West End
16105

REGIONAL STORM WATER MANAGEMENT FACILITY

SOUTH ROANOKE COUNTY HIGH SCHOOL SITE

DESIGN REPORT

ROANOKE COUNTY, VIRGINIA

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AUGUST 2000

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Project Overview

This project will help Roanoke County through the implementation of a multi-faceted and cost-effective stormwater management facility that combines water quality/quantity control efforts with streambank enhancement/restoration and perpetual conservation of a multi-purpose riparian easement/buffer zone. This successful implementation of this locally-unique project would be consistent with various local and regional studies previously undertaken to understand the effects and impacts of a regional management program on existing flood control and water quality management problems. The project will also serve as an educational tool by providing an outdoor laboratory for water quality improvement and monitoring studies for high school students, as well as Roanoke College and Virginia Western Community College students.

The proposed school property is a largely undeveloped tract of land located west of Brambleton Avenue (Route 221) and Pleasant Hill Drive, and south of Farmington Drive. The site is bounded on all sides by the existing single-family residential developments of Nottingham Hills on the north, Kingston Court on the east, Nichols Estates on the south, and Canterbury Park on the south and west. The initial site is comprised of three parcels of land totaling approximately 69.5 acres with frontage on Farmington Drive. An existing building onsite is presently used as a residence. The main dwelling and ancillary buildings are accessed by means of a paved driveway running along the eastern boundary line, with an entrance onto Farmington Drive. The three individual parcels are currently under the ownership of The Roanoke County School Board. See Appendix A for site plan.

The site is partially wooded, with the majority of tree cover occurring in the western portion of the property and along the stream valley of Mud Lick Creek. The remainder of the site is open, lying in field or meadow condition. The main topographical feature of the site is Mud Lick Creek and the associated stream valley that runs southwest to northeast through the entire site. Approximately three fifths of the site lies on the western side of Mud Lick, and is typified by gentle to rolling terrain, with elevations falling 130 feet from the western boundary to the creek. On the east side, elevations fall approximately 50 feet from the property boundary to the creek. There is an existing pond, approximately two acres in area, to the west of the residence on the main tract. Mud Lick Creek passes below and immediately to the west of this pond. There is a 100-year flood plain associated with Mud Lick Creek that has been mapped and shown on Panel 61 of 90, Map Number 511610061-D, of the FEMA Flood Insurance Rate map for Roanoke County and is dated October 15, 1993.

The construction of the proposed South County High School will define the limits of area available for stormwater management storage volumes. Extensive earthwork operations will be undertaken to accommodate the entire site program supporting various school site elements. The limits of the embankment area directly adjacent and parallel to Mud Lick Creek to the west will form a uniform 3:1 slope rising an average of 50-feet from the basin floor. The majority of the existing slope along the east will be left in its natural state, with the exception of those areas requiring grading for recreational amenities, and will rise an average of 20-feet from the basin floor. The lowest elevation within the basin area is 1096 and the maximum elevation available for volume consideration is 1120, which yield 24-feet of effective basin area. The northern limits of the stormwater management facility will be limited by the proposed access road crossing that will serve the school building located on the west side of Mud Lick Creek. The low point elevation

of the road were it crosses the creek will be approximately 1124. The southern limits of the facility will be limited by Canter Drive, which serves the existing Canterbury Park subdivision. The existing road elevation is above the useable elevation considered for the stormwater management facility. Effective water surface area available for storm routing consideration, based on the constraints of the proposed site improvements, will be approximately 6.0 acres.

The Virginia Stormwater Management Handbook, First Edition 1999, was used as the basis of design for the water quality aspects. While the handbook has yet to be adopted, it reflects consistency between the Virginia SWM Regulations (DCR), The Chesepeake Bay Preservation Act (CBPA) and regulations (CBLAD) and the Virginia Pollution Discharge Elimination System (VPDES) permit (DEQ).

Hydrology Design

The Mud Lick Creek watershed is a 9.6-square mile drainage basin located in east central Roanoke County and southeast Roanoke City. The watershed is fan shaped and has a length of about 4.5 miles and a maximum width of about 3.5 miles near its headwaters. The Mud Lick Creek basin is located entirely within Roanoke County and the City of Roanoke. Mud Lick Creek originates on Long Ridge, near Poor Mountain, at an elevation of approximately 2300 feet above sea level and flows in a southeasterly direction for about 1.7 miles. The course continues in a northeasterly direction for approximately 4.5 miles until reaching its confluence with the Roanoke River within the City limits. Land along the main stem of Mud Lick Creek is relatively undeveloped until the stream intersects with Farmington Drive where the downstream land use becomes primarily residential with some scattered commercial development. The Wood's End Facility is located approximately 1100' upstream from Farmington Drive and serves 1,218.8 acres (1.9 $mi.^2$).

The SCS Unit Hydrograph Method was used to compute the hydrograph for the design. The drainage basin was delineated from USGS topography and the time of concentration to the Wood's End facility was calculated using 5 distinct flow segments: 1 overland flow segment, 1 shallow concentrated flow segment, and 3 channel segments. The time-of-concentration to the facility is 1.26 hours. See Appendix B for the drainage basin map.

Information from maps developed for the Roanoke Valley Regional Stormwater Management Plan were used to determine the hydrologic soil groups and existing land uses. Future land uses were primarily determined from maps developed for the Roanoke Valley Regional Stormwater Management Plan but were modified to incorporate know development such as the new high school on the Wood's End property. These maps are included in Appendix B.

Runoff curve numbers for the different land uses were assigned based on values obtained in TR-55 as they related to the descriptions of land uses defined in the Roanoke County 1998 Community Plan. The existing land uses were assigned the following TR-55 cover descriptions for determining CN value:

Existing Land Use Shown	TR-55 Cover Description Assigned
Residential (2 acre lots)	Residential (2 acre lots)
Residential (1 acre lots)	Residential (1 acre lots)
Residential (1/2 acre lots)	Residential (1/2 acre lots)
Residential (1/3 acre lots)	Residential (1/3 acre lots)
Pasture	Pasture, good condition
Open Space	Open space, good condition
Brush	Brush, good condition
Agriculture	Woods-grass combination, fair condition
Woods and Forest	Woods, good condition

Most cover descriptions assigned follow TR-55 exactly. The agriculture cover description of woods-grass combination, fair condition was used because it represents orchards or tree farms as defined in TR-55. The existing agricultural land uses observed

seemed to be typified by orchards or tree farms. However, since there are other agricultural uses which may represent higher curve numbers, the CN associated with fair conditions will be used.

The future land uses were assigned the following TR-55 cover descriptions for determining CN value:

Future Land Use Shown	TR-55 Cover Description Assigned
Medium Density Residential	Residential (1/2 acre lots)
Low Density Residential	Residential (2 acre lots)
Parks / Open Spaces	Open Space, good condition
Woods / Forest	Woods, good condition
Surface Water	Impervious
Rural Village	Residential (2 acre lots)
Village Center	Residential (1/8 acre lots, town houses)
Neighborhood Conservation	Average of Residential (1/3 acre lots) and Agriculture defined under Existing Land Use Above

Medium density residential, low density residential, parks/open spaces, woods/forest, and surface water are straightforward interpretations. Rural Village, Village Center, and Neighborhood Conservation represent land uses defined in Roanoke County's 1998 Community Plan.

The Rural Village land use is characterized by rural landscapes where protection of the rural character is desired. Development is encouraged to leave land available for productive agricultural activities. Cluster developments are encouraged which allows for 50% to 70% of parks and open space. An average curve number of residential (1 acre) and agricultural, as defined under existing land use, will be assigned to represent this land use type.

A Village Center serves as a focal point to surrounding rural areas by providing neighborhood-oriented commercial services and businesses, churches, post offices, fire stations, and schools. The Village Center development should be consistent with adjacent communities in which it serves. These land uses are typically not as intense as commercial and business districts which could average 85% impervious. The residential (1/8 acre lots, town houses) with an average of 65% of impervious area represents a more typical development density expected for this land use.

The Neighborhood Conservation land use represents established residential neighborhoods where conservation and continuation of the existing housing pattern are desired. For the study drainage basin, areas that are shown as Neighborhood Conservation typically border residential (1/3 acre lots) and agricultural land uses. Therefore, the average curve number of these two uses will be assigned.

Using the drainage area of 1,218.8 acres, time-of-concentration of 1.26 hours, existing CN value of 67.9, and a future CN value of 73.9, the following flow rates were calculated:

Storm Frequency	Existing Conditions	Future Conditions	Percent Increase
1	267	441	65%
2	417	626	50%
5	767	1032	35%
10	960	1248	30%
25	1371	1708	25%
50	1674	2041	22%
100	2039	2429	19%
PMF	12278	12707	3%

See Appendix C for breakdown of land use, CN values, and runoff calculations.

Outlet Structure Design

The outlet structure design incorporates a base flow pipe to allow normal stream flows through the embankment, 30-hour drawdown of 2.0 times the water quality volume, release of the 2-year storm event at pre-developed rates, reduction of flow rates for other storm events, and the ability to safely pass 41% of the probable maximum flood (PMF). While Roanoke County will maintain and operate the facility as a Class I dam, the nature of the design allows for protection above of a 1/2 PMF to be incorporated into the emergency action plan instead of modifying the design with potentially significant cost, maintenance, and aesthetic implications.

Due to the timing of the project and its relationship to the school construction, an important aspect to the design is the utilization of 12-1/2' structural plate pipe. The structural plate pipe was specified for the school construction and any changes to material or size could cause significant cost and schedule impacts to both projects.

The base flow of Mud Lick Creek will be passed through a 24" pipe. The upstream endwall for the pipe will include a debris rack to prevent clogging of the pipe and an 18" orifice plate to decrease the release rate of 2.0 times the water quality volume and achieve a minimum 30-hour drawdown. Both ends of the pipe will be located at the existing center and invert of Mud Lick Creek. A small pit will be excavated at each end of the pipe to allow the accumulation of sediment to aid in the maintenance of the base flow pipe and adjacent creek channel.

The primary overflow structure will consist of three 12-1/2' diameter structural plate pipes located at an elevation in the embankment to allow the storage of 2.0 times the water quality volume. The three pipes will pass through the embankment at approximately 4.3% where it will discharge into a dissipation basin. The pipes will have capacity in excess of the 100-year storm event without allowing the roadway to overtop.

The access road for the high school will serve as the emergency overflow spillway. The design flood for the emergency overflow spillway is 1/2 PMF. The design flood would overtop the roadway by 1.1 feet at the low point of the road. Procedures will be in place in the emergency action plan to prevent overtopping of the road up to 1/2 PMF.

The outlet structure design will release the following post-developed flows:

Storm Event	Routed Q	% Reduction of Post-Developed Flow Increases
1	221	117%
2	414	101%
5	855	67%
10	1086	56%
25	1550	47%
50	1873	46%
100	2240	48%
PMF	12480	53%

See Appendix D for routing calculations.

Erosion Protection Design

Three critical locations for erosion protection for the Wood's End facility are the pipe penetrations through the embankment, outfall basin of principle spillway, and channel from outfall basin to Mud Lick Creek.

