. Riprap Types for Emergency Spillway Protection





PLAN VIEW
TOP SLAB NOT SHOWN

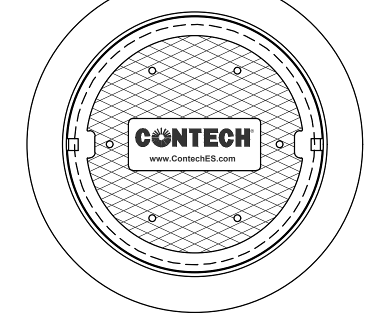


SECTION A-A

Stormceptor®
FOR PATENT INFORMATION, GO TO www.ContechES.com/IP

STORMCEPTOR DESIGN NOTES

THE STANDARD STC900 CONFIGURATION IS SHOWN.



FRAME AND COVER
(MAY VARY)
NOT TO SCALE

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			
WATER QUALITY FLOW RATE (cfs [L/s])			
PEAK FLOW RATE (cfs [L/s])			
RETURN PERIOD OF PEAK FLOW (yrs)			
RIM ELEVATION			
PIPE DATA:	INVERT	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
NOTES / SPECIAL REQUIREMENTS:			

GENERAL NOTES

1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. STORMCEPTOR WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STORMCEPTOR STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2' [610], AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.
5. STORMCEPTOR STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C478 AND AASHTO LOAD FACTOR DESIGN METHOD.
6. ALTERNATE UNITS ARE SHOWN IN MILLIMETERS [mm].

INSTALLATION NOTES

A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMCEPTOR MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH®
ENGINEERED SOLUTIONS LLC
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STC900
STORMCEPTOR
STANDARD DETAIL

APPENDIX F

Lake Fork Dirty Woman Creek Hydraulic Calculations

Improved Inlet Calculations – HY8
Emergency Overflow Structure Calculations
Outfall Structure Energy Dissipation Basin Calculations
UDSewer Input and Output Tables - 100-year Storm Event

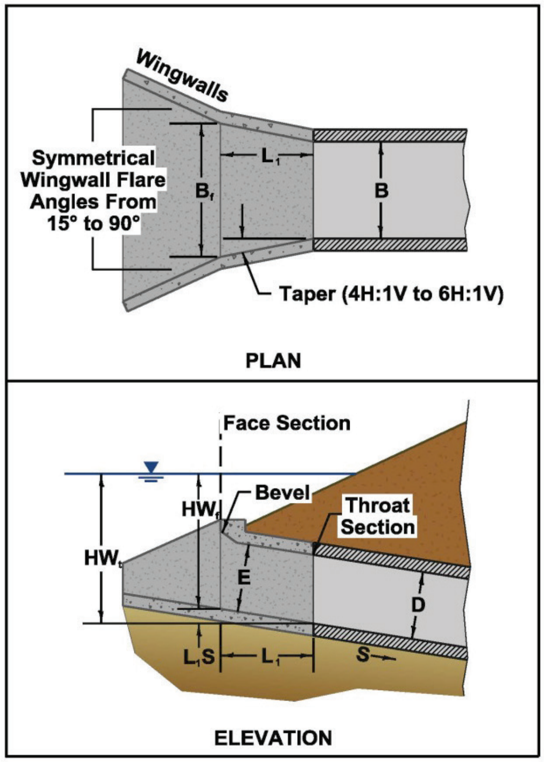


Figure 3.19. Side-tapered inlet.

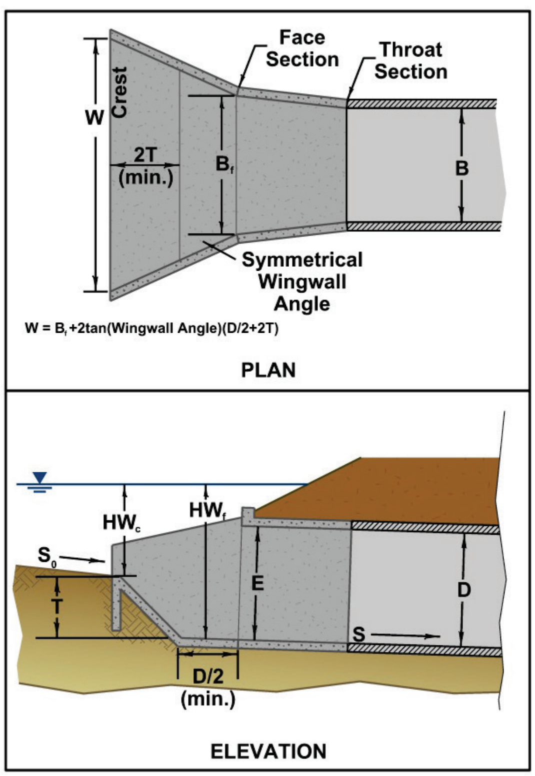


Figure 3.20. Side-tapered inlet with inlet depression.

data
with CLOMR
ppendix B.1,
80 cfs

PROJECT: North Bay at Lake Woodmoor Side-Tapered Inlet w/ Depression	STATION: ________ SHEET 1 OF 1	**TAPERED INLET DESIGN FORM** DESIGNER / DATE: CJC / 6/02/22 REVIEWER / DATE: /

DESIGN DATA: 7133.0=BACK OF WALK

Q 100 = 520 CFS; EL_{hi} 7132.0 (FT)

EL. THROAT INVERT ________ ( ) 7121.8

EL. STREAM BED AT FACE ________ ( ) 7123.8

T 2 TAPER 4 : 1 (4 : 1 TO 6 : 1)

STREAM SLOPE, S_o = ________ ( ) / ( )

SLOPE OF BARREL, S = 0.01 (FT) / (FT)

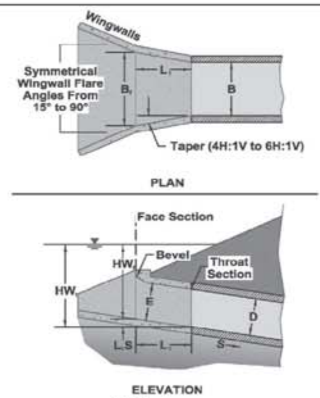
S_D 2 : 1 (2 : 1 TO 3 : 1)

BARREL SHAPE AND MATERIAL: 8' x 5' RCB

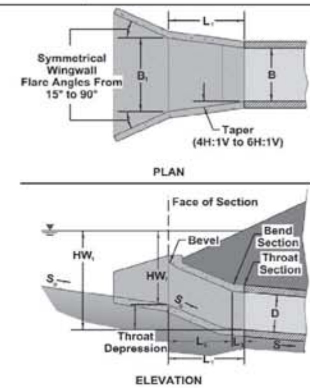
N = 1, B = 8 FT, D = 5 FT

INLET EDGE DESCRIPTION ________

2T=2(2)=4 FT



Side-taper



Slope-taper

COMMENTS

Q (CFS)	EL_{hi} (FT)	EL. Throat Invert	EL. Face Invert (1)	HW_f (2)	HW_f / E (3)	Q / B_f (4)	MIN. B_f (5)	Selected B_f	SLOPE-TAPERED ONLY: MIN. L_3 (6)	L_2 (7)	Check L_2 (8)	Adj. L_3 (9)	Adj. Taper (10)	L_1 (11)	SIDE-TAPERED w/ depression: EL. Crest Inv.	HW_c (12)	MIN. W (13)
520	7132.0	7121.8	7121.9	10.1	2.0	56	9.3	10						4	7123.8	8.2	7.8

(1) SIDE-TAPERED : EL. FACE INVERT = EL. THROAT INVERT + 1 FT (0.3 M APPROX.)
SLOPE-TAPERED : EL. FACE INVERT = EL. STREAM BED AT FACE

(2) $HW_f = EL_{hi}$ - EL. FACE INVERT

(3) $1.1\,D \geq E \geq D$; E = D FOR BOX CULVERTS E=D=5
10.1/5=2.0

(4) FROM DESIGN CHARTS Chart 58B

(5) MIN. $B_f = Q / (Q / B_f)$ 520 / 56 = 9.3

(6) MIN. L_3 = 0.5 NB

(7) L_2 = (EL. FACE INVERT- EL. THROAT INVERT) S_D

(8) CHECK $L_2 = \left[\frac{B_f - NB}{2}\right]$ TAPER $- L_3$

(9) If (8)>(7), ADJ. $L_3 = \left[\frac{B_f - NB}{2}\right]$. TAPER - L_2

(10) If (7) >(8), ADJ. TAPER = $(L_2 + L_3) / \left[\frac{B_f - NB}{2}\right]$

(11) SIDE-TAPERED : $L = \left[\frac{B_f - NB}{2}\right]$ TAPER [(10 - 1 (8)) / 2] x 4 = 4
SLOPE-TAPERED : $L_1 = L_2 + L_3$

(12) $HW_C = EL_{hi}$ - EL. CREST INVERT 7132.0-7123.8=8.2

(13) MIN. $W = K_u\, Q / HW_c^{1.5}$ Where K_u = 0.35 (0.64 SI)
W = 0.35 (520) / 8.2^1.5 = 7.8 min.

SELECTED DESIGN

B_f ________

L_1 ________

L_2 ________

L_3 ________

BEVELS ANGLE ________

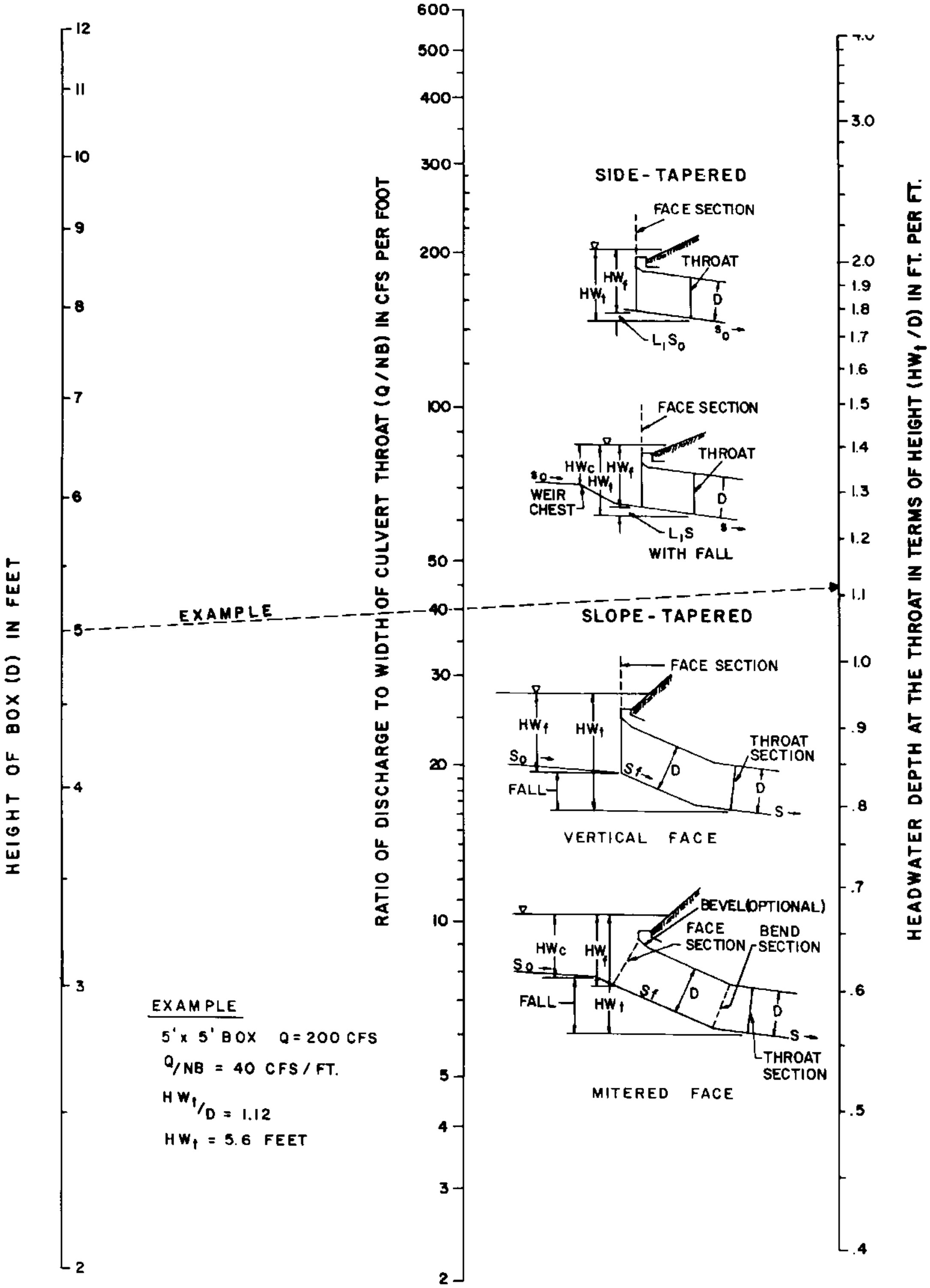
b = ____ ( ); d = ____ ( )

TAPER ________ : 1

S_D = ________ : 1

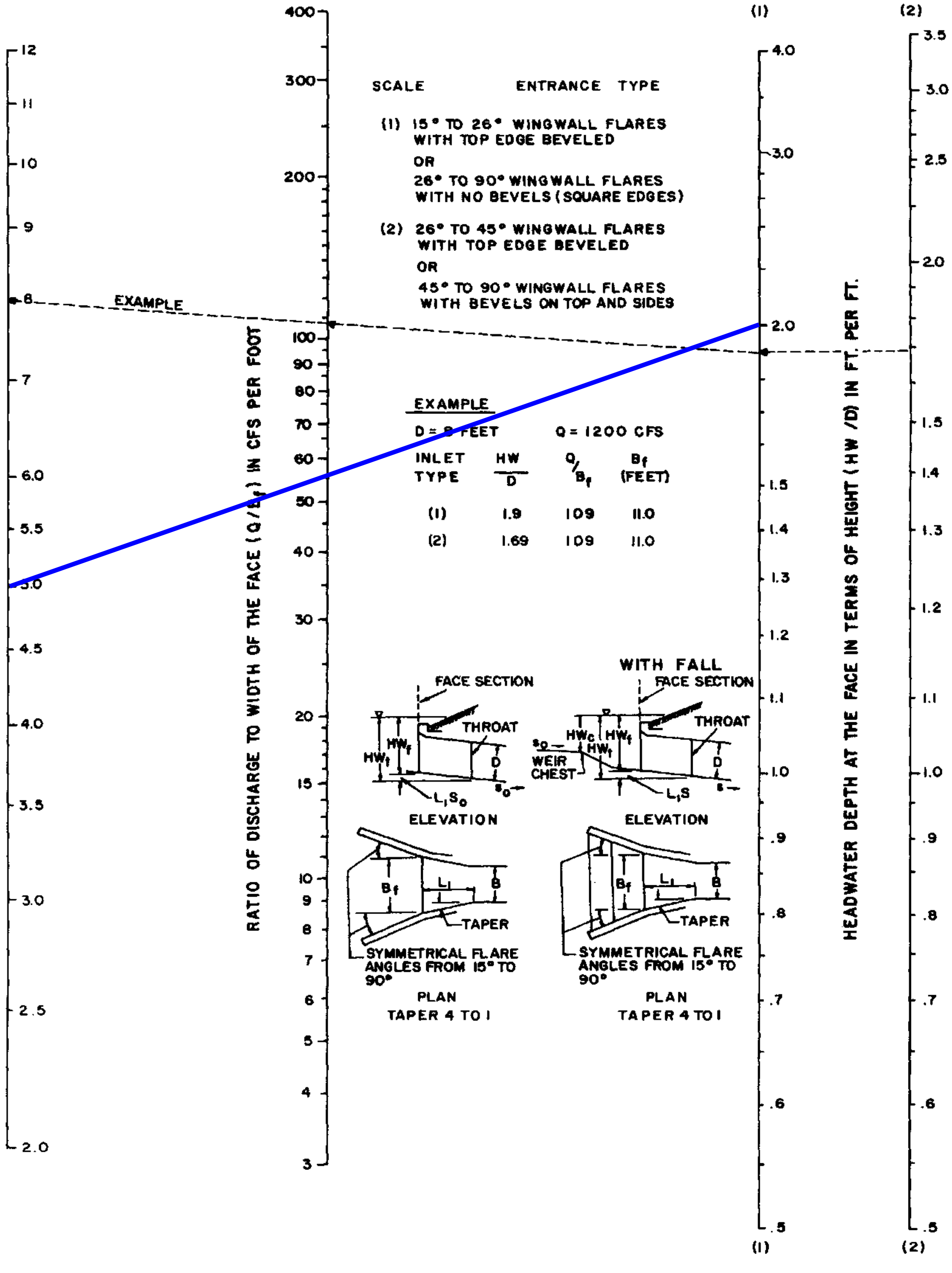
Figure 3.24. Tapered inlet design form.