The pipe penetrations through the embankment will be designed with concrete cradles, graded filters, and partially graded filters. The cradle and filters will serve to safely move any water seepage through the embankment without causing any piping of the soil.

The outfall of the three pipes will discharge to a rip-rap basin. The rip-rap basin design was developed using the HY8Energy program developed by the Federal Highway Administration. HY8Energy is based on the Hydraulic Engineering Circular Number 14 - Hydraulic Design of Energy Dissipators for Culverts and Channels. The design anticipates the scour hole that would normally be created at the outlet of a culvert so that the scour hole can be constructed and lined with rip-rap. The 100-year storm event was used as the design flow for sizing the rip-rap basin.

Another location that could experience significant erosion is the channel constructed to convey flows from the rip-rap basin to Mud Lick Creek. The channel will be a lined with a permanent geotextile is capable of withstanding the flow velocities anticipated.

See the Geotechnical Design section for information on seepage and piping prevention.

Geotechnical Design

The geotechnical design for the Wood's End facility was performed by Engineering Consulting Services, Limited (ECS) and is detailed in their report dated May 22, 2000. The following briefly describes the design.

Elements that will be incorporated in the design to control seepage and prevent piping included a clay cutoff trench, drainage blanket, concrete cradle, graded filter, and the replacement of any unsuitable soils.

The cutoff trench should be constructed through the sandy alluvial deposits and extend a minimum of 2 feet into the residual soils and/or weathered shale to reduce seepage losses beneath the embankment. The average depth of the cutoff trench is estimated to be 10 feet below existing grades based on the soil borings. A minimum cutoff trench depth of 2 feet into residual soils will be required along the abutment side slopes up to elevation 1,122 feet. (ECS 2000)

A drainage blanket, consisting of VDOT Grading G, Fine Aggregate or equivalent, should be placed along the prepared subgrade behind the downstream end wall and continue up each abutment to elevation 1,110 feet. The drainage blanket should be at least 18 inches in thickness and a minimum of 30 feet in width. Filter fabric, conforming to Mirafi 140N or equivalent, should be placed along the top and bottom of the drainage blanket to prevent fines from migrating into the sand. A 4-inch diameter slotted PVC pipe should be placed at the downstream end of the blanket, and sloped toward the end wall. The drainage pipe should daylight at the end wall at about elevation 1,092.5 feet. (ECS 2000)

Typically, compaction cannot be properly controlled below the mid-height of the base flow pipe. To prevent seepage losses at this pipe, a concrete cradle will be incorporated in the design. The concrete cradle should have a minimum thickness of 4 inches below the pipe invert and extend at least 8 inches laterally up to the mid-height of the pipe. The cradle of the base flow pipe should continue 100 linear feet from the upstream end wall. Compacted soil can then be placed above the mid-height of the pipe. (ECS 2000) The principal outlet structures will also require a concrete cradle up to the mid-height of the pipe and continue 25 linear feet from the first complete circular section of pipe which relates to approximately 47 total linear feet from the end of the pipes. Compacted soil can then be placed above the mid-height of the pipe.

The base flow pipe should also incorporate a graded filter that will extend from the end of the concrete cradle 50 linear feet downstream. The graded filter should consist of VDOT No. 78 stone, completely encapsulated with filter fabric, and extend a minimum lateral distance equal to the base flow pipe diameter. The graded filter should transition to a partially graded filter from the end of the graded filter to the end wall. The partially graded filter should consist of a minimum bedding of 6 inches up to the mid-height of the base flow pipe. Two 4-inch diameter slotted PVC pipes should be placed on either side of the base flow pipe and connected with the drainage blanket pipes. (ECS 2000)

An existing sanitary sewer located beneath the embankment will be replaced. All existing backfill associated with the sanitary sewer that is located beneath the embankment will be replaced with compacted clay fill. (ECS 2000)

Environmental

ECS, Inc., under direction of the Roanoke County School Board, has performed a phase I ESA of the subject property. Per their report, the site would generally be considered developable with no major impediments to construction.

ECS, Inc., by direction of the Roanoke County School Board, conducted a site visit with the Army Corps of Engineers to confirm their site assessment of wetland conditions on the property. The Army Corps has agreed that no jurisdictional wetlands are present onsite. Mud Lick Creek and its tributary located near the southern property boundary are regulated waters of the U. S. The pond located east of Mud Lick Creek is not jurisdictional and may be drained to accommodate construction activities on the site. Care must be taken during draining operations to minimize impact to the adjacent creek and downstream properties. A nationwide permit, secured through the local Army Corps of Engineers office, will be required for the road and stormwater management embankments crossing Mud Lick Creek.

The Virginia Marine Resources Commission has declined jurisdiction over the project based on the size of the drainage basin and the base flow of Mud Lick Creek.

The Department of Environmental Quality (DEQ) has verbally declined jurisdiction over the project. The DEQ is satisfied with the Army Corps of Engineers approval for a nationwide permit.

Operation and Maintenance

A Class I Operation and Maintenance Certificate is required for the Wood's End Facility through the Virginia Soil and Water Conservation Board and will be for a term of six years. A reinspection report certified by a professional engineer must be filed every two years. The owner must also submit an annual inspection report on official forms when no professional reinspection is required. The six year operation and maintenance certificate must be renewed 90 days prior to its expiration. The Virginia Soil and Water Conservation Board must be notified immediately if any changes occur downstream, either cultural or land use, that would present hazard to life or property in the event of failure.

Regular inspections should be conducted twice a year. Perform regular inspection during wet weather to determine if the facility is functioning properly. Special inspections should be conducted after all unusual occurrences, such as major storms (5" in 24 hours or greater), earthquakes, or sustained periods of high-velocity winds.

Regular inspections should include but not be limited to the following:

1. Inspect the upstream face of the dam embankment for adequate condition of the embankment.
2. Inspect the downstream face of the dam for any indication of distress such as seepage, sliding, or slumping.
3. Inspect entire embankment for undesirable vegetation and rodents.
4. Inspect the base flow pipe and principal overflow pipe to ensure they are free from debris.
5. Inspect the rip-rap stilling basin to ensure that the shape is not irregular from damage or that any rip-rap is deficient from flooding or vandalism.
6. Inspect the debris rack and orifice plate for any structural damage and clean away any debris that may be caught.
7. Inspect sediment pits at the inlet/outlet of the base flow pipe to determine the amount of sediment that has accumulated. Clean the sediment pit out if half the initial volume has been filled.
8. Immediately notify the proper authorities if any concerns are encountered.

Maintenance should include but not be limited to the following:

1. Mow the top and side slopes of the embankments a minimum of two times a year, once in June and once in September. Trees and woody vegetation growth shall be kept from all portions of the dam embankment. Other side slopes, and maintenance access should be mowed as needed.
2. Maintenance should include removing debris from dam, replacing damaged riprap, and repairing erosion in the facility.
3. Adequate vegetation (grass) cover shall be maintained on the dam embankment at all times.
4. Repair structural components of the facility such as the dam, pipes, debris rack, endwalls, or rip-rap basin upon the detection of any damage.
5. Remove any accumulated sediment in the sediment pits, rip-rap basin, or forebay if it reduces the design storage, interferes with the function of the outlet structures, when deemed necessary for aesthetic reasons, or when deemed necessary by the owner.

Rodent activity must also be monitored and controlled as part of a regular operation and maintenance of the facility. The following information obtained from Department of

Conservation and Recreation Dam Safety Program describes the three most destructive rodents to earthfilled dams and how to control them.

Groundhogs

The groundhog is the largest member of the squirrel family. This animal will burrow in from the downstream side of the dam staying above the phreatic line (the upper surface of seepage) so as to remain dry. The burrow will have many tunnels and chambers and always more than one entrance. Occupied burrows are easily spotted as the groundhog continually removes dirt from the den so that fresh dirt is visible on the surface of the dam.

Controlling a groundhog infestation should commence in early spring when burrows are active and easy to find. If control measures are delayed other game animals may be damaged as during the fall and winter they may take refuge in the groundhog burrow. Fumigation is one of the most affective methods of controlling groundhog population. However, around buildings or in a high fire hazard area trapping or shooting may be a better approach. It has also been noted that a well cleared and mowed dam discourages inhabitation.

Muskrats

The muskrat is a small stocky rodent with rich dark brown fur. Muskrats are chiefly nocturnal. Muskrat dens are constructed by burrowing into the banks of lakes and streams. These burrows start from six to eighteen inches below the water surface and the tunnel then rises to above the phreatic surface. It can be seen that the burrow starting from the reservoir side offers a path for water flow, and can seriously weaken the embankment. It becomes even more hazardous when a muskrat den on the upstream side is close to a groundhog den on the downstream side. If the earth partition between these dens should fail there is a conduit completely through the dam.

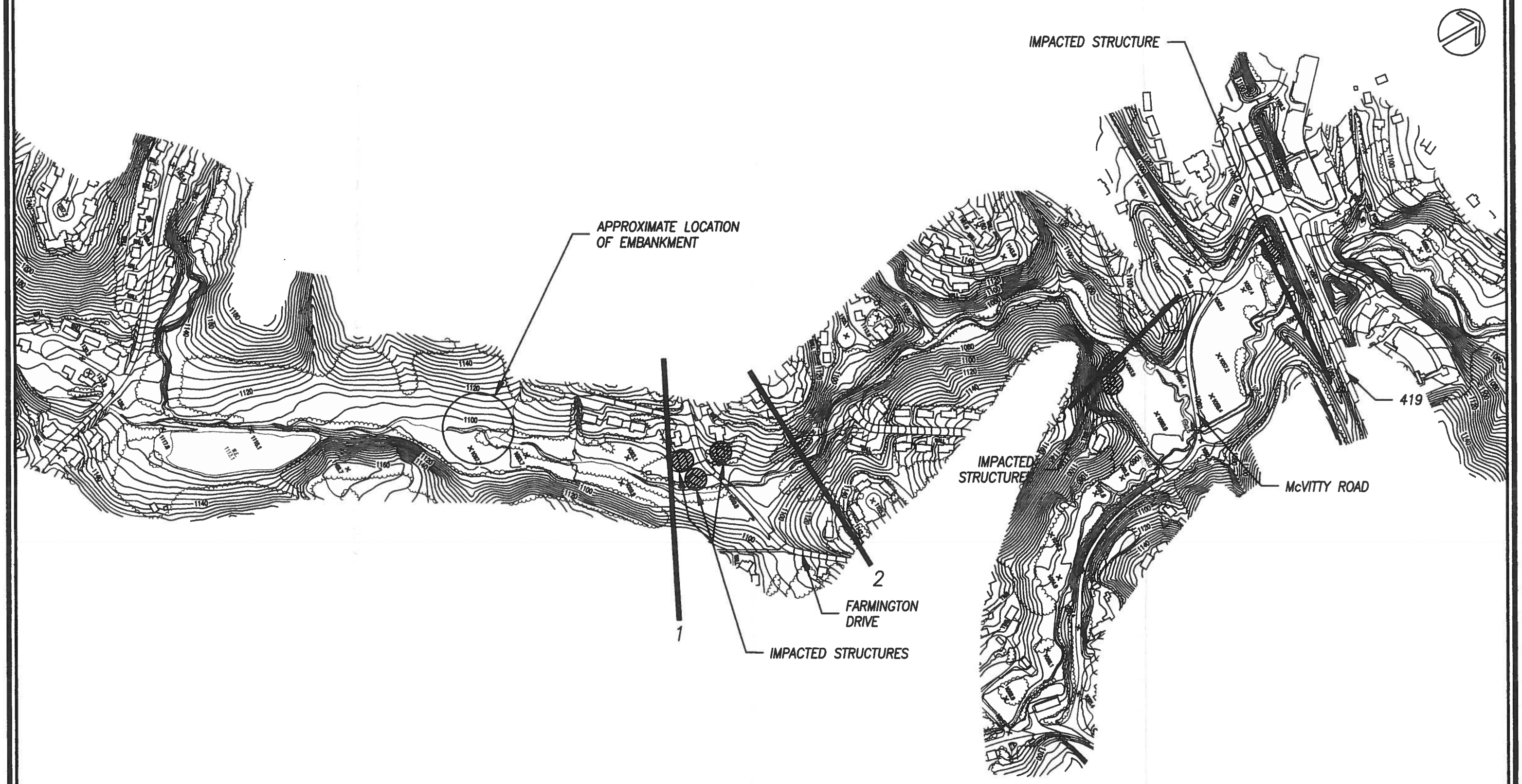
A successful method for eliminating the muskrat burrow is to place rip-rap on the upstream face of the dam. This rip-rap should start about three feet beneath the surface. As the muskrat attempts to burrow the rip-rap will collapse into the excavation and discourage the attempt. Heavy wire fencing lain in a similar manner will accomplish the same result. However, rip-rap slows wave erosion on the upstream face of the dam and thus has a two-fold value. Also removal of vegetation along the shore line will discourage habitation. Trapping may also be considered as a method of eliminating the muskrat.

Beavers

Beavers will plug spillways and have even been known to try to raise the elevation of the dam. This kind of activity can lead to the overtopping of the dam. Removal of the cuttings will remove the problem, but only temporarily. Beavers are not easily discouraged and they will continue to build. Some success has been obtained by placing electrically charged wires in spillways. If the dam is frequented by the genera1 public this might not be a good idea, and of course trapping is always an alternative.

Filling the burrow

One method for back filling the burrow is called mud-packing. This method consists of placing one or two lengths of metal stove or vent pipe vertically over the burrow. When the pipe is properly sealed a slurry of 90 percent earth and 10 percent concrete, plus an appropriate amount of water to make the slurry flow, is placed in the pipe and allowed to flow into the burrow. The last six inches is filled with dirt that will support grass growth.



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ROANOKE REGIONAL STORMWATER MANAGEMENT FACILITY

DAM BREACH ANALYSIS

1"=400'

AUGUST 2000

PROJECT: 00075

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Emergency Action Plan

Roanoke County has plans to incorporate a gauging system with the facility that will monitor and alert the County of conditions at the facility. The County will have in place individuals responsible for the monitoring of the facility during storm conditions or when the integrity of the facility is jeopardized.

As mentioned in the report, the County will have procedures in place for the placement of sandbags on the crest of the embankment to a height of no less than 2.0' to help ensure that the 1/2 PMF storm event does not overtop the embankment.

Other elements of the emergency action plan which will be detailed in a separate document include the following:

1. At least three individuals responsible for the monitoring of the facility.
2. Education of local enforcement agencies which might be needed to close roads, notify residents, or evacuate residents.
3. Notification of the local emergency coordinator.
4. Listing of life and property that could be affected and would be notified of a potential problem with the facility.
5. Identification of different stages of alert associated with the facility.
6. Written acknowledgement from the County's representatives, emergency coordinators, and other agencies who need to be aware of and understand their roles should the emergency action plan need to be implemented.

Dam Breach Analysis

A breach analysis has been performed for the facility. The methodology used included deriving breach flow from the "decay rate" equation and computing the water surface elevations at critical cross-sections identified downstream. The dam breach analysis will be used to determine the impact of a breach on downstream properties as well as individuals who should be notified if a potential failure could occur. The dam breach analysis is not intended to determine the water surface elevation at any particular cross-section to a high degree of accuracy, only to determine if the structure is likely to be impacted. For this analysis, any structure within 5' of elevation to the calculated water surface elevation is considered impacted.

The discharge value was changed at each cross section based on the result of the "decay rate" equation. The sections were analyzed individually without the use of a backwater effect. This corresponds to the hydraulic situation that would occur during a true breach event. In such a case the flow depth at each section would be independent of the downstream conditions due to the relatively short period of time that it would take for the discharge to rise to the peak value. The traditional steady flow assumptions of HEC-2 do not get incorporated into the calculations when critical depth results. This is valid because the flow is not steady during a breach event.

Four critical cross-sections were analyzed from the facility to the point that Mud Lick Creek passes under route 419 approximately 1 mile downstream. The dam breach is expected to impact 5 existing structures and overtop Farmington Drive and McVitty Road. The analysis stops at route 419 where the dam breach will not overtop the road embankment and will pass through the culverts under route 419. The discharge of the breach downstream of route 419 will be controlled by the capacity of the existing culverts and should therefore be contained within the currently mapped 100-year floodplain.

The attached map shows the property and roadways affected by a dam breach.

Water Quality

The Water Quality Report element of the Roanoke Valley Regional Stormwater Management Plan recommended that flood control facilities referenced in the Regional Plan be converted to Best Management Practice (BMP) facilities during final design of the facilities in order to reduce nutrients, metals and sediment loads to downstream receiving waters. Physical limitations of the site determined that, in order to address water quality as well as quantity concerns, an Extended Detention Basin (EDB) with Forebay BMP be utilized. The Virginia Stormwater Management Handbook, First Edition 1999, was used as the basis of design for the EDB in an effort to assure consistency between the Virginia SWM Regulations (DCR), The Chesapeake Bay Preservation Act (CBPA) and accompanying regulations (CBLAD), and the Virginia Pollution Discharge Elimination System (VPDES) permit administered by the Department of Environmental Quality (DEQ).

The Mud Lick Creek basin is located in a watershed (HUC L04) that is considered as a high priority for urban nutrients and urban erosion and is ranked overall as high in terms of NPS pollution potential, and has a Natural Heritage ranking of medium (as referenced in the NPS Pollution Potential and Natural Heritage Watershed Rankings table). While Mud Lick Creek is not on the 303(d) impaired segment list, the 1998 303(d) TMDL Priority List does include 11.72 miles of the Roanoke River within HUC L04 as being impaired for fecal coliform and general standard benthics. As a tributary to the 303(d) portion of the river, any efforts made to reduce fecal coliform and benthic pollution levels on Mud Lick Creek will have a positive impact by reducing pollutant loadings for the Roanoke River.

Conversations with Virginia Department of Environmental Quality (DEQ) personnel revealed that DEQ has not undertaken any water quality monitoring along Mud Lick Creek and, due to budgetary constraints, cannot commit any agency resources to establishment of a monitoring site along Mud Lick Creek. Therefore, there are currently no DEQ-documented water quality problems on this tributary of the Roanoke River and no plans to document any such problems in the immediate future. A monitoring program associated with this project will be implemented to provide baseline data for documenting existing water quality conditions along Mud Lick Creek and water quality sampling data obtained over a three-year period that would be used to monitor the effectiveness of the EDB BMP. This data could then be used by DEQ to supplement the water quality monitoring database in the area of Mud Lick Creek.

The EDB proposed for this project will reduce phosphorus, nitrogen, suspended solids, lead and zinc loadings through differential settling and biological uptake, and to a lesser extent for dry facilities, transformation by aquatic organisms and wetland vegetation. Settling efficiency and, to some extent, biological uptake and transformation are dependent on runoff detention time and the presence of appropriate wetland and aquatic vegetation. However, extending the detention time and constructing forebays to treat runoff from small, more frequent storms can increase pollutant removal efficiency. Extending the detention time of dry ponds is an effective, low cost means of removing particulate pollutants and controlling increases in downstream bank erosion. Studies show if stormwater runoff is detained for 24 hours or more, as much as 90 percent removal of pollutants is possible. A 30-hour drawdown allows additional time for ideal settling conditions to develop within the stormwater facility (DCR 1999).

This project utilizes both an extended 30-hour drawdown of two times the WQV and a wetland-enhanced forebay to increase pollutant removal efficiency in a cost-effective manner. In addition a 50-foot riparian easement/buffer zone will be provided (or protected where existing) to facilitate surface runoff pollutant removal. Streambank stabilization and enhancement efforts below the outfall structure of the EDB on Mud Lick Creek (on school-owned property), coupled with relocation and restoration of the stream channel (with approval of private property owners) to alleviate current flooding and streambank destabilization problems, will add to the overall project effectiveness from a water quality standpoint.

Appendix A

Buffer
Buffer
Passive Rec. Area
School
Football
Buffer
Softball
Buffer
Creek
Multi-Purpose Field
Buffer
Lick
Mud
Soccer
Tennis
Buffer
Canter
Drive
Storm Water Facility Study Area
Baseball
Buffer

ENGINEERING CONCEPTS, INC.