CHART 57B



THROAT CONTROL FOR BOX CULVERTS WITH TAPERED INLETS

CHART 58B



FACE CONTROL FOR BOX CULVERTS WITH SIDE TAPERED INLETS

Crossing Data - North Bay at Lake Woodmoor

Crossing Properties

Name: North Bay at Lake Woodmoor

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	Minimum, Design, and Maximum	
Minimum Flow	1.000	cfs
Design Flow	520.000	cfs
Maximum Flow	520.000	cfs
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	7121.160	ft
Constant Tailwater Elevation	7126.160	ft
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.000	ft
Crest Length	50.000	ft
Crest Elevation	7133.000	ft
Roadway Surface	Paved	
Top Width	40.000	ft

Information on sheet is not readable. Please reprint.

Culvert Properties

Culvert 1

Add Culvert

Duplicate Culvert

Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Culvert 1	
Shape	Concrete Box	
Material	Concrete	
Span	8.000	ft
Rise	5.000	ft
Embedment Depth	0.000	in
Manning's n	0.013	
Culvert Type	Side-Tapered	
Tapered Inlet Edge	Beveled Edge Top (26-45°) Wingwall	
Face Width	10.000	ft
Side Taper (4:1 to 6:1)	4.000	_:1
Inlet Depression?	Yes	
Depression	2.000	ft
Depression Slope (2-3)	2.000	(_:1)
Crest Width	8.250	ft
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.000	ft
Inlet Elevation	7123.770	ft
Outlet Station	60.660	ft
Outlet Elevation	7121.160	ft
Number of Barrels	1	

Help | Click on any icon for help on a specific topic | Low Flow | AOP | Energy Dissipation | Analyze Crossing | OK | Cancel

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: North Bay at Lake Woodmoor

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7126.16	1.00	1.00	0.00	1
7126.20	52.90	52.90	0.00	1
7126.79	104.80	104.80	0.00	1
7127.63	156.70	156.70	0.00	1
7128.38	208.60	208.60	0.00	1
7129.06	260.50	260.50	0.00	1
7129.71	312.40	312.40	0.00	1
7130.32	364.30	364.30	0.00	1
7130.90	416.20	416.20	0.00	1
7131.45	468.10	468.10	0.00	1
7131.99	520.00	520.00	0.00	1
7133.00	622.74	622.74	0.00	Overtopping

HY-8 Analysis Results

Culvert Summary Table - Culvert 1

Culvert Crossing: North Bay at Lake Woodmoor

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.00	1.00	7126.16	2.38	4.35	1-S1f	0.04	0.08	5.00	5.00	0.03	0.00
52.90	52.90	7126.20	3.98	4.38	1-S1f	0.75	1.11	5.00	5.00	1.32	0.00
104.80	104.80	7126.79	4.98	4.50	1-S1f	1.18	1.75	5.00	5.00	2.62	0.00
156.70	156.70	7127.63	5.82	4.68	5-S1f	1.54	2.28	5.00	5.00	3.92	0.00
208.60	208.60	7128.38	6.56	4.94	5-S1f	1.87	2.76	5.00	5.00	5.21	0.00
260.50	260.50	7129.06	7.25	5.29	5-S1f	2.18	3.21	5.00	5.00	6.51	0.00
312.40	312.40	7129.71	7.89	5.78	5-S1f	2.48	3.62	5.00	5.00	7.81	0.00
364.30	364.30	7130.32	8.50	6.11	5-S2n	2.76	4.01	3.24	5.00	14.04	0.00
416.20	416.20	7130.90	9.08	6.65	5-S2n	3.04	4.38	3.58	5.00	14.54	0.00
468.10	468.10	7131.45	9.64	7.26	5-S2n	3.31	4.74	3.90	5.00	14.99	0.00
520.00	520.00	7131.99	10.18	7.94	5-S2n	3.58	5.00	4.22	5.00	15.41	0.00

Per HMS data provided with CLOMR data in Appendix B.1, Q100 = 580 cfs

HY-8 Analysis Results

Water Surface Profiles

Culvert Crossing: North Bay at Lake Woodmoor

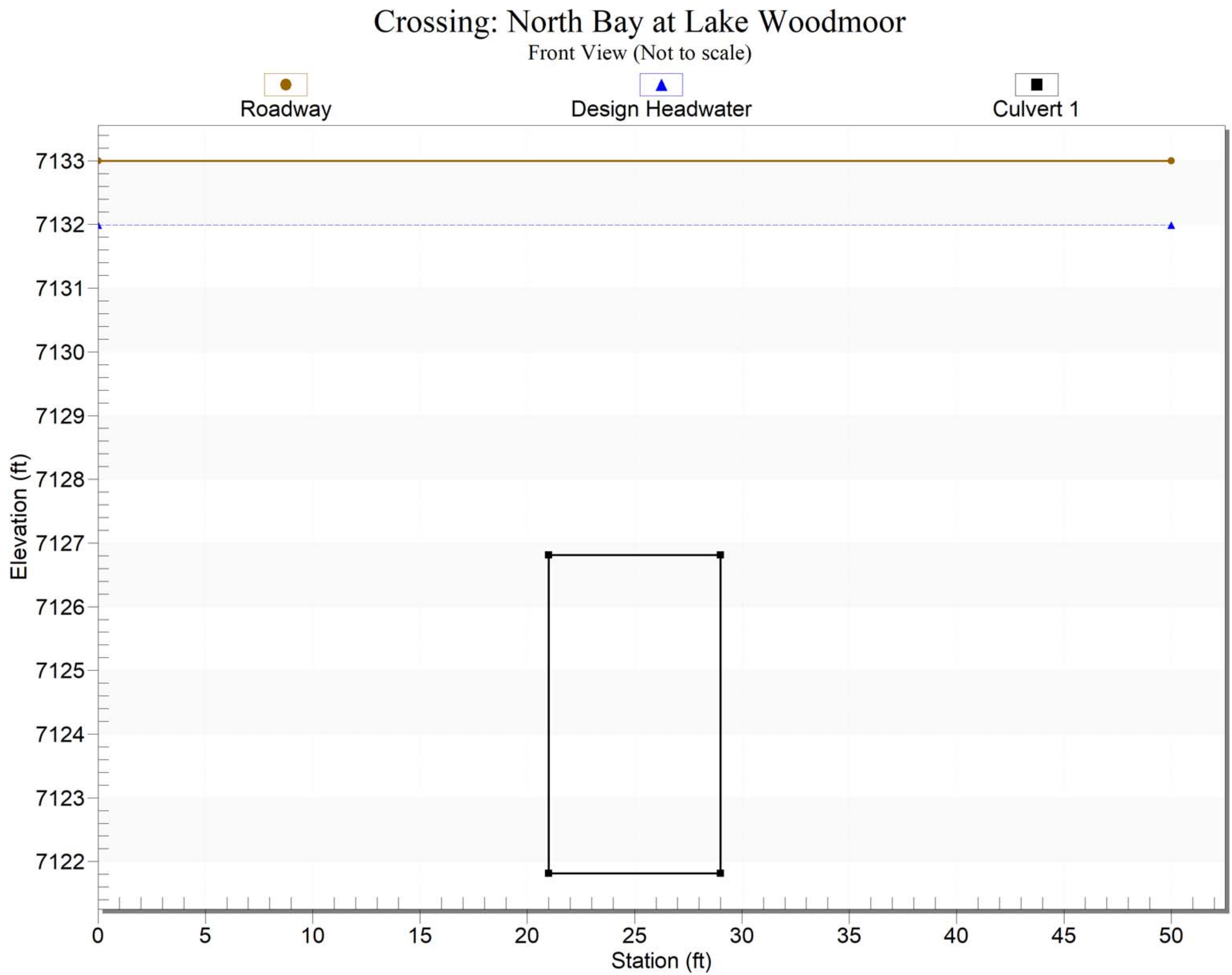
Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Length Full (ft)	Length Free (ft)
1.00	1.00	7126.16	2.38	4.35	1-S1f	0.00	60.71
52.90	52.90	7126.20	3.98	4.38	1-S1f	0.00	60.71
104.80	104.80	7126.79	4.98	4.50	1-S1f	0.00	60.71
156.70	156.70	7127.63	5.82	4.68	5-S1f	0.00	60.71
208.60	208.60	7128.38	6.56	4.94	5-S1f	0.00	60.71
260.50	260.50	7129.06	7.25	5.29	5-S1f	0.00	60.71
312.40	312.40	7129.71	7.89	5.78	5-S1f	0.00	60.71
364.30	364.30	7130.32	8.50	6.11	5-S2n	0.00	60.71
416.20	416.20	7130.90	9.08	6.65	5-S2n	0.00	60.71
468.10	468.10	7131.45	9.64	7.26	5-S2n	0.00	60.71
520.00	520.00	7131.99	10.18	7.94	5-S2n	0.00	60.71

HY-8 Analysis Results

Tapered Inlet Table

Culvert Crossing: North Bay at Lake Woodmoor

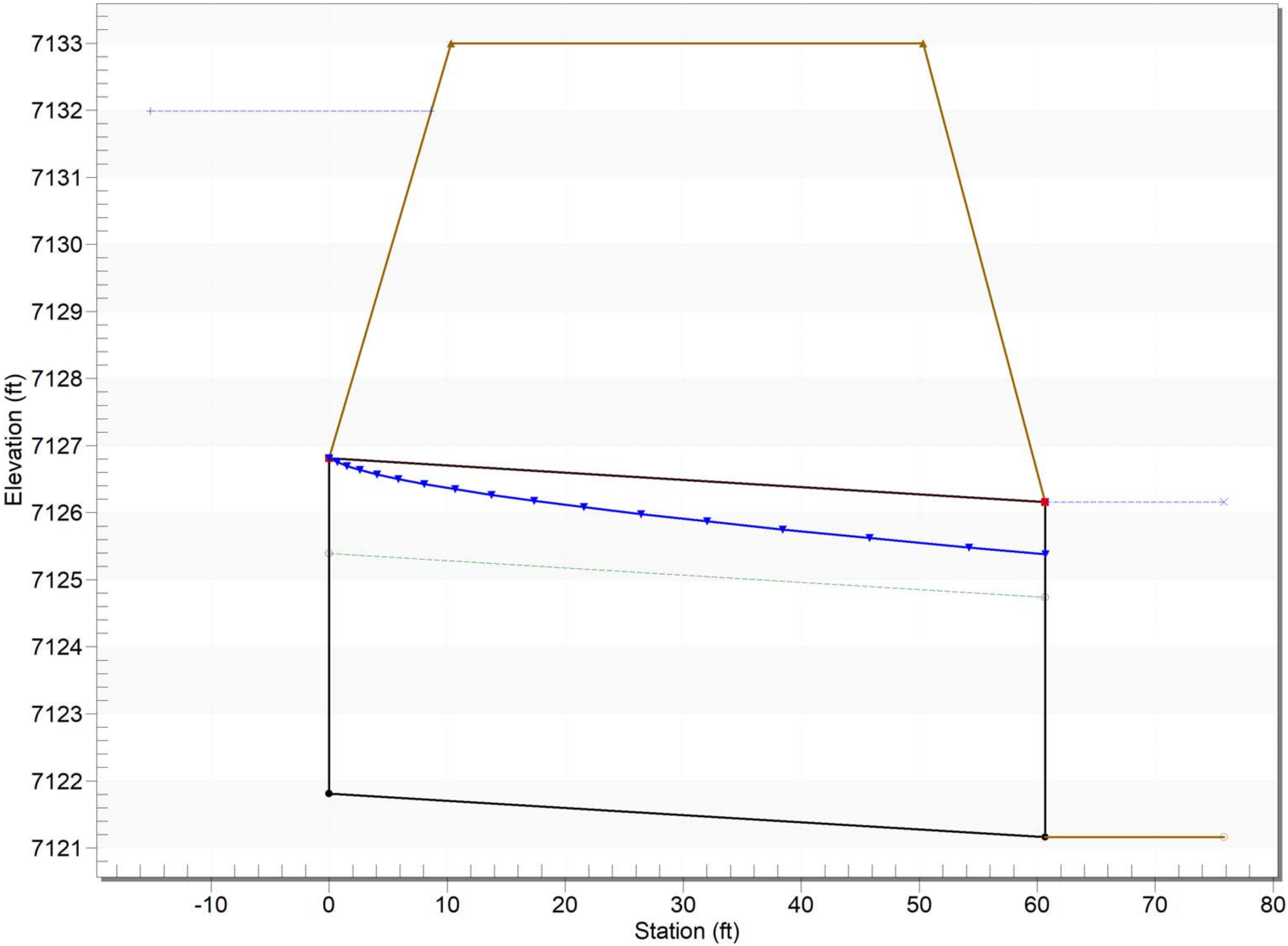
Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Crest Control Elev(ft)	Face Control Elev(ft)	Throat Control Elev(ft)	Tailwater Elevation (ft)
1.00	1.00	7126.16	2.38	4.35	1-S1f	7124.19	7121.93	7122.44	7126.16
52.90	52.90	7126.20	3.98	4.38	1-S1f	7125.80	7123.51	7123.47	7126.16
104.80	104.80	7126.79	4.98	4.50	1-S1f	7126.79	7124.49	7124.37	7126.16
156.70	156.70	7127.63	5.82	4.68	5-S1f	7127.63	7125.32	7125.18	7126.16
208.60	208.60	7128.38	6.56	4.94	5-S1f	7128.38	7126.06	7125.90	7126.16
260.50	260.50	7129.06	7.25	5.29	5-S1f	7129.06	7126.73	7126.57	7126.16
312.40	312.40	7129.71	7.89	5.78	5-S1f	7129.71	7127.59	7127.20	7126.16
364.30	364.30	7130.32	8.50	6.11	5-S2n	7130.32	7128.12	7127.80	7126.16
416.20	416.20	7130.90	9.08	6.65	5-S2n	7130.90	7128.73	7128.39	7126.16
468.10	468.10	7131.45	9.64	7.26	5-S2n	7131.45	7129.43	7129.00	7126.16
520.00	520.00	7131.99	10.18	7.94	5-S2n	7131.99	7130.20	7129.62	7126.16



Crossing: North Bay at Lake Woodmoor
Front View (Not to scale)
Roadway
Design Headwater
Culvert 1
Elevation (ft)
7133
7132
7131
7130
7129
7128
7127
7126
7125
7124
7123
7122
0
5
10
15
20
25
30
35
40
45
50
Station (ft)