COUNTY OF ROANOKE VIRGINIA 1838

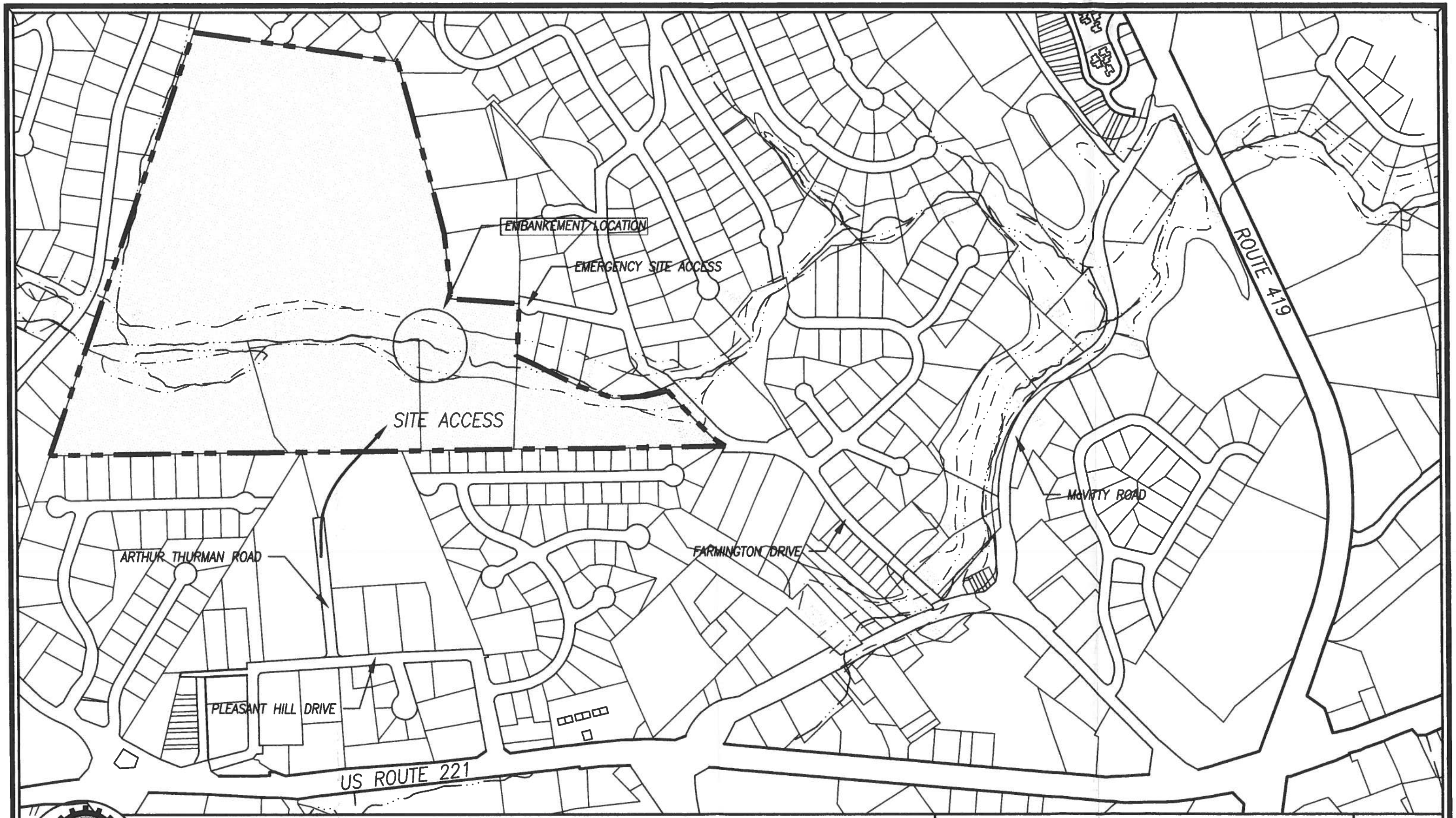
FEASIBILITY STUDY
REGIONAL STORM WATER MANAGEMENT FACILITY
SOUTH ROANOKE COUNTY HIGH SCHOOL SITE

OVERALL HIGH SCHOOL SITE PLAN

100' 0' 100' 200'
SCALE: 1"=100'

November 3, 1999

Appendix B



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ROANOKE REGIONAL STORMWATER MANAGEMENT FACILITY

VICINITY MAP

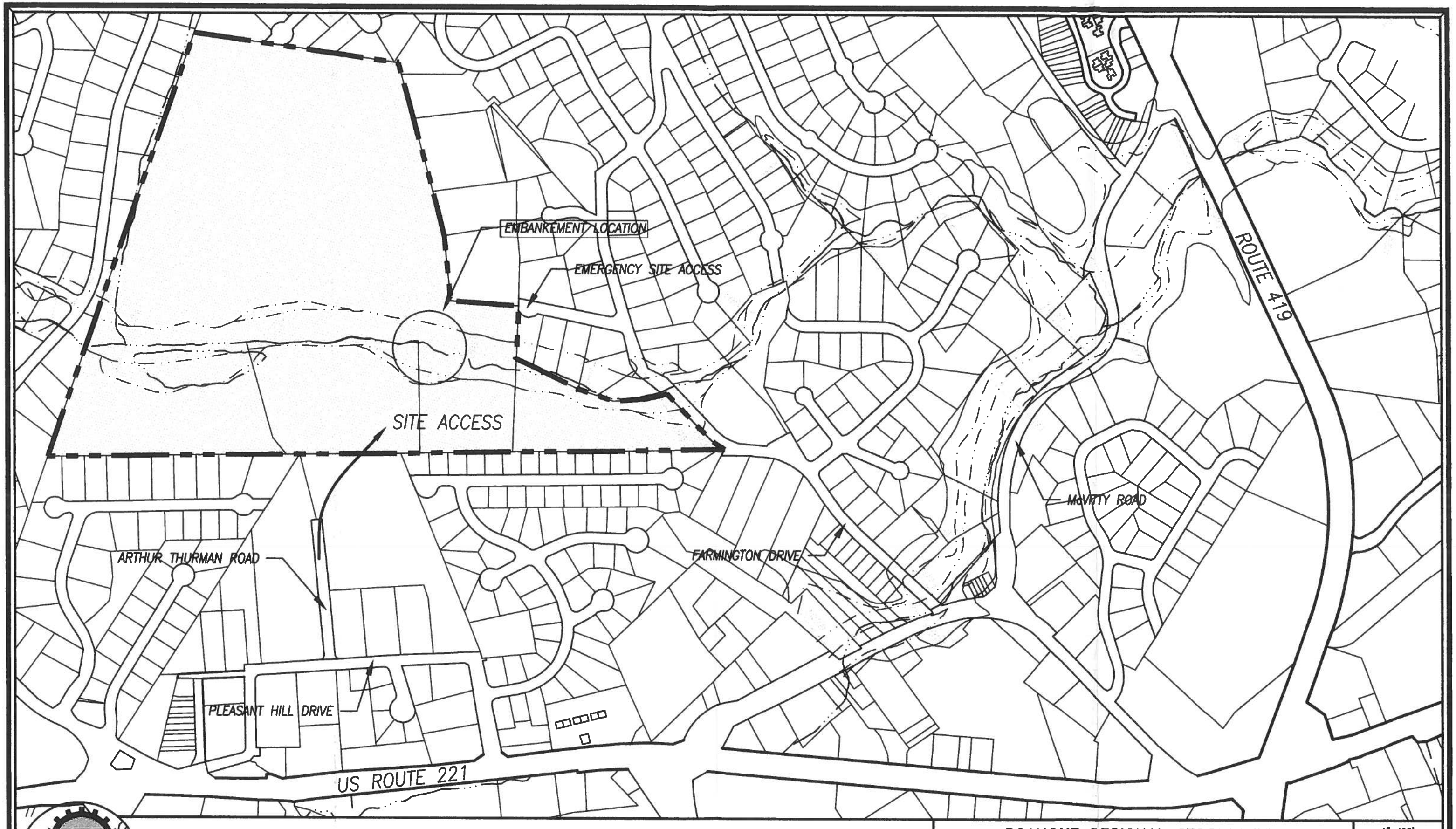
ROANOKE COUNTY, VRIGINIA

1"=400'

AUGUST 2000

PROJECT: 00075

1 of 1



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ROANOKE REGIONAL STORMWATER MANAGEMENT FACILITY

VICINITY MAP

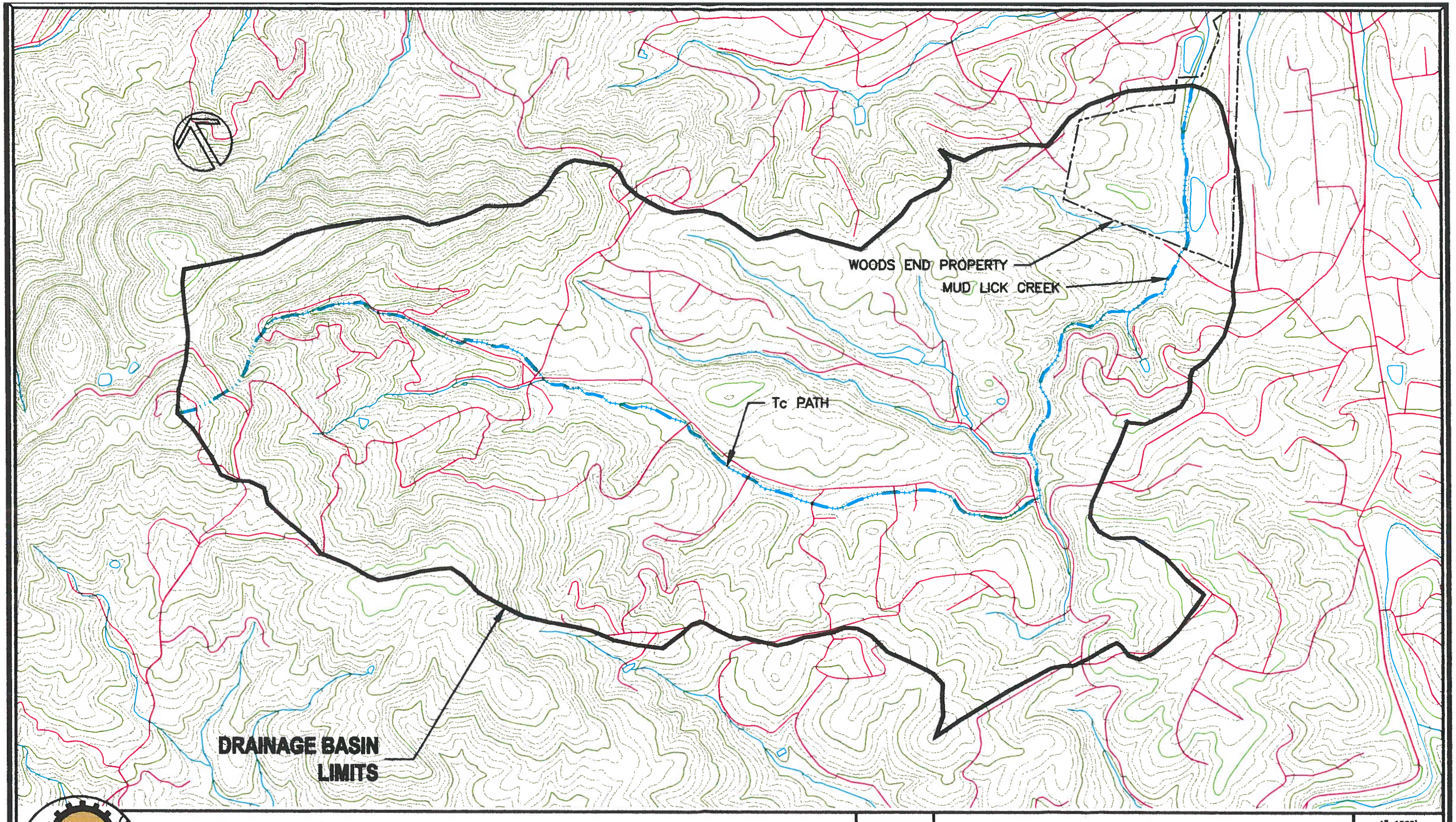
ROANOKE COUNTY, VRIGINIA

1"=400'

AUGUST 2000

PROJECT: 00075

1 of 1



ENGINEERING CONCEPTS, INC.
20 S. ROANOKE ST., PO BOX 619
FINCASTLE, VIRGINIA 24090
540.473.1253 FAX: 540.473.1254

Drawn	WTR	DRAINAGE BASIN	1"=1000'
Designed	RHW		06/20/00
Checked		1000' 0' 1000' 2000'	PROJECT: 00075
Approved		SCALE: 1"=1000'	of