Crossing - North Bay at Lake Woodmoor, Design Discharge - 520.0 cfs

Culvert - Culvert 1, Culvert Discharge - 520.0 cfs



North Bay at Lake Woodmoor
Emergency Overflow Calculations

R
,

Spillway Structure Calculations

Orifice Coefficient	0.6
Water Surf. Increment	0.20 ft
Outlet Pipe Invert El	7121.70
100yr Water Surf El	7132.00
Spillway Grate El	7130.00
Top of Embankment El	7133.00
Maximum W.S. El (HEC1)	7133.00

100-year Flow = 520 cfs

Spillway Grate			
H_o	7130.00	L_o	29.0'
W_o	8.0 ft	S_o	0:1
R-Value	75%	Clog Factor	45%
C_d	0.62	C_o	0.60
H_b	0.0 ft	Hypotenuse	8.0'
Open Area	232.00sf	Area w/R	174.0sf

Pipe Outlet	Slot	
Orifice Ht	60.0 inch	8x5RCB
Orifice Width	96.00 inch	
H/2	2.50-ft	
Orifice Area	5760.0 sq-in	
	40.000 sf	
Outlet Invert Elev	7121.70	
Orifice Centerline El	7124.20	

Circle	0:1
Slot	4:1
Restrictor	3:1

C_d	Overflow Grate Type
0.62	1:0 (Flat) Slope - Close Mesh
0.60	1:0 (Flat) Slope - Type C Grate
0.63	4:1 Slope - Close Mesh
0.62	4:1 Slope - Type C Grate
0.60	3:1 Slope - Close Mesh
0.58	3:1 Slope - Type C Grate

	Spillway Grate				Pipe Outlet			
Water Surf. El	**H**	Max. Qgrate	Flow in grate	Vgrate	Head	Max. Qorifice	**Flow Out**	
7130.00	0.0'	0.0cfs	0.0cfs	0.0ft/s	5.8'	463.8cfs	**0.0cfs**	
7130.20	0.2'	9.1cfs	9.1cfs	0.1ft/s	6.0'	471.8cfs	**9.1cfs**	
7130.40	0.4'	25.6cfs	25.6cfs	0.1ft/s	6.2'	479.6cfs	**25.6cfs**	
7130.60	0.6'	47.1cfs	47.1cfs	0.3ft/s	6.4'	487.2cfs	**47.1cfs**	
7130.80	0.8'	72.4cfs	72.4cfs	0.4ft/s	6.6'	494.8cfs	**72.4cfs**	
7131.00	1.0'	101.3cfs	101.3cfs	0.6ft/s	6.8'	502.2cfs	**101.3cfs**	
7131.20	1.2'	133.1cfs	133.1cfs	0.8ft/s	7.0'	509.6cfs	**133.1cfs**	
7131.40	1.4'	167.7cfs	167.7cfs	1.0ft/s	7.2'	516.8cfs	**167.7cfs**	
7131.60	1.6'	204.9cfs	204.9cfs	1.2ft/s	7.4'	523.9cfs	**204.9cfs**	
7131.80	1.8'	244.5cfs	244.5cfs	1.4ft/s	7.6'	531.0cfs	**244.5cfs**	
7132.00	2.0'	286.4cfs	286.4cfs	1.6ft/s	7.8'	537.9cfs	**286.4cfs**	
7132.20	2.2'	330.4cfs	330.4cfs	1.9ft/s	8.0'	544.8cfs	**330.4cfs**	
7132.40	2.4'	376.5cfs	376.5cfs	2.2ft/s	8.2'	551.5cfs	**376.5cfs**	
7132.60	2.6'	424.5cfs	424.5cfs	2.4ft/s	8.4'	558.2cfs	**424.5cfs**	
7132.80	2.8'	474.4cfs	474.4cfs	2.7ft/s	8.6'	564.8cfs	**474.4cfs**	
7133.00	3.0'	526.1cfs	526.1cfs	3.0ft/s	8.8'	571.3cfs	**526.1cfs**	Max. W.S. Elev
7133.00	3.0'	526.1cfs	526.1cfs	3.0ft/s	8.8'	571.3cfs	**526.1cfs**	Top Embankment

Equations for Spillway Grate:

(Equations taken from "USBR, Physical Modeling of Overflow Outlets Outlets for Extended Detention Stormwater Basins", Sept 2014)

H_o=Overflow Weir Front Edge Elevation

L_o=Overflow Weir Front Edge Length

W_o=Overflow Weir Width (horizontal front to back dimension)

S_o=Overflow Weir Side Slope (Typically matches embankment slope)

R-Value=Open area ratio for the grate (Typically 70%, can be between 50-85%)

C_d=Discharge coefficient based on slope and grate type

Per HMS data provided with CLOMR data in Appendix B.1, Q100 = 580 cfs

D (in)	78
Q100 (cfs)	520
Pipe Inv (ft)	7106.8
Tw Elev (ft)	7109.0
Tw (ft)	2.2

$Y_o = brink\ depth$
$D = dia.\ of\ culvert$
$T_w = tailwater\ depth$

Determine size of riprap basin:

$\frac{Q}{D^{2.5}}$ 4.83

$\frac{T_w}{D}$ 0.34

Determine Brink Depth:

$\frac{Y_o}{D}$ Use Figure III-10: $\frac{Y_o}{D} =$ 0.82 $\therefore\ Y_o = (0.82)(3.5) =$ **5.33 (ft) BRINK DEPTH**

$\frac{T_w}{Y_o}$ 0.41 **OK** T_w/Y_o is < 0.75

Determine Brink Area:

$\frac{d}{D}$ 0.82 Use Table III-2: $\frac{A}{D^2} =$ 0.6893 $\therefore\ A = (0.6893)(6.5^2) =$ **29.12 (ft^2) BRINK AREA**

$V_o = \frac{Q}{A}$ 17.86 ft/sec

Determine Equivalent Brink Depth:

$Y_e = \left(\frac{A}{2}\right)^{1/2}$ 3.82 ft equivalent brink depth

Froude # (Fig. X1-2) = 1.61

Use Fig XI-2: Try: $\frac{d_{50}}{Y_e} =$ 0.35 $d_{50} = (0.36)(Y_e) =$ 1.34 16.0 inches

(use 18"---->Type H Riprap)

Detrermine Depth of Scour:

$\frac{h_s}{Y_e} =$ 0.78 (from Fig) $h_s = (0.78)(Y_e)$ 2.98 ft depth of scour

As a check, is $2 < h_s/d_{50} < 4$? 2.98/1.34 = 2.2 **OK**

Determine length of the riprap basin:

Length of Dissipator Pool-------> 10*hs OR 3*Wo (whichever is greater)
29.8 ft
OR
19.5 ft
29.8 (ft) LENGTH

Length of Apron------------------> 5*hs OR Wo (whichever is greater)
14.9 ft
OR
6.5 ft
14.9 (ft) LENGTH

Total Basin Length = **44.6 ft**

Source: "Hydraulic Design of Energy Dissipators for Culverts and Channels", H.E.C. No. 14, Chapter XI

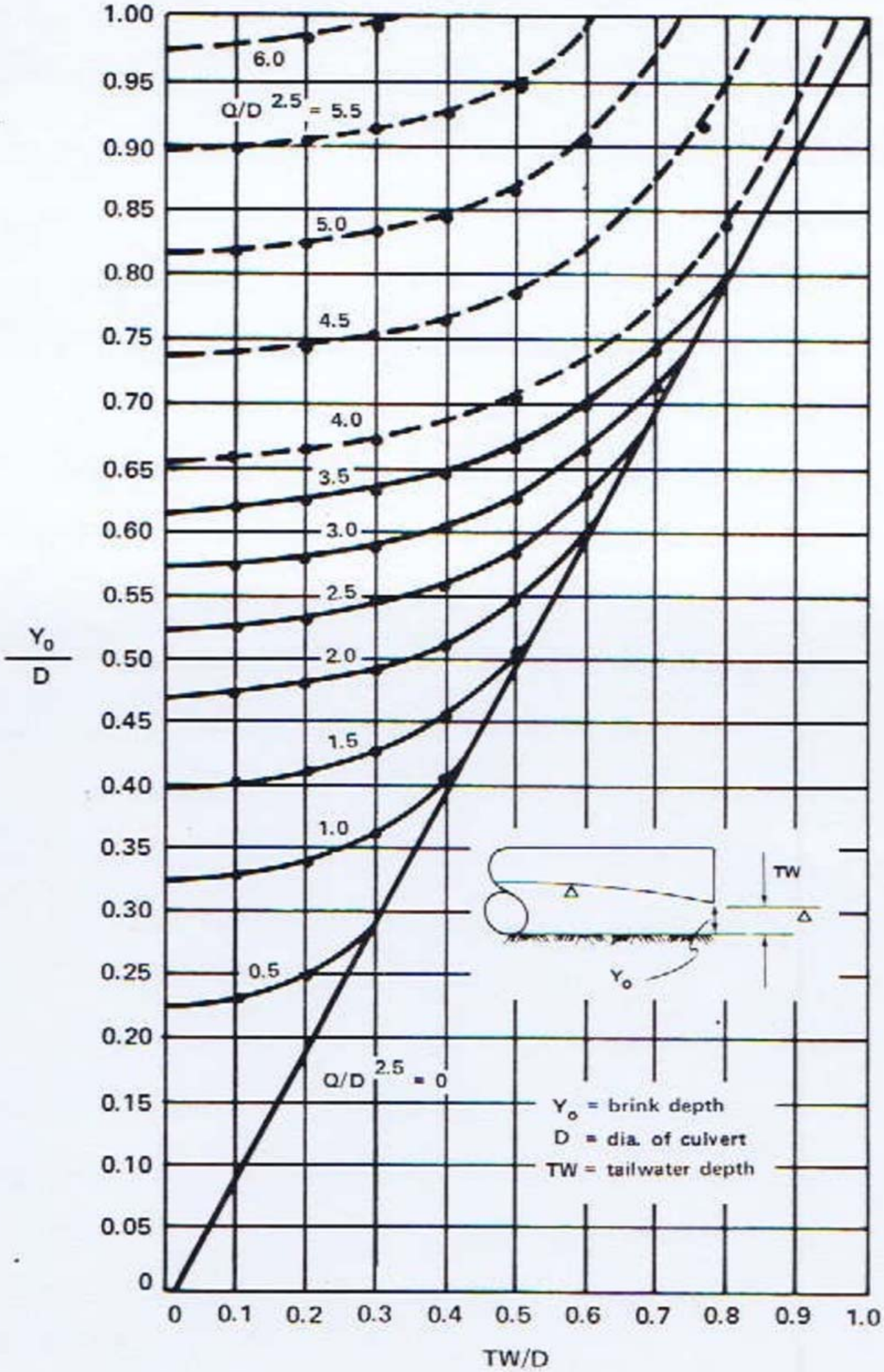


Figure III-10 Dimensionless Rating Curve for the Outlets of Circular Culverts on Horizontal and Mild Slopes from Reference III-2

Table III-2.–*Uniform flow in circular sections flowing partly full.* From Reference III-3.

d - depth of flow
D - diameter of pipe
A - area of flow
R - hydraulic radius

Q = discharge in cubic feet per second by Manning's formula
n = Manning's coefficient
S = slope of the channel bottom and of the water surface

$\frac{d}{D}$	$\frac{A}{D^2}$	$\frac{R}{D}$	$\frac{Qn}{D^{8/3}S^{1/2}}$	$\frac{Qn}{d^{8/3}S^{1/2}}$	$\frac{d}{D}$	$\frac{A}{D^2}$	$\frac{R}{D}$	$\frac{Qn}{D^{8/3}S^{1/2}}$	$\frac{Qn}{d^{8/3}S^{1/2}}$
0.01	0.0013	0.0066	0.00007	15.04	0.51	0.4027	0.2531	0.239	1.442
0.02	0.0037	0.0132	0.00031	10.57	0.52	0.4127	0.2562	0.247	1.415
0.03	0.0069	0.0197	0.00074	8.56	0.53	0.4227	0.2592	0.255	1.388
0.04	0.0105	0.0262	0.00138	7.38	0.54	0.4327	0.2621	0.263	1.362
0.05	0.0147	0.0325	0.00222	6.55	0.55	0.4426	0.2649	0.271	1.336
0.06	0.0192	0.0389	0.00328	5.95	0.56	0.4526	0.2676	0.279	1.311
0.07	0.0242	0.0451	0.00455	5.47	0.57	0.4625	0.2703	0.287	1.286
0.08	0.0294	0.0513	0.00604	5.09	0.58	0.4724	0.2728	0.295	1.262
0.09	0.0350	0.0575	0.00775	4.76	0.59	0.4822	0.2753	0.303	1.238
0.10	0.0409	0.0635	0.00967	4.49	0.60	0.4920	0.2776	0.311	1.215
0.11	0.0470	0.0695	0.01181	4.25	0.61	0.5018	0.2799	0.319	1.192
0.12	0.0534	0.0755	0.01417	4.04	0.62	0.5115	0.2821	0.327	1.170
0.13	0.0600	0.0813	0.01674	3.86	0.63	0.5212	0.2842	0.335	1.148
0.14	0.0668	0.0871	0.01952	3.69	0.64	0.5308	0.2862	0.343	1.126
0.15	0.0739	0.0929	0.0225	3.54	0.65	0.5404	0.2882	0.350	1.105
0.16	0.0811	0.0985	0.0257	3.41	0.66	0.5499	0.2900	0.358	1.084
0.17	0.0885	0.1042	0.0291	3.28	0.67	0.5594	0.2917	0.366	1.064
0.18	0.0961	0.1097	0.0327	3.17	0.68	0.5687	0.2933	0.373	1.044
0.19	0.1039	0.1152	0.0365	3.06	0.69	0.5780	0.2948	0.380	1.024
0.20	0.1118	0.1206	0.0406	2.96	0.70	0.5872	0.2962	0.388	1.004
0.21	0.1199	0.1259	0.0448	2.87	0.71	0.5964	0.2975	0.395	0.985
0.22	0.1281	0.1312	0.0492	2.79	0.72	0.6054	0.2987	0.402	0.965
0.23	0.1365	0.1364	0.0537	2.71	0.73	0.6143	0.2998	0.409	0.947
0.24	0.1449	0.1416	0.0585	2.63	0.74	0.6231	0.3008	0.416	0.928
0.25	0.1535	0.1466	0.0634	2.56	0.75	0.6319	0.3017	0.422	0.910
0.26	0.1623	0.1516	0.0686	2.49	0.76	0.6405	0.3024	0.429	0.891
0.27	0.1711	0.1566	0.0739	2.42	0.77	0.6489	0.3031	0.435	0.873
0.28	0.1800	0.1614	0.0793	2.36	0.78	0.6573	0.3036	0.441	0.856
0.29	0.1890	0.1662	0.0849	2.30	0.79	0.6655	0.3039	0.447	0.838
0.30	0.1982	0.1709	0.0907	2.25	0.80	0.6736	0.3042	0.453	0.821
0.31	0.2074	0.1756	0.0966	2.20	0.81	0.6815	0.3043	0.458	0.804
0.32	0.2167	0.1802	0.1027	2.14	0.82	0.6893	0.3043	0.463	0.787
0.33	0.2260	0.1847	0.1089	2.09	0.83	0.6969	0.3041	0.468	0.770
0.34	0.2355	0.1891	0.1153	2.05	0.84	0.7043	0.3038	0.473	0.753
0.35	0.2450	0.1935	0.1218	2.00	0.85	0.7115	0.3033	0.477	0.736
0.36	0.2546	0.1978	0.1284	1.958	0.86	0.7186	0.3026	0.481	0.720
0.37	0.2642	0.2020	0.1351	1.915	0.87	0.7254	0.3018	0.485	0.703
0.38	0.2739	0.2062	0.1420	1.875	0.88	0.7320	0.3007	0.488	0.687
0.39	0.2836	0.2102	0.1490	1.835	0.89	0.7384	0.2995	0.491	0.670
0.40	0.2934	0.2142	0.1561	1.797	0.90	0.7445	0.2980	0.494	0.654
0.41	0.3032	0.2182	0.1633	1.760	0.91	0.7504	0.2963	0.496	0.637
0.42	0.3130	0.2220	0.1705	1.724	0.92	0.7560	0.2944	0.497	0.621
0.43	0.3229	0.2258	0.1779	1.689	0.93	0.7612	0.2921	0.498	0.604
0.44	0.3328	0.2295	0.1854	1.655	0.94	0.7662	0.2895	0.498	0.588
0.45	0.3428	0.2331	0.1929	1.622	0.95	0.7707	0.2865	0.498	0.571
0.46	0.3527	0.2366	0.201	1.590	0.96	0.7749	0.2829	0.496	0.553
0.47	0.3627	0.2401	0.208	1.559	0.97	0.7785	0.2787	0.494	0.535
0.48	0.3727	0.2435	0.216	1.530	0.98	0.7817	0.2735	0.489	0.517
0.49	0.3827	0.2468	0.224	1.500	0.99	0.7841	0.2666	0.483	0.496
0.50	0.3927	0.2500	0.232	1.471	1.00	0.7854	0.2500	0.463	0.463

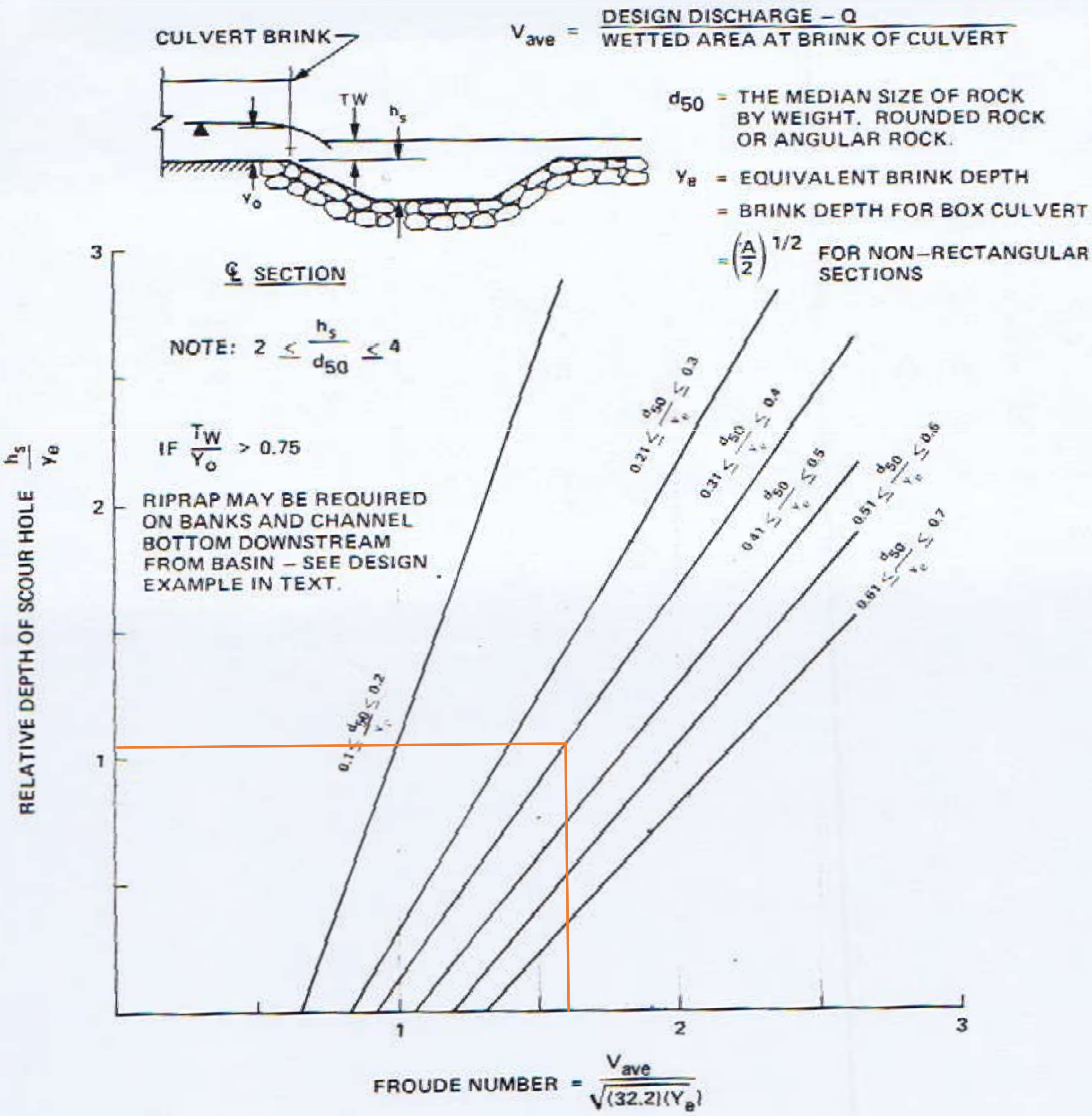


FIGURE X1–2. RELATIVE DEPTH OF SCOUR HOLE VERSUS FROUDE NUMBER AT BRINK OF CULVERT WITH RELATIVE SIZE OF RIPRAP AS A THIRD VARIABLE

NOTE A — IF EXIT VELOCITY OF BASIN IS SPECIFIED, EXTEND BASIN AS REQUIRED TO OBTAIN SUFFICIENT CROSS-SECTIONAL AREA AT SECTION A–A SUCH THAT Q_{des}/(CROSS SECTION AREA AT SEC. A–A) = SPECIFIED EXIT VELOCITY.

NOTE B — WARP BASIN TO CONFORM TO NATURAL STREAM CHANNEL. TOP OF RIPRAP IN FLOOR OF BASIN SHOULD BE AT THE SAME ELEVATION OR LOWER THAN NATURAL CHANNEL BOTTOM AT SEC. A–A.

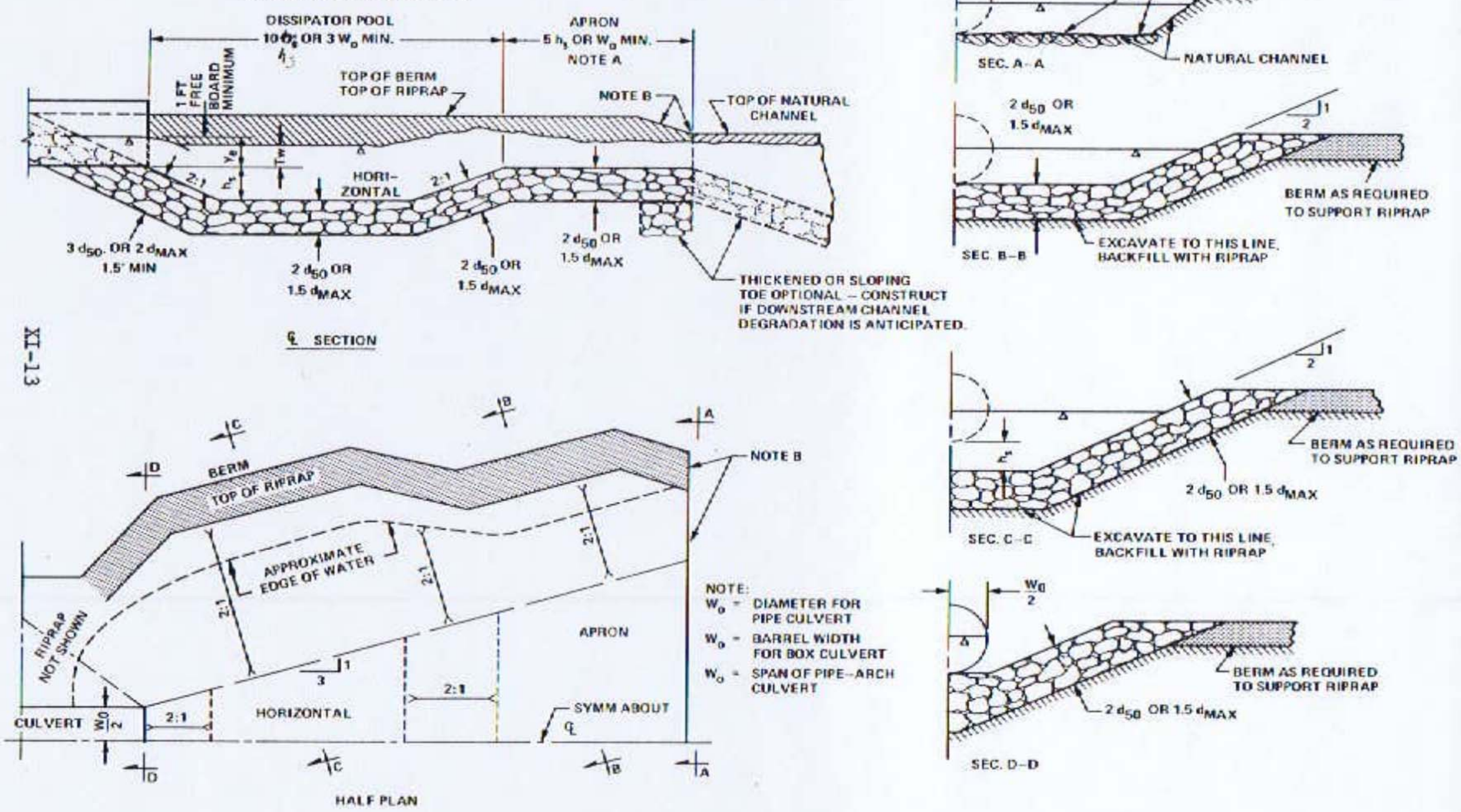
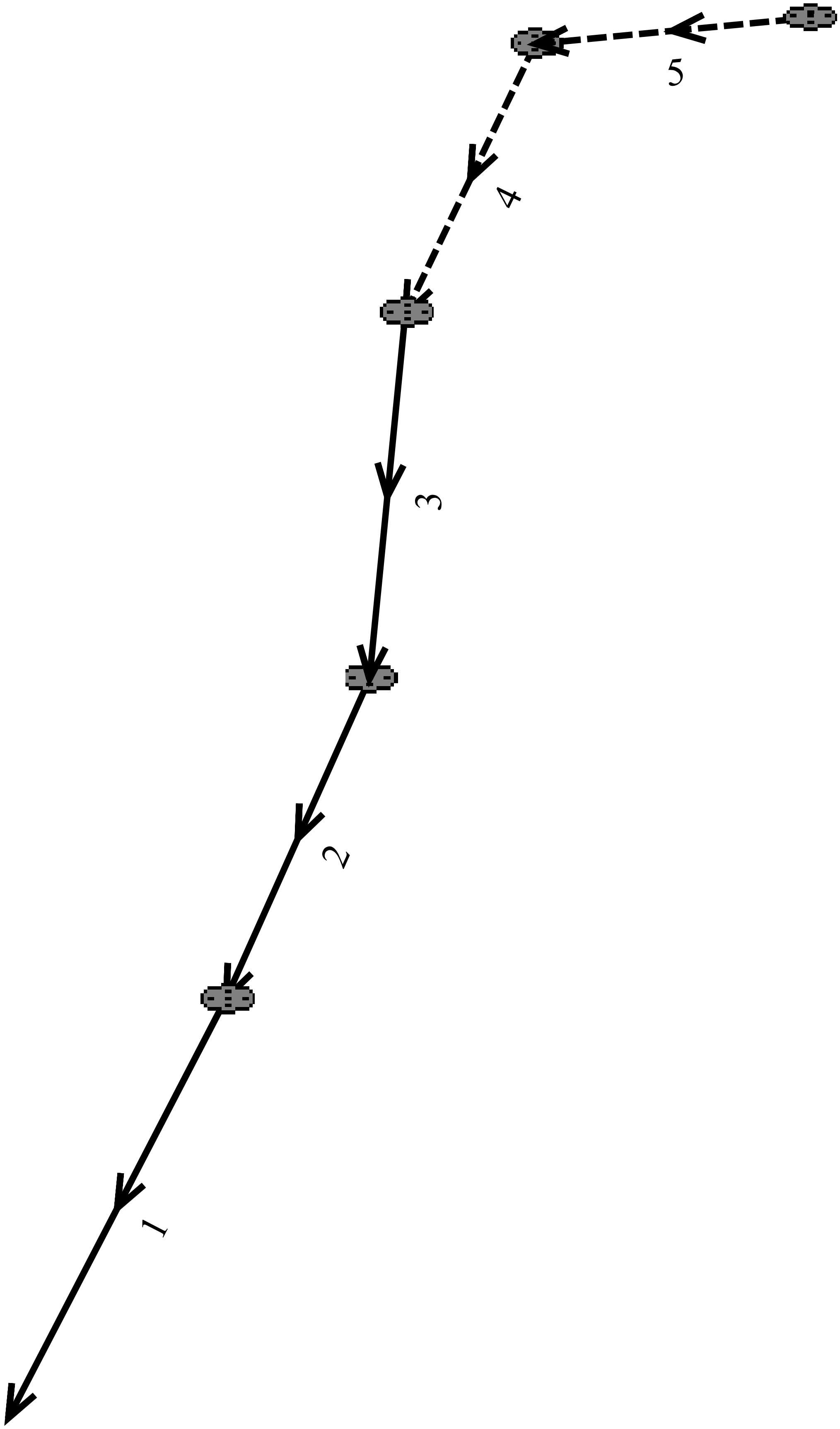


FIGURE XI-1. DETAILS OF RIPRAPPED CULVERT ENERGY BASIN



1
2
3
4
5

Program: UDSEWER Math Model Interface 2.1.1.4 **Run Date:** 6/2/2022 8:32:45 PM	# UDSewer Results Summary **Project Title:** North Bay at Lake Woodmoor **Project Description:** 100 year

Storm Sewer design will be reviewed with Final Drainage Report.