KEY:

SOIL CLASS "A"

SOIL CLASS "B"

SOIL CLASS "C"

SOIL CLASS "D"

WOODS END PROPERTY

MUD LICK CREEK

DRAINAGE BASIN LIMITS

ENGINEERING CONCEPTS, INC.
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Drawn	WTR
Designed	RHW
Checked	
Approved	

HYDROLOGIC SOIL GROUPS

1000' 0' 1000' 2000'

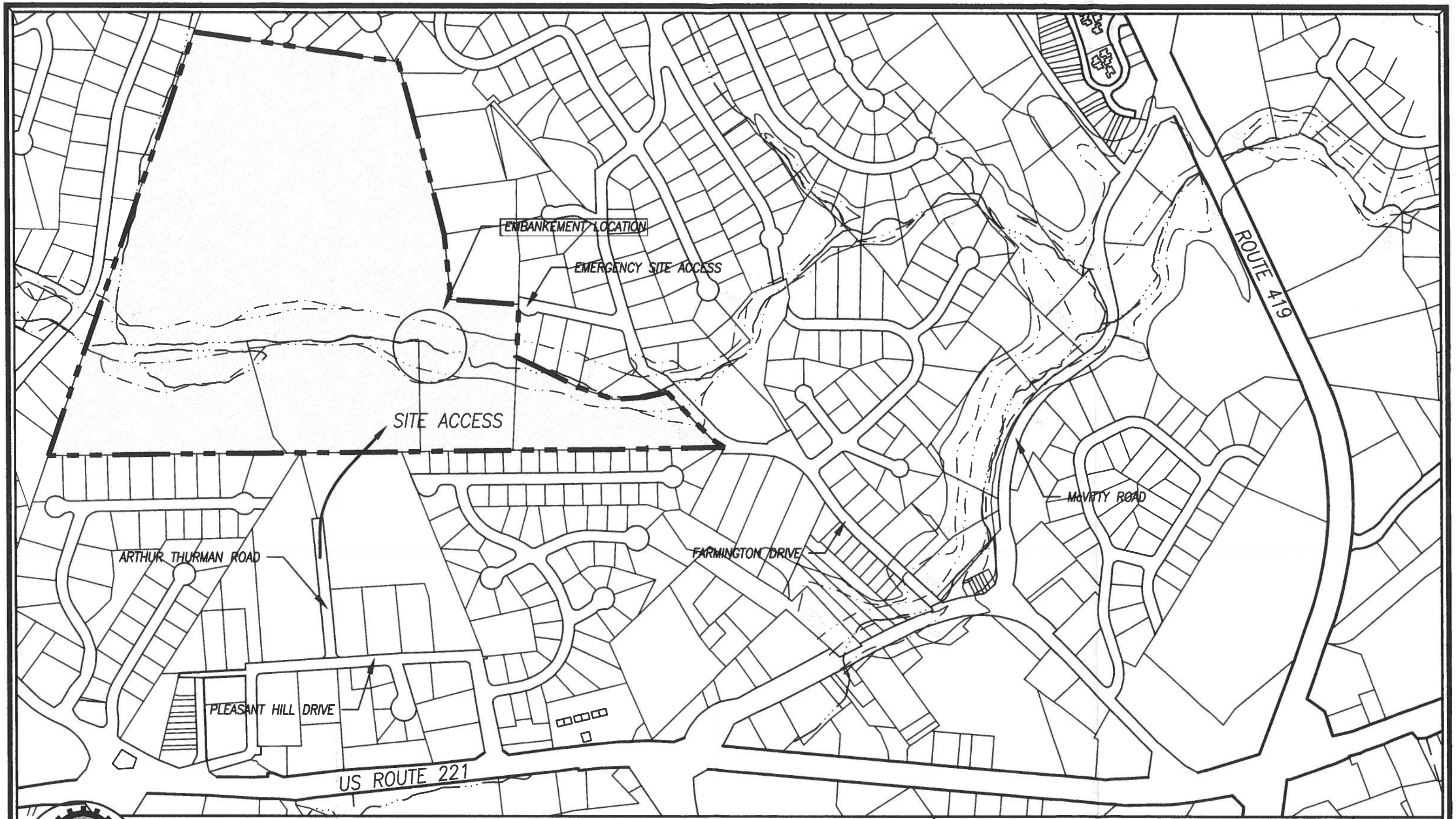
SCALE: 1"=1000'

1"=1000'

06/20/00

PROJECT: 00075

of



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ROANOKE REGIONAL STORMWATER MANAGEMENT FACILITY

VICINITY MAP

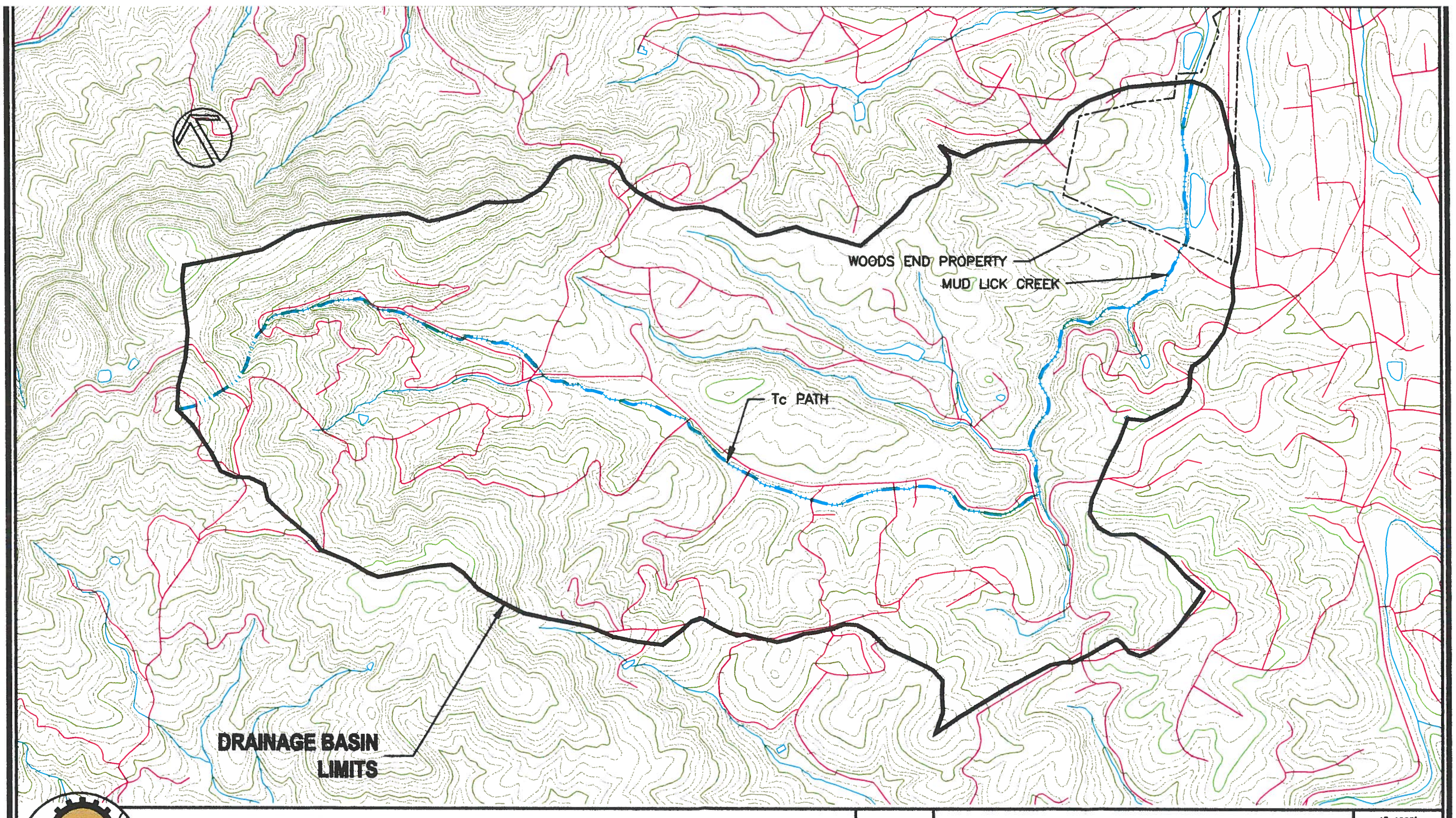
ROANOKE COUNTY, VRIGINIA

1"=400'

AUGUST 2000

PROJECT: 00075

1 of 1



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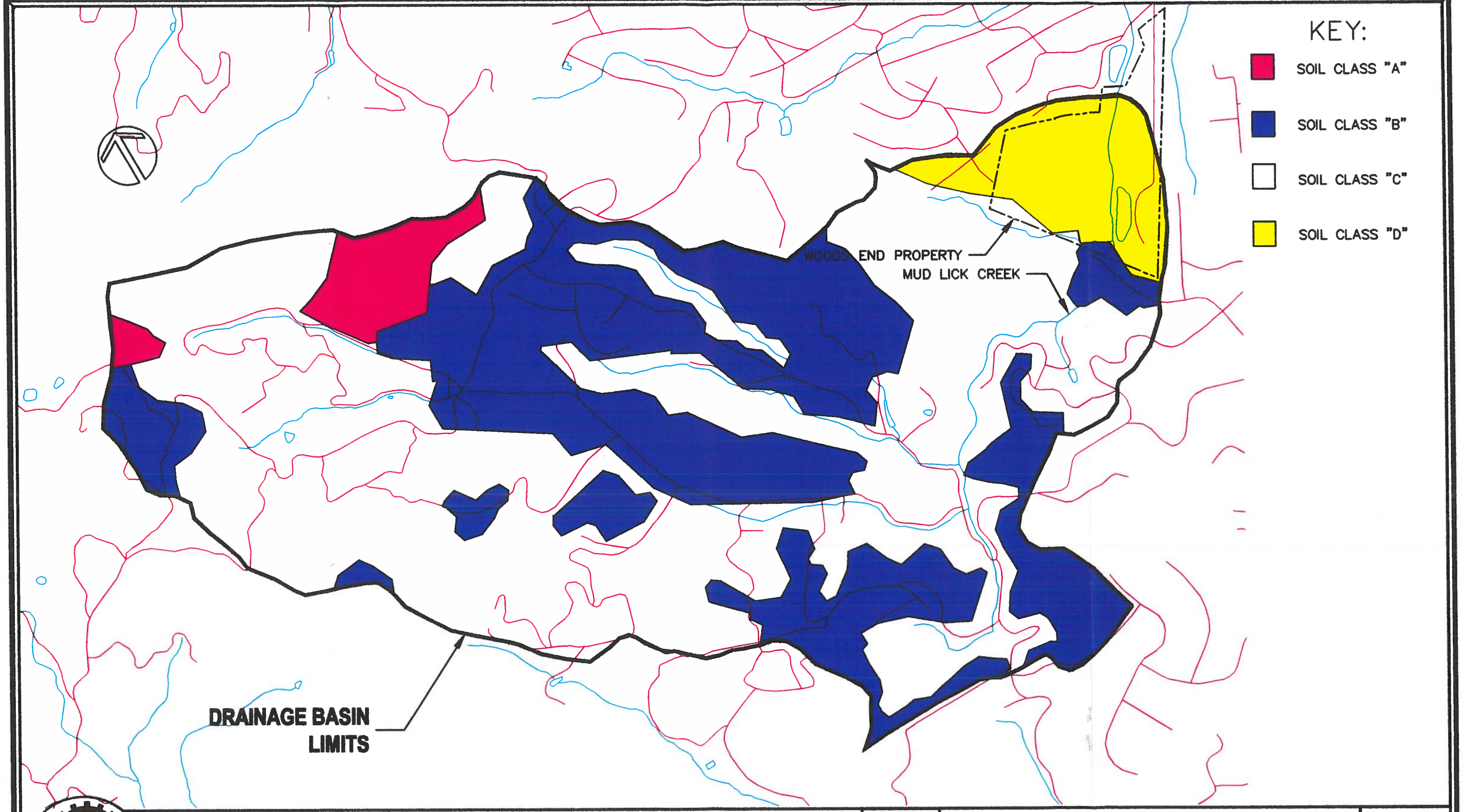
Drawn	WTR
Designed	RHW
Checked	
Approved	