System Input Summary

Rainfall Parameters

Rainfall Return Period: 100
Rainfall Calculation Method: Formula

One Hour Depth (in):
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: No

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 7109.00

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
OUTFALL 1	7116.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	7122.85	520.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

2	7127.18	520.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	7132.14	520.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	7130.00	520.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	7130.00	520.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
OUTFALL 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	520.00	
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	520.00	
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	520.00	
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	520.00	
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	520.00	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
1	160.00	7106.78	1.0	7108.38	0.013	0.03	0.25	CIRCULAR	78.00 in	78.00 in
2	125.20	7109.49	1.0	7110.74	0.013	0.06	1.00	CIRCULAR	78.00 in	78.00 in
3	122.80	7114.25	1.0	7115.48	0.013	0.06	1.00	CIRCULAR	78.00 in	78.00 in
4	54.70	7121.15	1.0	7121.70	0.013	0.22	1.00	BOX	5.00 ft	8.00 ft
5	8.00	7121.72	1.0	7121.80	0.013	0.05	1.00	BOX	5.00 ft	8.00 ft

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
1	525.69	15.84	70.77	16.44	63.18	18.06	1.34	Supercritical	520.00	0.00	Velocity is Too High
2	525.69	15.84	70.77	16.44	63.18	18.06	1.34	Supercritical	520.00	0.00	Velocity is Too High
3	525.69	15.84	70.77	16.44	63.18	18.06	1.34	Supercritical	520.00	0.00	Velocity is Too High
4	610.98	15.27	60.00	13.00	44.12	17.68	1.62	Supercritical	520.00	0.00	
5	610.98	15.27	60.00	13.00	44.12	17.68	1.62	Pressurized	520.00	8.00	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	**Peak Flow (cfs)**	**Cross Section**	**Rise**	**Span**	**Rise**	**Span**	**Rise**	**Span**	**Area (ft^2)**	**Comment**
1	520.00	CIRCULAR	78.00 in	78.00 in	78.00 in	78.00 in	78.00 in	78.00 in	33.18	
2	520.00	CIRCULAR	78.00 in	78.00 in	78.00 in	78.00 in	78.00 in	78.00 in	33.18	
3	520.00	CIRCULAR	78.00 in	78.00 in	78.00 in	78.00 in	78.00 in	78.00 in	33.18	
4	520.00	BOX	5.00 ft	8.00 ft	8.00 ft	8.00 ft	5.00 ft	8.00 ft	40.00	Existing height is smaller than the suggested height.
5	520.00	BOX	5.00 ft	8.00 ft	8.00 ft	8.00 ft	5.00 ft	8.00 ft	40.00	Existing height is smaller than the suggested height.

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 7109.00

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	**Downstream (ft)**	**Upstream (ft)**	**Bend Loss (ft)**	**Lateral Loss (ft)**	**Downstream (ft)**	**Upstream (ft)**	**Downstream (ft)**	**Friction Loss (ft)**	**Upstream (ft)**
1	7106.78	7108.38	0.00	0.00	7112.04	7114.28	7117.11	1.36	7118.47
2	7109.49	7110.74	0.23	0.00	7114.75	7116.64	7119.82	1.01	7120.83
3	7114.25	7115.48	0.23	0.00	7119.52	7121.38	7124.58	0.99	7125.57
4	7121.15	7121.70	0.58	1.19	7124.83	7127.06	7129.68	0.00	7129.68
5	7121.72	7121.80	0.13	0.00	7127.19	7127.25	7129.81	0.06	7129.87

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Excavation Estimate:

The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

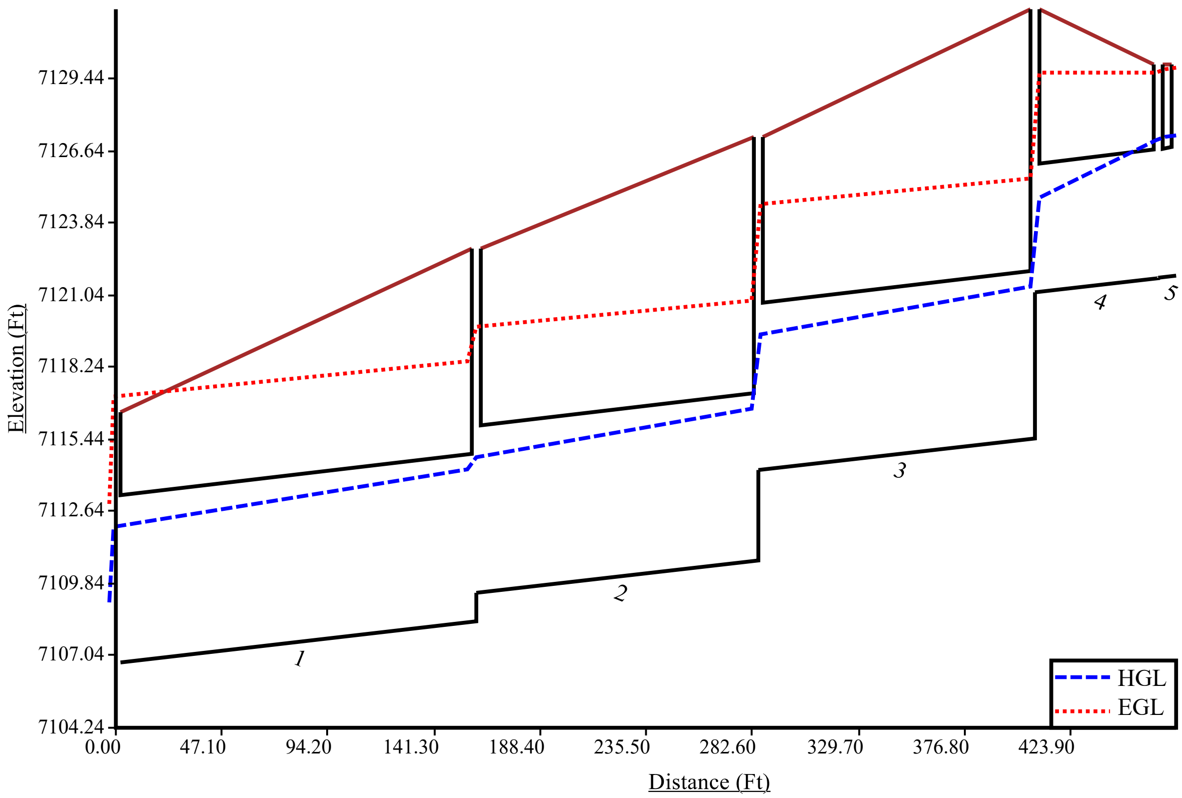
					Downstream			Upstream				
Element Name	**Length (ft)**	**Wall (in)**	**Bedding (in)**	**Bottom Width (ft)**	**Top Width (ft)**	**Trench Depth (ft)**	**Cover (ft)**	**Top Width (ft)**	**Trench Depth (ft)**	**Cover (ft)**	**Volume (cu. yd)**	**Comment**
1	160.00	7.50	8.00	10.75	13.94	11.01	2.60	23.44	15.76	7.35	979.60	
2	125.20	7.50	8.00	10.75	21.22	14.65	6.24	27.38	17.73	9.32	1031.06	
3	122.80	7.50	8.00	10.75	20.36	14.22	5.80	27.82	17.95	9.54	1004.59	
4	54.70	9.00	8.00	12.50	20.97	12.40	5.24	15.60	9.72	2.55	300.71	
5	8.00	9.00	8.00	12.50	15.56	9.70	2.53	15.40	9.62	2.45	36.42	

Total earth volume for sewer trenches = 3352 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
    - Four inches for pipes less than 33 inches.
    - Six inches for pipes less than 60 inches.
    - Eight inches for all larger sizes.

LFDWC 100-Year

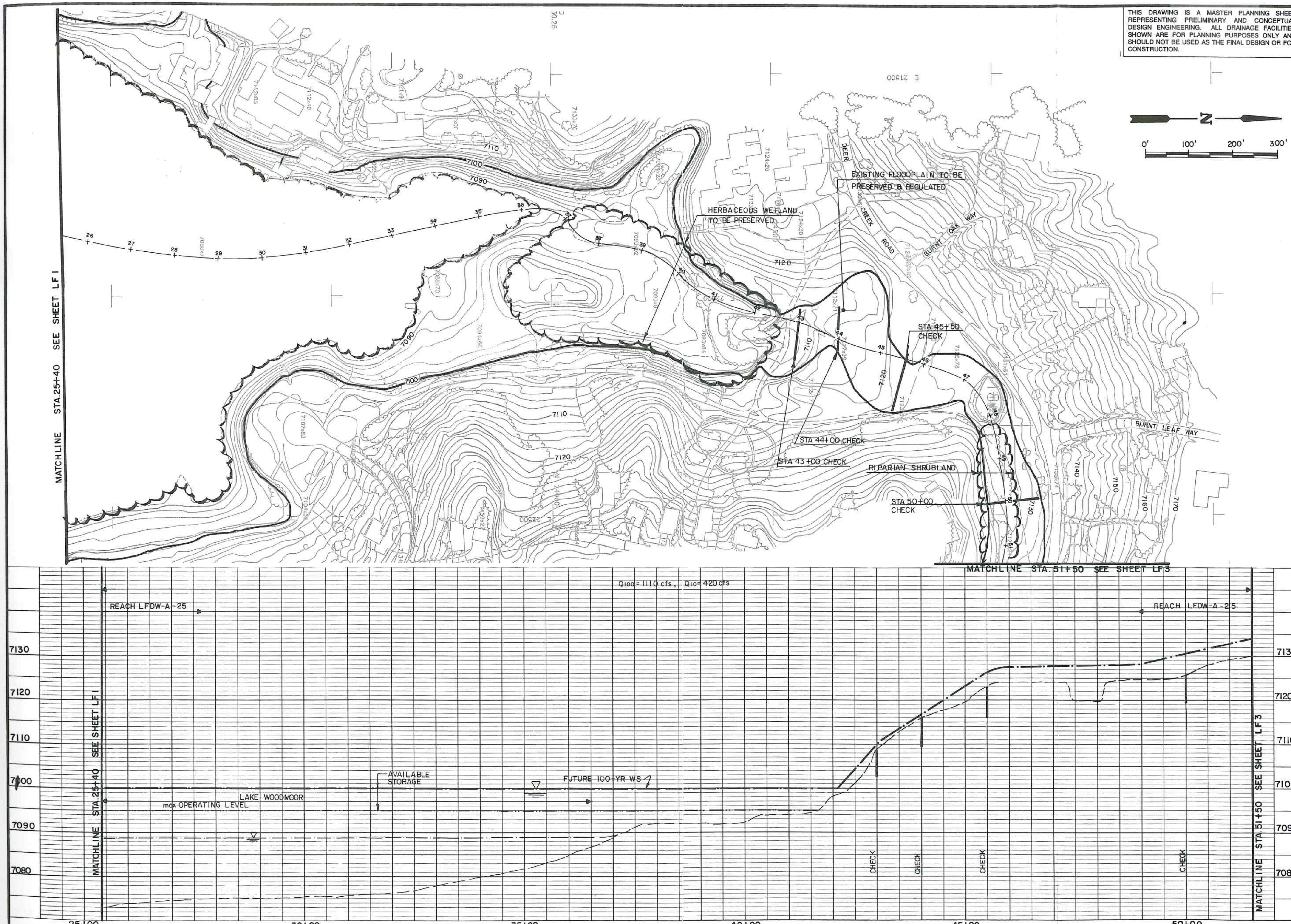
<u>profile</u>



APPENDIX G

Referenced Information

Excerpts from Dirty Woman and Crystal Creeks Drainage Basin Planning Study
FEMA Letter of Map Change for Lake Fork Dirty Woman Creek LOMR
Woodmoor Water and Sanitation District Letter-Detention and Stormwater Quality



THIS DRAWING IS A MASTER PLANNING SHEET REPRESENTING PRELIMINARY AND CONCEPTUAL DESIGN ENGINEERING. ALL DRAINAGE FACILITIES SHOWN ARE FOR PLANNING PURPOSES ONLY AND SHOULD NOT BE USED AS THE FINAL DESIGN OR FOR CONSTRUCTION.

Kiowa Engineering Corporation
419 West Bijou Street
Colorado Springs, Colorado
80905-1308

Dirty Woman and Crystal Creeks Drainage Basin Planning Study

PRELIMINARY DESIGN

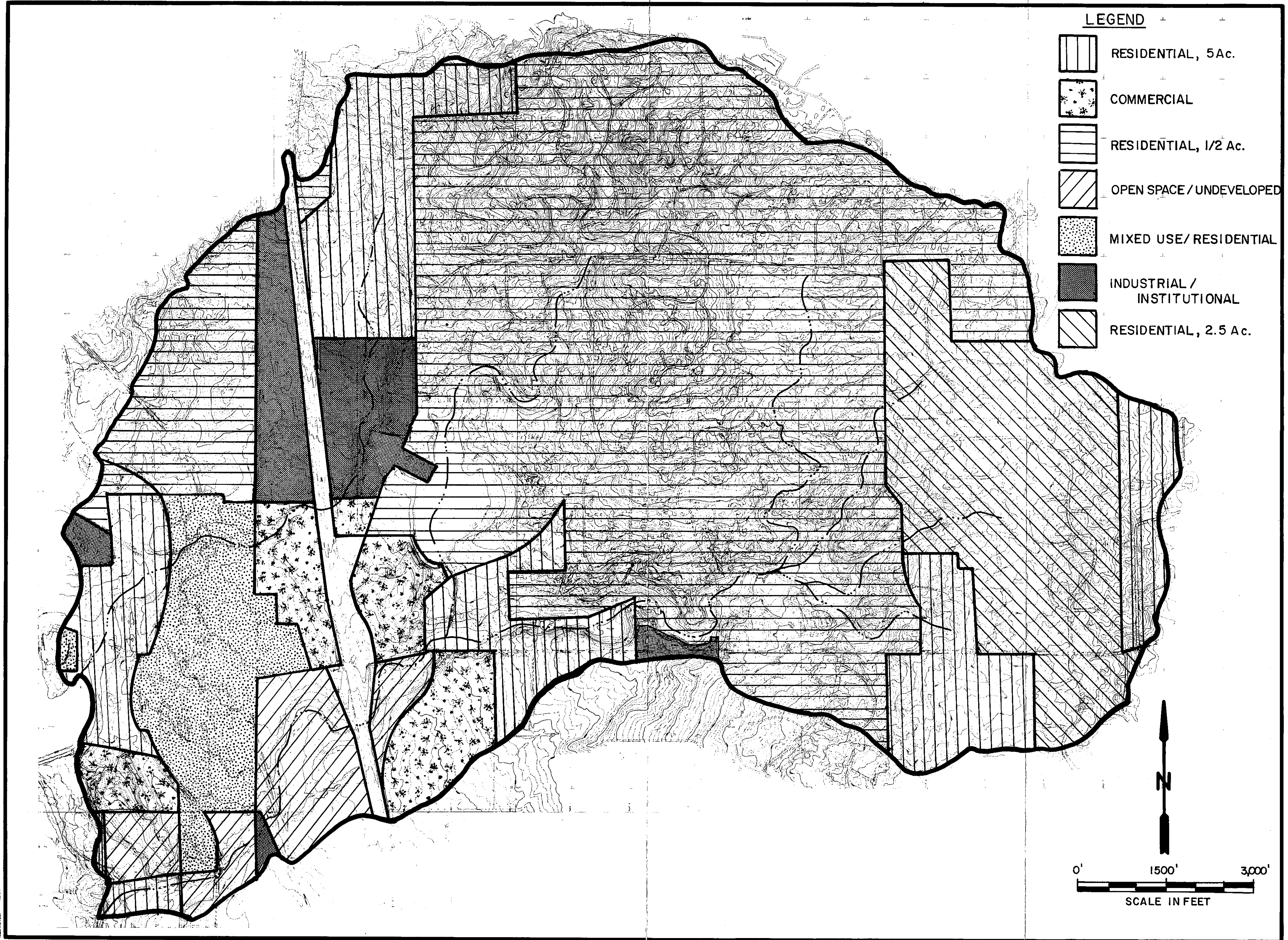
Lake Fork Dirty Woman Creek

Sta. 25+40 to Sta. 51+50

El Paso County Department of Public Works Stormwater Management Division

Project No.	91·07·17
Date:	1/93
Design:	AWMc
Drawn:	EAK
Check:	RNW
Revisions:	

LF2



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

DIRTY WOMAN CREEK & CRYSTAL CREEK
DRAINAGE BASIN PLANNING STUDY
PROPOSED LAND USE MAP

Project No.	91-07-17
Date:	12/91
Design:	AW Mc
Drawn:	EAK
Check:	RNW
Revisions:	