DRAINAGE BASIN

1000' 0' 1000' 2000'

SCALE: 1"=1000'

1"=1000'	
06/20/00	
PROJECT: 00075	
of	



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Drawn	WTR
Designed	RHW
Checked	
Approved	

HYDROLOGIC SOIL GROUPS

1000' 0' 1000' 2000'

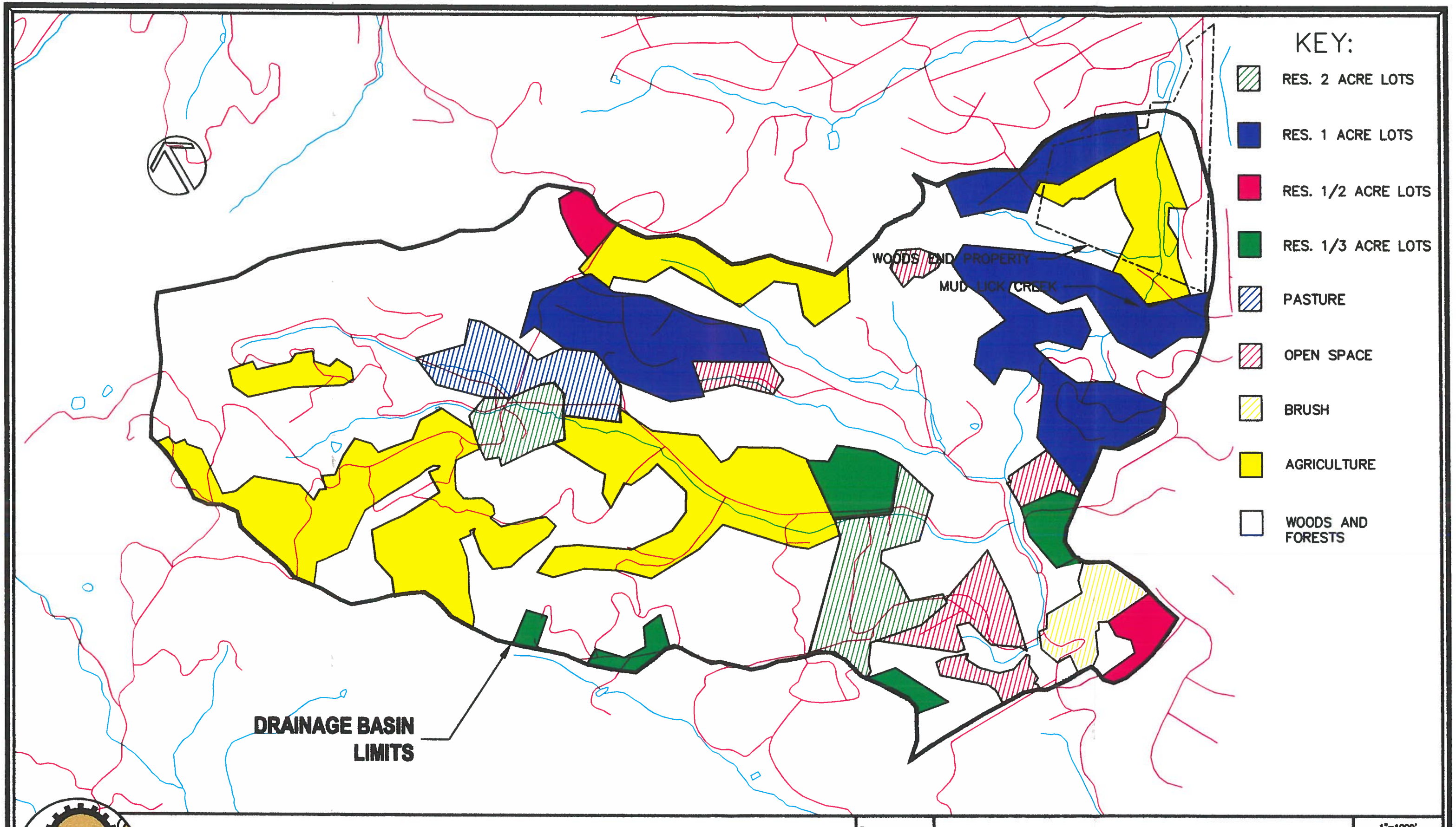
SCALE: 1"=1000'

1"=1000'

06/20/00

PROJECT: 00075

of



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Drawn	WTR
Designed	RHW
Checked	
Approved	

EXISTING LAND USE

1000' 0' 1000' 2000'

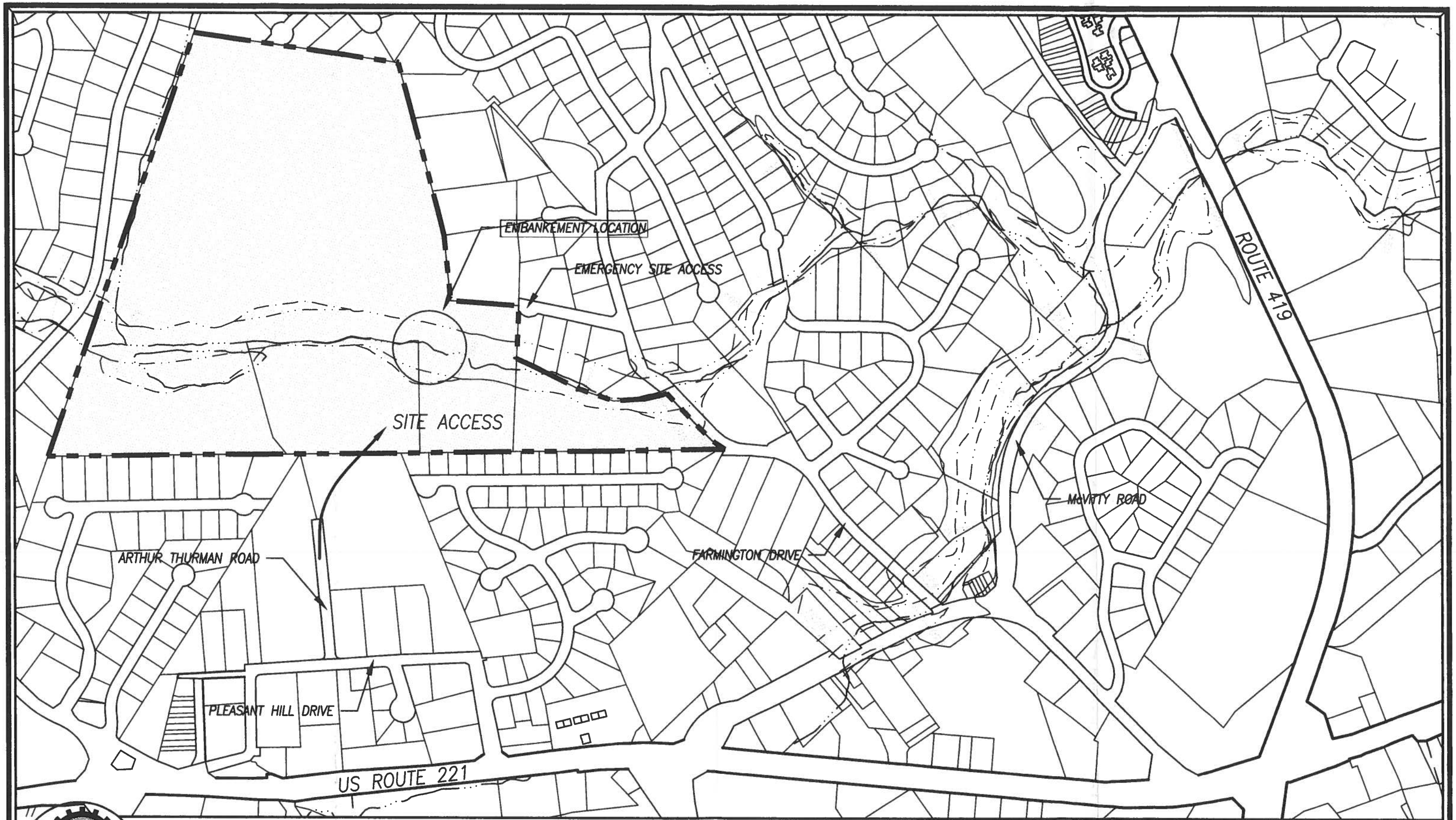
SCALE: 1"=1000'

1"=1000'