FIG 3

TABLE 12: DIRTY WOMAN & CRYSTAL CREEKS DRAINAGE BASIN PLANNING STUDY
COST ESTIMATE -- SELECTIVE DRAINAGEWAY IMPROVEMENTS
SELECTED ALTERNATIVE

REACH NUMBER	REACH LENGTH (FT)	NUMBER CHECK STRUCTURES	CHECK LENGTH (FT)	NUMBER DROP STRUCTURES	DROP LENGTH (FT)	LENGTH BANK SLOPE PROTECT (FT)	LENGTH OF 100 YR CHANNEL (FT)	LENGTH OF 10 YR CHANNEL (FT)	LENGTH OF CHNL STAB. & REPAIR (FT)	LENGTH OF OUTLET PROTECT (FT)	LENGTH OF SPILLWAY PROTECT (FT)	LENGTH OF BERM PROTECT (FT)	MITIGATION (AC)	LAND ACQUISTION (AC)	TOTAL COST
DW-A-01	1,095	3	245	1	85	300	130			95			0.70		$144,182
DW-A-02	625			1	60	300		125					0.38		$45,672
DW-A-03	1,335	1	60	3	290	1530				80					$158,690
DW-A-04	120														$0
DW-A-05	2,870	3	220	3	290	1020				100			0.61		$190,316
DW-A-06	1,820	6	785	1	65	700							0.71		$236,752
DW-B-07	2,150	2	185	1	120	370				90	100		0.94		$129,645
DW-B-08	3,455	5	610	1	120			100		50			0.46		$211,935
DW-B-09	520			1	120	200				50			0.22	0.742	$62,391
DW-B-10	585	1	120	1	160					110			0.25	1.265	$114,250
DW-B-11	490			1	80						50	240	0.16		$48,512
UFDW-A-12	2,800	6	480	1	40	400				50			0.52		$148,924
UFDW-A-13	2,335	1	75												$18,600
SFDW-A-14	1,010	1	95							60			0.11		$29,290
SFDW-A-15	1,540	1	160							90			0.06		$47,857
SFDW-A-16	1,905	1	40	3	100					65					$50,140
MFDW-A-17	1,375	1	100			400				60			0.30		$40,874
MFDW-A-18	1,855	1	100	1	90	200				60			0.11		$66,389
MFDW-A-19	375	1	120	1	40	170				70			0.23		$54,727
MFDW-A-20	1,105	2	80	3	130	520				50			0.23		$82,488
NFDW-A-21	560	2	190	1	130					70			0.23		$99,039
NFDW-B-22	5,275	2	140	1	50	200				70	80		0.14		$80,921
NFDW-B-23	850	2	95	2	80					40			0.07		$54,955
NFDW-U-46	1,060														$0
LFDW-A-24	1,265	3	160	6	280					70					$142,440
LFDW-A-25	1,170	4	490							60	100		0.18		$149,335
LFDW-B-26	1,035	2	220	1	80					60			0.24		$88,404
LFDW-B-27	845	1	200	1	110					80	50		0.18		$106,225
LFDW-B-28	1,460	2	240	1	150					90			0.07		$119,465
LFDW-B-29	505			3	140			410		90		150			$115,370
LFDW-B-30	200			1	100										$34,500
LFDW-U-44	1,560							1250							$162,500
LFDW-U-45	1,450														$0
TOTAL DIRTY WOMAN CREEK															$3,034,789
CC-A-31	565	2	160					450		60			0.92		$107,129
CC-A-32	1,880														$0
CC-B-33	290						290								$79,750
CC-B-34	250						250								$68,750
CC-B-35	235								230				0.40		$59,084
CC-B-36	780	1	140							70			0.14		$41,459
CC-B-37	1,045														$0
CC-C-38	45														$0
CC-C-39	2,445	4	330	1	80					90	75		0.22		$134,605
CC-C-40	550	1	80							60					$25,120
CC-U-41	4,050	3	300												$74,400
CC-U-42	3,325														$0
CC-U-43	3,375	3	300												$74,400
TOTAL CRYSTAL CREEK															$664,696

TABLE 14: DIRTY WOMAN & CRYSTAL CREEKS DRAINAGE BASIN PLANNING STUDY OVERALL COST ESTIMATE SELECTED ALTENATIVE

REACH NUMBER	DRAINAGEWAY SUBTOTAL COSTS	CULVERT SUBTOTAL COSTS	OVERALL REACH COSTS	SUGGESTED NON-REIMBURSIBLE COST ALLOCATION			REIMBURSIBLE COSTS
				TOWN OF MONUMENT	CDoT	EL PASO COUNTY	
DW-A-01	$144,182	$105,800	$249,982	$105,800			$144,182
DW-A-02	$45,672	$0	$45,672	$45,672			$0
DW-A-03	$158,690	$123,750	$282,440			$123,750 (1)	$158,690
DW-A-04	$0	$0	$0				$0
DW-A-05	$190,316	$136,250	$326,566	$73,490	$136,250 (2)		$116,826
DW-A-06	$236,752	$0	$236,752	$236,752			$0
DW-B-07	$129,645	$86,000	$215,645			$135,320	$80,325
DW-B-08	$211,935	$61,250	$273,185			$107,050	$166,135
DW-B-09	$62,391	$136,875	$199,266			$199,266	$0
DW-B-10	$114,250	$0	$114,250			$114,250	$0
DW-B-11	$48,512	$71,600	$120,112			$120,112	$0
UFDW-A-12	$148,924	$6,960	$155,884			$155,884	$0
UFDW-A-13	$18,600	$0	$18,600			$18,600	$0
SFDW-A-14	$29,290	$0	$29,290			$29,290	$0
SFDW-A-15	$47,857	$72,500	$120,357			$120,357	$0
SFDW-A-16	$50,140	$17,480	$67,620			$67,620	$0
MFDW-A-17	$40,874	$24,200	$65,074			$65,074	$0
MFDW-A-18	$66,389	$8,000	$74,389			$74,389	$0
MFDW-A-19	$54,727	$16,250	$70,977			$70,977	$0
MFDW-A-20	$82,488	$11,200	$93,688			$93,688	$0
NFDW-A-21	$99,039	$15,800	$114,839			$114,839	$0
NFDW-B-22	$80,921	$0	$80,921			$80,921	$0
NFDW-B-23	$54,955	$27,900	$82,855			$82,855	$0
NFDW-U-46	$0	$9,000	$9,000			$9,000	$0
LFDW-A-24	$142,440	$81,000	$223,440				$223,440
LFDW-A-25	$149,335	$28,800	$178,135			$178,135	$0
LFDW-B-26	$88,404	$95,200	$183,604			$183,604	$0
LFDW-B-27	$106,225	$33,800	$140,025			$140,025	$0
LFDW-B-28	$119,465	$35,000	$154,465			$154,465	$0
LFDW-B-29	$115,370	$27,000	$142,370			$142,370	$0
LFDW-B-30	$34,500	$0	$34,500			$34,500	$0
LFDW-U-44	$162,500	$16,800	$179,300			$179,300	$0
LFDW-U-45	$0	$0	$0				$0
TOTAL DIRTY WOMAN CREEK			$4,283,203	$461,714	$136,250	$2,795,641	$889,598
CC-A-31	$107,129	$16,000	$123,129	$123,129			$0
CC-A-32	$0	$0	$0				$0
CC-B-33	$79,750	$0	$79,750	$79,750			$0
CC-B-34	$68,750	$0	$68,750	$68,750			$0
CC-B-35	$59,084	$0	$59,084	$59,084			$0
CC-B-36	$41,459	$76,400	$117,859	$117,859			$0
CC-B-37	$0	$0	$0				$0
CC-C-38	$0	$125,000	$125,000		$125,000		$0
CC-C-39	$134,605	$53,300	$187,905				$187,905
CC-C-40	$25,120	$14,400	$39,520				$39,520
CC-U-41	$74,400	$80,120	$154,520	$107,800			$46,720
CC-U-42	$0	$49,000	$49,000	$49,000			$0
CC-U-43	$74,400	$0	$74,400				$74,400
TOTAL CRYSTAL CREEK			$1,078,917	$605,372	$125,000	$0	$348,545

(1) A portion of this amount is reimbursible under County Bridge Fee
(2) Considered a bridge by El Paso County

Federal Emergency Management Agency

Washington, D.C. 20472

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

IN REPLY REFER TO:
Case No.: 99-08-012P

The Honorable Charles C. Brown
Chairman, El Paso County Board
of Commissioners
27 East Vermijo Avenue, Third Floor
Colorado Springs, Colorado 80903-2208

Community: El Paso County, Colorado
Community No.: 080059
Panel Affected: 08041C0276 F
Effective Date of This Revision: NOV 0 9 1998

102-D-A

Dear Mr. Brown:

This responds to a request that the Federal Emergency Management Agency (FEMA) revise the effective Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS) report for El Paso County, Colorado and Incorporated Areas (the effective FIRM and FIS report for your community), in accordance with Part 65 of the National Flood Insurance Program (NFIP) regulations. Mr. John Liou, Hydrologist, FEMA Region VIII, requested that FEMA revise the FIRM and FIS report to show the effects of a revised hydraulic analysis to correct the effective study along Dirty Woman Creek–Lake Fork and Lake Woodmoor.

Because this Letter of Map Revision (LOMR) is being issued to correct a mapping or study analysis error, fees were not assessed for the review.

We have completed our review of the submitted data and the flood data shown on the effective FIRM and FIS report. We have revised the FIRM and FIS report to modify the elevations of the flood having a 1-percent chance of being equaled or exceeded in any given year (base flood) along Dirty Woman Creek–Lake Fork from approximately 1,370 feet upstream to approximately 4,790 feet upstream of the confluence with Dirty Woman Creek. As a result of the modifications, the base flood elevations (BFEs) for Dirty Woman Creek–Lake Fork decreased. On the effective FIRM, the BFEs are shown as increasing throughout Lake Woodmoor. However, our review of the data used to create the effective FIRM revealed an error. The BFEs are at a constant elevation and have been corrected. This letter revises the BFEs for Lake Woodmoor and a reach of Dirty Woman Creek–Lake Fork from just upstream to approximately 700 feet upstream of Lake Woodmoor. The modifications are shown on the enclosed annotated copies of FIRM Panel(s) 08041C0276 F, Profile Panel(s) 314P and 315P, and affected portions of the Floodway Data Table. This LOMR hereby revises the above-referenced panel(s) of the effective FIRM and the affected portions of the FIS report, both dated March 17, 1997.

The modifications are effective as of the date shown above. The map panel(s) as listed above and as modified by this letter will be used for all flood insurance policies and renewals issued for your community.

The following table is a partial listing of existing and modified BFEs:

Location	Existing BFE (feet)*	Modified BFE (feet)*
Approximately 1,370 feet upstream of confluence with Dirty Woman Creek	7,102	7,102
Approximately 4,100 feet upstream of confluence with Dirty Woman Creek	7,110	7,102
Approximately 4,380 feet upstream of confluence with Dirty Woman Creek	7,116	7,115
Approximately 4,790 feet upstream of confluence with Dirty Woman Creek	7,128	7,128

*Referenced to the National Geodetic Vertical Datum, rounded to the nearest whole foot

Public notification of the modified BFEs will be given in *The Tribune* on or about December 10 and December 17, 1998. A copy of this notification is enclosed. In addition, a notice of changes will be published in the *Federal Register*. Within 90 days of the second publication in *The Tribune*, a citizen may request that FEMA reconsider the determination made by this LOMR. Any request for reconsideration must be based on scientific or technical data. All interested parties are on notice that, until the 90-day period elapses, the determination to modify the BFEs presented in this LOMR may itself be modified.

Because this LOMR will not be printed and distributed to primary users, such as local insurance agents and mortgage lenders, your community will serve as a repository for these new data. We encourage you to disseminate the information reflected by this LOMR throughout the community, so that interested persons, such as property owners, local insurance agents, and mortgage lenders, may benefit from the information. We also encourage you to prepare a related article for publication in your community's local newspaper. This article should describe the assistance that officials of your community will give to interested persons by providing these data and interpreting the NFIP maps.

We will not physically revise and republish the FIRM and FIS report for your community to reflect the modifications made by this LOMR at this time. When changes to the previously cited FIRM panel(s) and FIS report warrant physical revision and republication in the future, we will incorporate the modifications made by this LOMR at that time.

This LOMR is based on minimum floodplain management criteria established under the NFIP. Your community is responsible for approving all floodplain development, and for ensuring all necessary permits required by Federal or State law have been received. State, county, and community officials, based on knowledge of local conditions and in the interest of safety, may set higher standards for construction in the Special Flood Hazard Area. If the State, county, or community has adopted more restrictive or comprehensive floodplain management criteria, these criteria take precedence over the minimum NFIP criteria.

This determination has been made pursuant to Section 206 of the Flood Disaster Protection Act of 1973 (Public Law 93-234) and is in accordance with the National Flood Insurance Act of 1968, as amended (Title XIII of the Housing and Urban Development Act of 1968, Public Law 90-448), 42 U.S.C. 4001-4128, and 44 CFR Part 65. Pursuant to Section 1361 of the National Flood Insurance Act of 1968, as amended, communities participating in the NFIP are required to adopt and enforce floodplain management regulations that meet or exceed NFIP criteria. These criteria are the minimum requirements and do not supersede any State or local requirements of a more stringent nature. This includes adoption of the effective FIRM and FIS report to which the regulations apply and the modifications described in this LOMR.

FEMA makes flood insurance available in participating communities; in addition, we encourage communities to develop their own loss reduction and prevention programs. Our Project Impact initiative, developed by FEMA Director James Lee Witt, seeks to focus the energy of businesses, citizens, and communities in the United States on the importance of reducing their susceptibility to the impact of all natural disasters, including floods, hurricanes, severe storms, earthquakes, and wildfires. Natural hazard mitigation is most effective when it is planned for and implemented at the local level, by the entities who are most knowledgeable of local conditions and whose economic stability and safety are at stake. For your information, we are enclosing a Project Impact Fact Sheet. For additional information on Project Impact, please visit our Web site at **www.fema.gov**.

If you have any questions regarding floodplain management regulations for your community or the NFIP in general, please contact the Consultation Coordination Officer (CCO) for your community. Information on the CCO for your community may be obtained by contacting the Director, Mitigation Division of FEMA in Denver, Colorado, at (303) 235-4830. If you have any technical questions regarding this LOMR, please contact Ms. Sally P. Magee of our staff in Washington, DC, either by telephone at (202) 646-8242 or by facsimile at (202) 646-4596.

Sincerely,

Sally Magee

Sally P. Magee, Project Engineer
Hazards Study Branch
Mitigation Directorate

For: Matthew B. Miller, P.E., Chief
Hazards Study Branch
Mitigation Directorate

Enclosure(s)

cc: Mr. Dan Bunting
Regional Floodplain Administrator
Pikes Peaks Regional Building Department

CHANGES ARE MADE IN DETERMINATIONS OF BASE FLOOD ELEVATIONS FOR THE UNINCORPORATED AREAS OF EL PASO COUNTY, COLORADO, UNDER THE NATIONAL FLOOD INSURANCE PROGRAM

On March 17, 1997, the Federal Emergency Management Agency identified Special Flood Hazard Areas (SFHAs) in the unincorporated areas of El Paso County, Colorado, through issuance of a Flood Insurance Rate Map (FIRM). The Mitigation Directorate has determined that modification of the elevations of the flood having a 1-percent chance of being equaled or exceeded in any given year (base flood) for certain locations in this community is appropriate. The modified base flood elevations (BFEs) revise the FIRM for the community.

The changes are being made pursuant to Section 206 of the Flood Disaster Protection Act of 1973 (Public Law 93-234) and are in accordance with the National Flood Insurance Act of 1968, as amended (Title XIII of the Housing and Urban Development Act of 1968, Public Law 90-448), 42 U.S.C. 4001-4128, and 44 CFR Part 65.

A revised hydraulic analysis was performed to correct an error in the effective Flood Insurance Study and has resulted in decreased BFEs for Dirty Woman Creek–Lake Fork and Lake Woodmoor. The table below indicates existing and modified BFEs for selected locations along the affected lengths of the flooding source(s) cited above.

Location	Existing BFE (feet)*	Modified BFE (feet)*
Approximately 1,370 feet upstream of confluence with Dirty Woman Creek	7,102	7,102
Approximately 4,100 feet upstream of confluence with Dirty Woman Creek	7,110	7,102
Approximately 4,380 feet upstream of confluence with Dirty Woman Creek	7,116	7,115
Approximately 4,790 feet upstream of confluence with Dirty Woman Creek	7,128	7,128

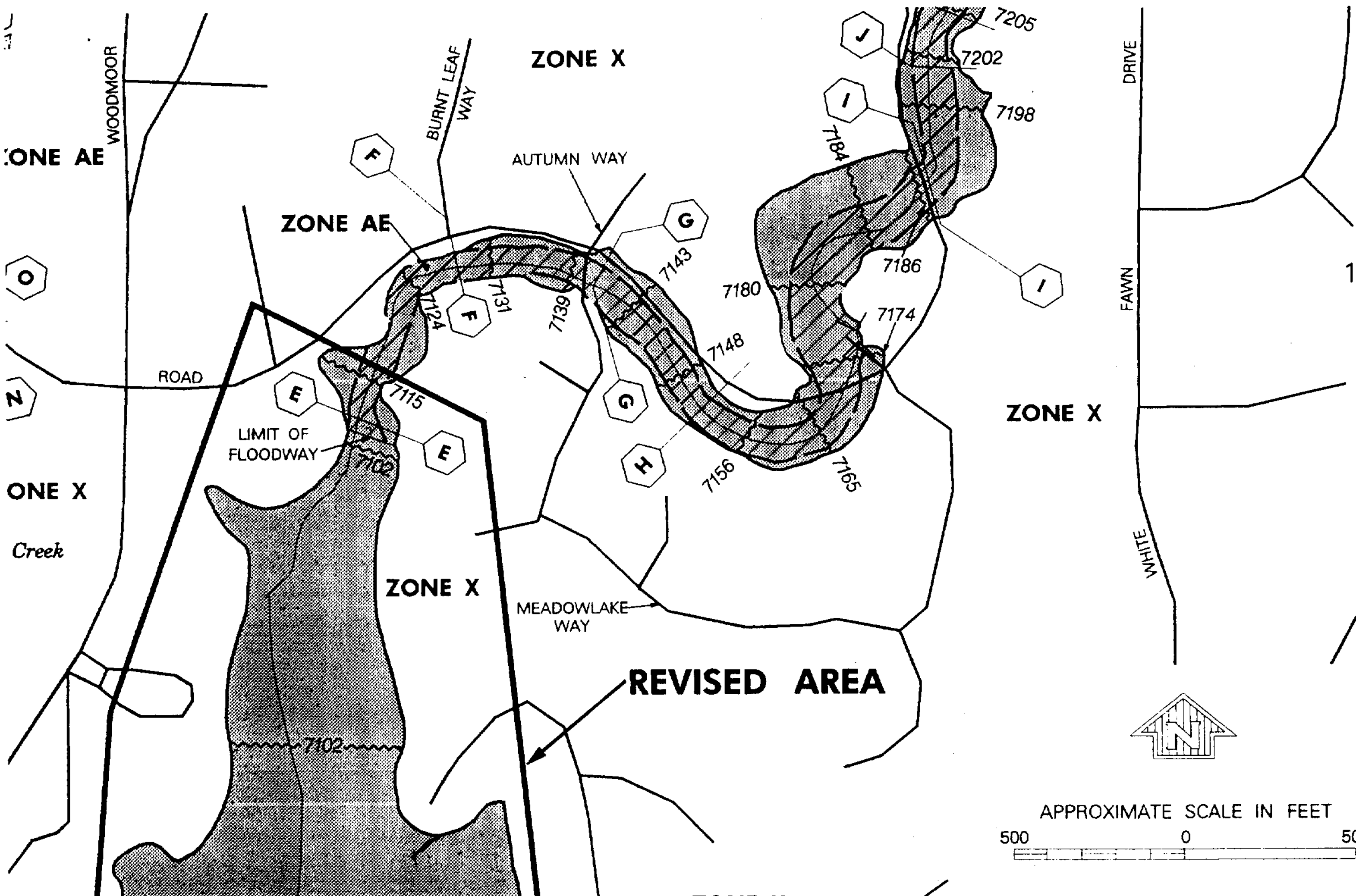
*National Geodetic Vertical Datum, rounded to nearest whole foot

Under the above-mentioned Acts of 1968 and 1973, the Mitigation Directorate must develop criteria for floodplain management. To participate in the National Flood Insurance Program (NFIP), the community must use the modified BFEs to administer the floodplain management measures of the NFIP. These modified BFEs will also be used to calculate the appropriate flood insurance premium rates for new buildings and their contents and for the second layer of insurance on existing buildings and contents.

Upon the second publication of notice of these changes in this newspaper, any person has 90 days in which he or she can request, through the Chief Executive Officer of the community, that the Mitigation Directorate reconsider the determination. Any request for reconsideration must be based on knowledge of changed conditions or new scientific or technical data. All interested parties are on notice that until the 90-day period elapses, the Mitigation Directorate's determination to modify the BFEs may itself be changed.

Any person having knowledge or wishing to comment on these changes should immediately notify:

The Honorable Charles C. Brown
Chairman, El Paso County Board of Commissioners
27 East Vermijo Avenue, Third Floor
Colorado Springs, Colorado 80903-2208



NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 276 OF 1300

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0276	F
MONUMENT, TOWN OF	080064	0276	F
PALMER LAKE, TOWN OF	080065		

REVISED TO REFLECT LOMR DATED NOV 09 1998

MAP NUMBER 08041C0276 F

EFFECTIVE DATE: MARCH 17, 1997

Federal Emergency Management Agency

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE
Dirty Woman Creek-Lake Fork								
A	130	62	79	6.1	7,014.5	7,014.5	7,014.5	0.0
B	580	26	57	8.5	7,061.8	7,061.8	7,061.8	0.0
C	1,203	43	67	7.1	7,091.2	7,091.2	7,091.2	0.0
D	1,358	64	77	6.3	7,101.9	7,101.9	7,101.9	0.0
E	4,198	71	138	8.0	7,108.9	7,108.9	7,109.4	0.5
F	4,788	68	136	8.1	7,128.1	7,128.1	7,128.1	0.0
G	5,216	150	879	1.2	7,140.5	7,140.5	7,140.7	0.2
H	5,720	80	136	7.5	7,150.4	7,150.4	7,150.5	0.1
I	7,168	130	160	6.4	7,188.8	7,188.8	7,188.9	0.1
J	7,508	110	138	6.4	7,201.3	7,201.3	7,201.4	0.1
K	7,691	130	154	5.7	7,204.8	7,204.8	7,204.8	0.0
L	8,356	70	119	7.5	7,220.9	7,220.9	7,221.1	0.2
M	8,731	75	128	6.9	7,233.8	7,233.8	7,234.0	0.2
N	9,309	130	491	1.2	7,252.0	7,252.0	7,252.2	0.2
O	9,669	70	91	6.5	7,269.5	7,269.5	7,269.7	0.2

REVISED DATA

[1]Feet Above Dirty Woman Creek

REVISED TO REFLECT LOMR DATED NOV 09 1998

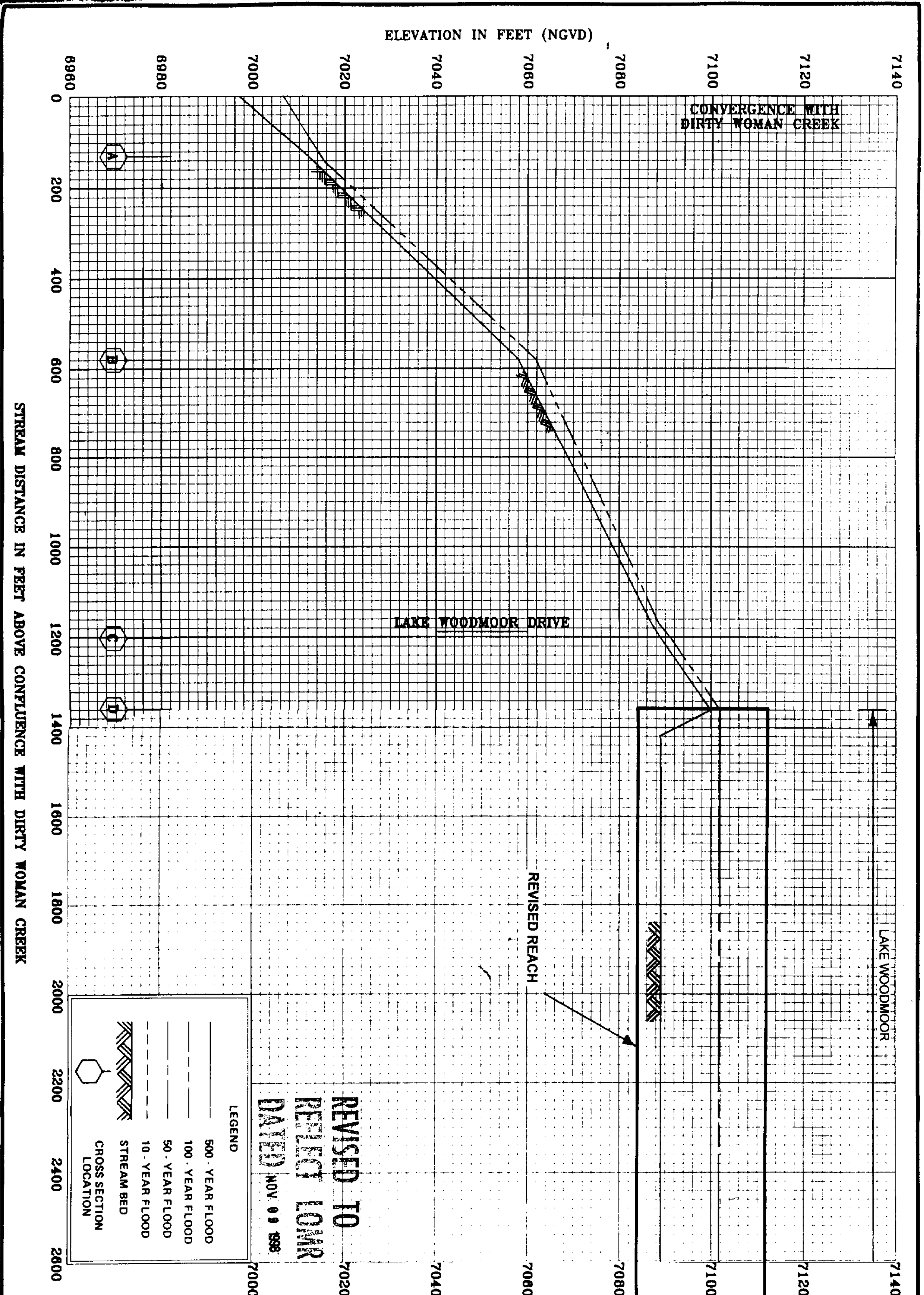
TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, CO
AND INCORPORATED AREAS

FLOODWAY DATA

DIRTY WOMAN CREEK-LAKE FORK



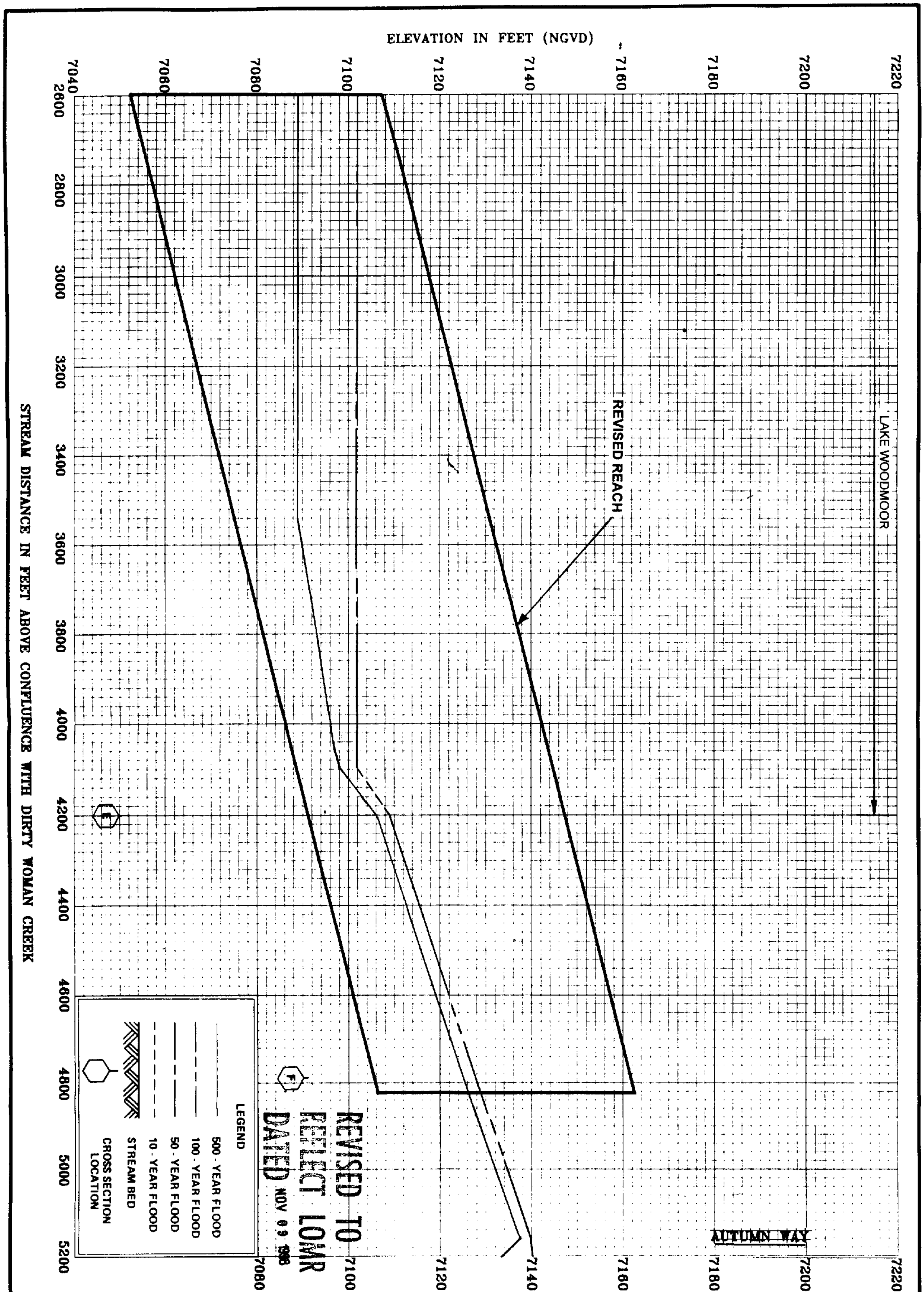
FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY,CO

AND INCORPORATED AREAS

FLOOD PROFILES

DIRTY WOMAN CREEK – LAKE FORK



FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOOD PROFILES
EL PASO COUNTY,CO	DIRTY WOMAN CREEK – LAKE FORK
AND INCORPORATED AREAS	

315P

WOODMOOR
Water & Sanitation District No. 1
P. O. Box 1407 • Monument, Colorado 80132
Phone (719) 488-2525 • Fax (719) 488-2530

May 31, 2022

To: La Plata Communities, Inc
Attn: Beth Diana
La Plata Communities, Inc
9540 Federal Drive, Suite 200
Colorado Springs, CO 80921

RE: Proposed Stormwater Drainage – North Bay at Lake Woodmoor

Dear Ms. Diana:

Woodmoor Water and Sanitation District ("the District") has reviewed the "Final Drainage Report for North Bay at Woodmoor" as prepared by Kiowa Engineering, dated September 23, 2016. The report proposes to utilize Lake Woodmoor for meeting both water quality and water quantity storm water detention pursuant to current El Paso County Drainage Criteria by allowing storm water runoff from the development to flow directly into Lake Woodmoor without any onsite permanent storm water controls. It is our understanding that current drainage criteria typically requires both storm water quantity as well as storm water quality detention facilities.