06/20/00

PROJECT: 00075

of



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ROANOKE REGIONAL STORMWATER MANAGEMENT FACILITY

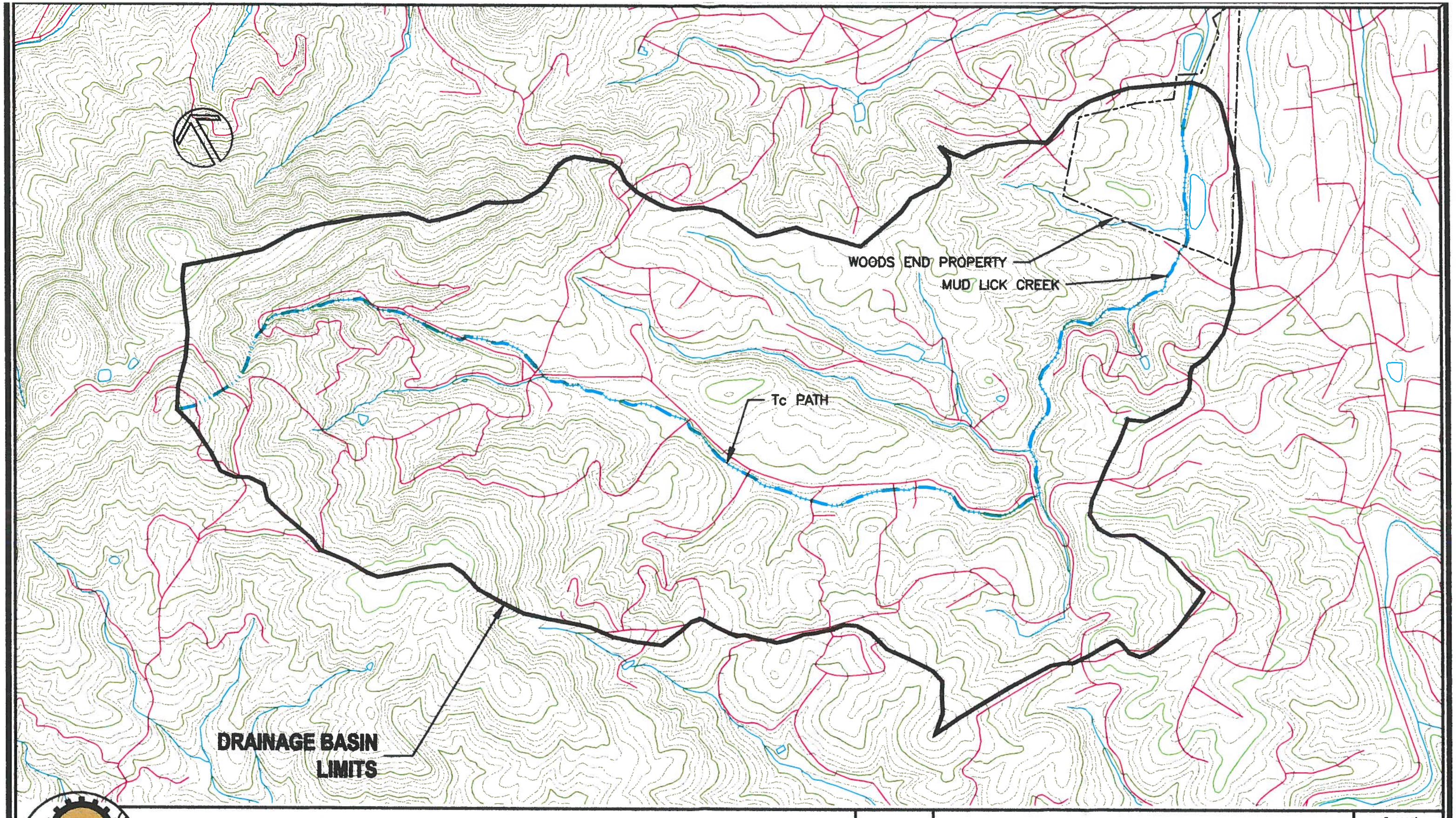
VICINITY MAP

ROANOKE COUNTY, VRIGINIA

1"=400'

AUGUST 2000

PROJECT: 00075



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540.473.1253 FAX: 540.473.1254

Drawn	WTR
Designed	RHW
Checked	
Approved	

DRAINAGE BASIN

1000' 0' 1000' 2000'

SCALE: 1"=1000'

1"=1000'

08/20/00

PROJECT: 00075

of

KEY:

SOIL CLASS "A"

SOIL CLASS "B"

SOIL CLASS "C"

SOIL CLASS "D"

WOODS END PROPERTY

MUD LICK CREEK

DRAINAGE BASIN LIMITS

ENGINEERING CONCEPTS, INC.

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Drawn	WTR
Designed	RHW
Checked	
Approved	

HYDROLOGIC SOIL GROUPS

1000' 0' 1000' 2000'

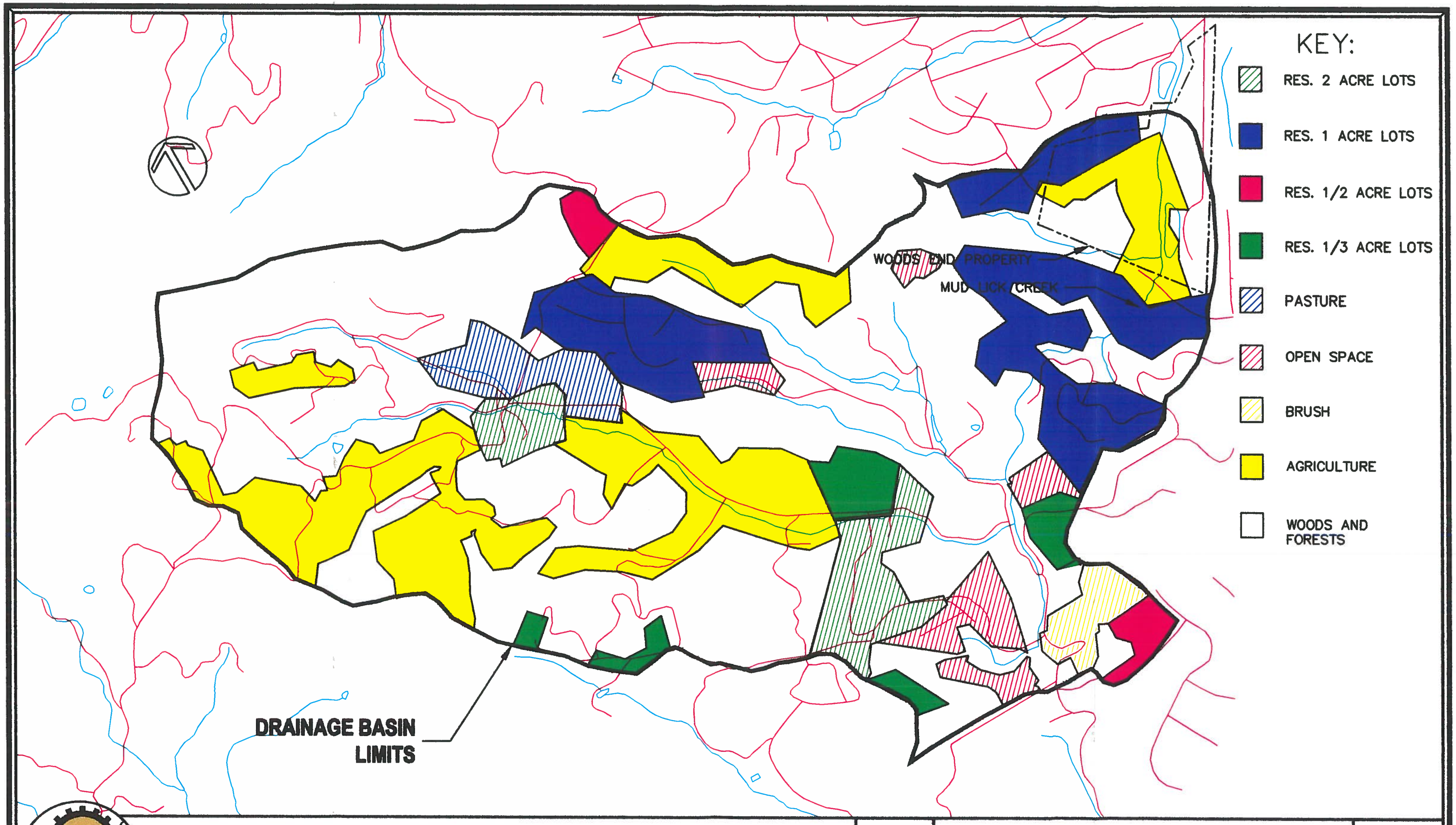
SCALE: 1"=1000'

1"=1000'

06/20/00

PROJECT: 00075

of



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540.473.1253 FAX: 540.473.1254

Drawn	WTR
Designed	RHW
Checked	
Approved	

EXISTING LAND USE

1000' 0' 1000' 2000'

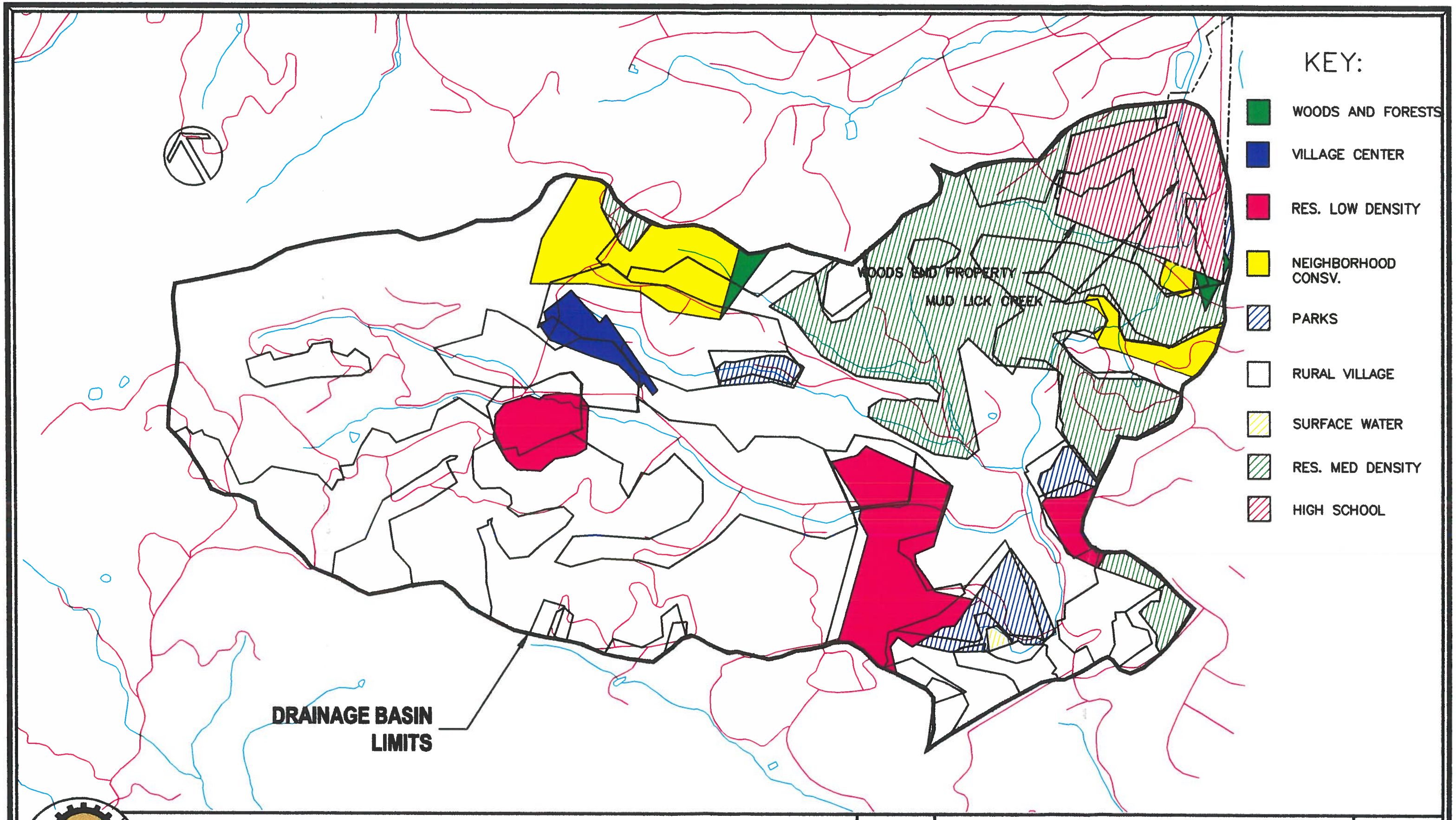
SCALE: 1"=1000'