The quantity of storm water entering Lake Woodmoor from the development does not cause the District concern. However, Lake Woodmoor is a primary drinking water supply for Woodmoor residents and therefore storm water quality is of concern. The District requests that permanent storm water quality BMPs be installed within the development that channels all developed flows through the BMPs in accordance with the current El Paso County Drainage Criteria. In addition, the District requests the usage of sand filters to other forms of permanent storm water quality BMPs.

Sincerely,

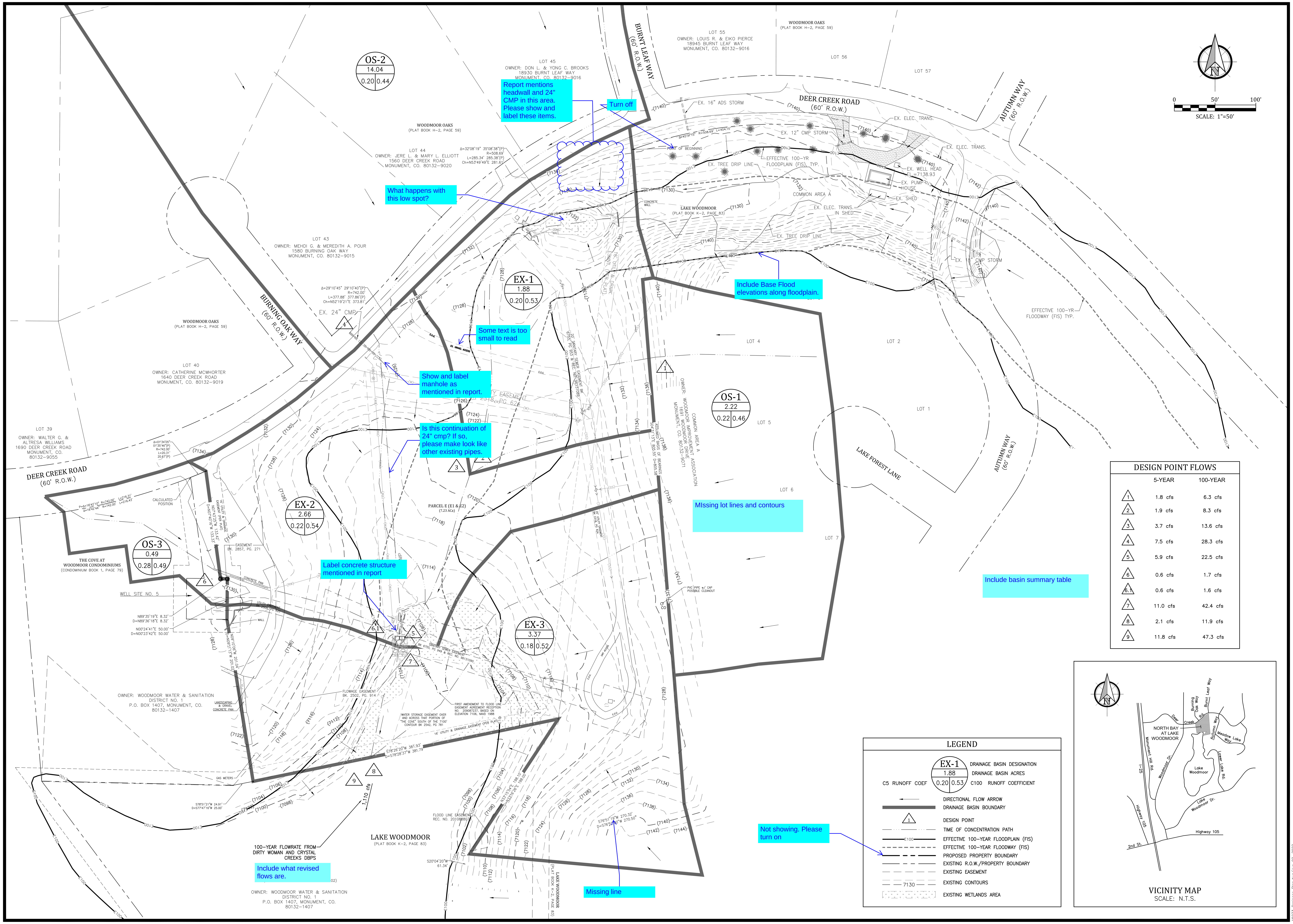
Jessie J. Shaffer
District Manager

Cc: Ariel Hacker – District Engineer
Dan LaFontaine – Operations Superintendent

APPENDIX H

Existing and Proposed Drainage Plans

Sheet DP1 - Drainage Plan Existing Condition
Sheet DP2 - Final Drainage Plan Developed Condition



DESIGN POINT FLOWS

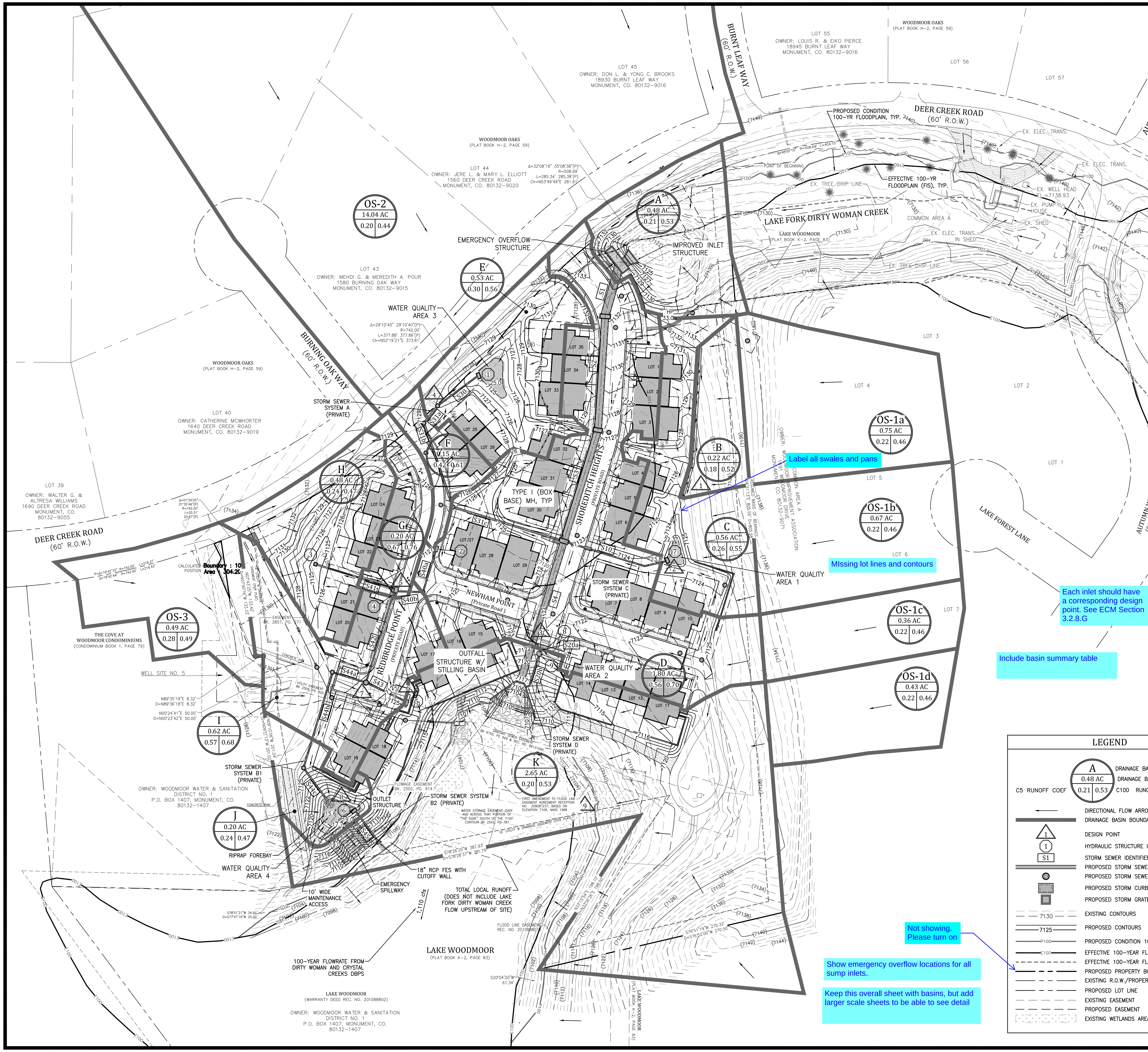
	5-YEAR	100-YEAR
1	1.8 cfs	6.3 cfs
2	1.9 cfs	8.3 cfs
3	3.7 cfs	13.6 cfs
4	7.5 cfs	28.3 cfs
5	5.9 cfs	22.5 cfs
6	0.6 cfs	1.7 cfs
6.1	0.6 cfs	1.6 cfs
7	11.0 cfs	42.4 cfs
8	2.1 cfs	11.9 cfs
9	11.8 cfs	47.3 cfs

Kiowa Engineering Corporation
Celebrating 30 years
1604 South 21st Street
Colorado Springs, Colorado 80904
(719)630-7342

North Bay at Lake Woodmoor
Drainage Plan
Existing Condition
El Paso County, Colorado

Project No.: 15073.2
Date: June 3, 2022
Design: CJC
Drawn: CJC
Check: MWE
Revisions:

SHEET
DP1



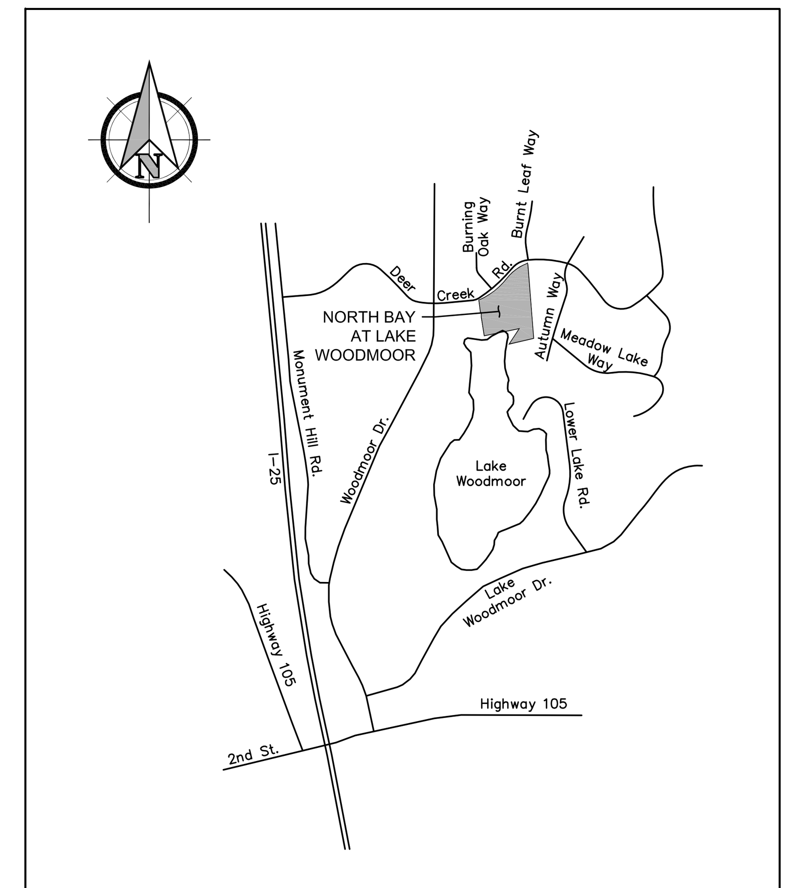
DESIGN POINT FLOWS

Design Point	5-YEAR	100-YEAR
1	0.8 cfs	2.8 cfs
2	1.9 cfs	6.6 cfs
3	5.4 cfs	11.7 cfs
4	8.0 cfs	29.6 cfs
5	1.5 cfs	3.7 cfs
6	2.0 cfs	4.5 cfs
7	3.2 cfs	7.6 cfs
8	3.4 cfs	8.1 cfs
9	2.2 cfs	9.7 cfs

STRUCTURE IDENTIFIER	STRUCTURE DESCRIPTION	STRUCTURE IDENTIFIER	STRUCTURE DESCRIPTION	STRUCTURE IDENTIFIER	STRUCTURE DESCRIPTION
1	TYPE D GRATED INLET	S1	8'x5' RCB	S40b	18" RCP
2	5' CURB INLET	S2	78" RCP	S41	18" RCP
3	TYPE C GRATED INLET	S3	78" RCP	S42	18" RCP
4	5' CURB INLET	S4	78" RCP	S43	18" RCP
5	5' CURB INLET	S10	18" RCP	S44a	18" RCP
6	TYPE D GRATED INLET	S20a	18" RCP	S44b	18" RCP
7	TYPE D GRATED INLET	S20b	18" RCP	S44c	18" RCP
8	10' CURB INLET	S30	18" RCP	S45	18" RCP
9	STORMCEPTOR	S31a	24" RCP		
		S31b	24" RCP		
		S31c	24" RCP		
		S40a	18" RCP		

LEGEND

A / 0.48 AC / 0.21 0.53	DRAINAGE BASIN DESIGNATION; DRAINAGE BASIN ACRES; C5 RUNOFF COEF; C100 RUNOFF COEFFICIENT
	DIRECTIONAL FLOW ARROW
	DRAINAGE BASIN BOUNDARY
1	DESIGN POINT
1	HYDRAULIC STRUCTURE IDENTIFIER
S1	STORM SEWER IDENTIFIER
	PROPOSED STORM SEWER PIPE
D	PROPOSED STORM SEWER MANHOLE
	PROPOSED STORM CURB INLET
	PROPOSED STORM GRATED INLET
7130	EXISTING CONTOURS
7125	PROPOSED CONTOURS
P100	PROPOSED CONDITION 100-YEAR FLOODPLAIN
E100	EFFECTIVE 100-YEAR FLOODPLAIN (FIS)
	EFFECTIVE 100-YEAR FLOODWAY (FIS)
	PROPOSED PROPERTY BOUNDARY
	EXISTING R.O.W./PROPERTY BOUNDARY
	PROPOSED LOT LINE
	EXISTING EASEMENT
	PROPOSED EASEMENT
	EXISTING WETLANDS AREA



VICINITY MAP
SCALE: N.T.S.

Celebrating 30 years
Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904
(719)630-7342

North Bay at Lake Woodmoor
Final Drainage Plan
Developed Condition
El Paso County, Colorado

Project No.:	15073.2
Date:	June 3, 2022
Design:	CJC
Drawn:	CJC
Check:	MWE
Revisions:	

SHEET
DP2