1"=1000'

06/20/00

PROJECT: 00075

of



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PINCASTLE, VIRGINIA 24090
540.473.1253 FAX: 540.473.1254

Drawn	WTR
Designed	RHW
Checked	
Approved	

FUTURE LAND USE

1000' 0' 1000' 2000'

SCALE: 1"=1000'

1"=1000'

06/20/00

PROJECT: 00075

of

Appendix C

Existing Land Cover:	Hydrologic Soil Group Classifcation:					Total Area In Acres:	eighted "C" Value
	A	B	C	D	Water		
		Areas: (Acres)					
Residential (2 acre lots)		33.2	19.8		*	53.0	69.5
Residential (1 acre lots)		19.2	13.8		*	32.9	72.6
esidential (1/2 acre lots)		12.7	1.9		*	14.6	71.3
esidential (1/3 acre lots)		53.8	45.9	19.5	*	119.2	77.8
Pasture		24.6	4.3		*	29.0	62.9
Open Space		23.0	13.9		*	36.9	65.9
Brush		11.5	5.3		*	16.8	53.3
Agriculture		75.0	125.9	24.3	*	225.3	73.0
Woods and Forest	39.9	148.7	474.7	27.9	*	691.2	64.7
Total:	39.9	401.7	705.5	71.7	*	1,218.8	

Land Use:	"C" Value for Specific Soil Type:			
	A	B	C	D
Residential (2 acre lots)	46	65	77	82
Residential (1 acre lots)	51	68	79	84
Residential (1/2 acre lots)	54	70	80	85
Residential (1/3 acre lots)	57	72	81	86
Pasture	39	61	74	80
Open Space	39	61	74	80
Brush	30	48	65	73
Agriculture	43	65	76	82
Woods and Forest	30	55	70	77

Future Land Cover:	Hydrologic Soil Group Classifcation:					Total Area In Acres:	Weighted "C" Values:
	A	B	C	D	Water		
		Areas: (Acres)			*		
Medium Density Res.		66.2	131.1	13.6	*	210.9	77.2
Neighborhood Consv.		24.4	22.9	0.1	*	47.4	73.4
Parks/Open Spaces		10.9	17.9	1.5	*	30.3	69.6
Village Center		8.9	2.5		*	11.4	86.1
Surface Water			1.1		*	1.1	98.0
Low Density Residential		43.8	34.8		*	78.6	70.3
Woods/Forest		2.7	0.3	1.5	*	4.5	63.3
Rural Village	40.2	243.9	490.4		*	774.5	72.5
South County High Schoo	0.0	1.0	2.8	56.3	*	60.1	85.5
Total:	40.2	401.8	703.8	73.0	0.0	1,218.8	

* Note - According to Roanoke Valley Regional Storm Water Management Plan there are no signifigant sustained bodies of water in map area MUD01.

Land Use:	"C" Value for Specific Soil Type:			
	A	B	C	D
Medium Density Res.	54	70	80	85
Neighborhood Consv.	50	68.5	78.5	84
Parks/Open Spaces	39	61	74	80
Village Center	77	85	90	92
Surface Water	98	98	98	98
Low Density Residential	46	65	77	82
Woods/Forests	30	55	70	77
Rural Village	47	66.5	77.5	83
South County High Schoo	57	72	81	86

NOTES:

Regional SWM Facility
Existing Conditions
Time of Concentration and Weighted CN Value

Sub-Area	Sub-CN	Product
53.0	69.5	3,679.99
32.9	72.6	2391.32891
14.6	71.3	1041.32527
119.2	77.8	9264.78491
29.0	62.9	1822.23654
36.9	65.9	2432.66264
16.8	53.3	895.67194
225.3	73.0	16442.7543
691.2	64.7	44751.3364
		0
		0
		0
		0
		0
		0
		0
		0
		0
		0

Area =	**1,218.81**	acres
	1.90	sq. miles
CN =	**67.87**	
S =	**4.73**	
Ia (in) =	**0.947**	
Tc (hr) =	**1.26**	

	2 yr.	10 yr.	25 yr.	100 yr.
Rainfall (in):	3.5	5	6	7.5
Overland Flow: (200' Max)				
n		0.3	0	
L (ft)		200	0	
P_2 (in)		3.5	0	
Height(ft)		50	0	
s (ft/ft)		0.25	0.00	
Tt (hr)		0.17	0.00	**0.17**
Shallow Concentrated Flow: (1000' Max)				
L (ft)		1,000	0	
Height(ft)		385	0	
s(ft/ft)		0.39	0	
Tt (hr)		0.04	0.00	**0.04**
Channel Flow:				
a (sf)		1	2	8
p_w (ft)		2	4	8
n		0.1	0.035	0.035
L (ft)		3,614	6,489	5,618
Height(ft)		427	183	65
s (ft/ft)		0.12	0.03	0.01
r (ft)		0.50	0.50	1.00
V (ft/s)		3.23	4.50	4.58
Tt (hr)		0.31	0.40	0.34 **1.05**

8/31/2000

Sub-Area	Sub-CN	Product
210.9	77.2	16,278.00
47.4	73.4	3477.45
30.3	69.6	2109.5
11.4	86.1	982.214452
1.1	98.0	107.8
78.6	70.3	5526.96
4.5	63.3	285
774.5	72.5	56114.75
60.1	85.5	5140.6
		0
		0
		0
		0
		0
		0
		0
		0
		0
		0

NOTES:

Regional SWM Facility
Future Conditions
Time-of-Concentration and weighted CN Value

	2 yr.	10 yr.	25 yr.	100 yr.
Rainfall (in):	3.5	5	6	7.5

Overland Flow: (200' Max)

n	0.3	0	
L (ft)	200	0	
P_2 (in)	3.5	0	
Height(ft)	50	0	
s (ft/ft)	0.25	0.00	
Tt (hr)	0.17	0.00	**0.17**

Shallow Concentrated Flow: (1000' Max)

L (ft)	1,000	0	
Height(ft)	385	0	
s(ft/ft)	0.39	0	
Tt (hr)	0.04	0.00	**0.04**

Channel Flow:

a (sf)	1	2	8	
p_w (ft)	2	4	8	
n	0.1	0.035	0.035	
L (ft)	3,614	6,489	5,618	
Height(ft)	427	183	65	
s (ft/ft)	0.12	0.03	0.01	
r (ft)	0.50	0.50	1.00	
V (ft/s)	3.23	4.50	4.58	
Tt (hr)	0.31	0.40	0.34	**1.05**

Area =	**1,218.81**	acres
	1.90	sq. miles
CN =	**73.86**	
S =	**3.54**	
Ia (in) =	**0.708**	
Tc (hr) =	**1.26**	

Appendix D

Job File: N:\PROJECTS\00\00075\ENGINEER\PONDPAK\DESIGN.PPW
Rain Dir: D:\ENGINEER\HAESTAD\PPKW\RAINFALL\

==========
JOB TITLE
==========

Existing Conditions Runoff Flows

Table of Contents

DESIGN STORMS SUMMARY

Design Storm File,ID = BOBBY.RNQ Roanoke

Storm Tag Name = PMF
Description: 6 Hour PMF

Data Type, File, ID = Synthetic Storm CUSTOM.RNF Distribution A
Storm Frequency = PMF yr
Total Rainfall Depth= 28.5000 in
Duration Multiplier = 6
Resulting Duration = 6.0000 hrs
Resulting Start Time= .0000 hrs Step= .3000 hrs End= 6.0000 hrs

Storm Tag Name = 1yr
Description: 1-year storm

Data Type, File, ID = Synthetic Storm SCSTYPES.RNF TypeII 24hr
Storm Frequency = 1yr yr
Total Rainfall Depth= 3.0000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

Storm Tag Name = 2yr
Description: 2-year storm

Data Type, File, ID = Synthetic Storm SCSTYPES.RNF TypeII 24hr
Storm Frequency = 2yr yr
Total Rainfall Depth= 3.5000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

Storm Tag Name = 5yr
Description: 5-year storm

Data Type, File, ID = Synthetic Storm SCSTYPES.RNF TypeII 24hr
Storm Frequency = 5yr yr
Total Rainfall Depth= 4.5000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

DESIGN STORMS SUMMARY

Design Storm File,ID = BOBBY.RNQ Roanoke

Storm Tag Name = 10yr
Description: 10-year storm

Data Type, File, ID = Synthetic Storm SCSTYPES.RNF TypeII 24hr
Storm Frequency = 10yr yr
Total Rainfall Depth= 5.0000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

Storm Tag Name = 25yr
Description: 25-year storm

Data Type, File, ID = Synthetic Storm SCSTYPES.RNF TypeII 24hr
Storm Frequency = 25yr yr
Total Rainfall Depth= 6.0000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

Storm Tag Name = 50yr
Description: 50-year storm

Data Type, File, ID = Synthetic Storm SCSTYPES.RNF TypeII 24hr
Storm Frequency = 50yr yr
Total Rainfall Depth= 6.7000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

Storm Tag Name = 100yr
Description: 100-year storm

Data Type, File, ID = Synthetic Storm SCSTYPES.RNF TypeII 24hr
Storm Frequency = 100yr yr
Total Rainfall Depth= 7.5000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

SCS UNIT HYDROGRAPH METHOD
(Computational Notes)

DEFINITION OF TERMS: ----------

At = Total area (acres): At = Ai+Ap
Ai = Impervious area (acres)
Ap = Pervious area (acres)
CNi = Runoff curve number for impervious area
CNp = Runoff curve number for pervious area
fLoss = f loss constant infiltration (depth/time)
dt = Computational increment (duration of unit excess rainfall)
Default dt is smallest value of 0.1333Tc, rtm, and th
(Smallest dt is then adjusted to match up with Tp)
UDdt = User specified override computational main time increment
(only used if UDdt is => .1333Tc)
D(t) = Point on distribution curve (fraction of P) for time step t

K = 2 / (1 + (Tr/Tp)): default K = 0.75: (for Tr/Tp = 1.67)
Ks = Hydrograph shape factor
= Unit Conversions * K:
= ((1hr/3600sec) * (1ft/12in) * ((5280ft)**2/sq.mi)) * K
Default Ks = 645.333 * 0.75 = 484

Lag = Lag time from center of excess runoff (dt) to Tp: Lag = 0.6Tc
P = Total precipitation depth, inches
Pa(t) = Accumulated rainfall at time step t
Pi(t) = Incremental rainfall at time step t
qp = Peak discharge (cfs) for 1in. runoff, for 1hr, for 1 sq.mi.
= (Ks * A * Q) / Tp (where Q = 1in. runoff, A=sq.mi.)
Qu(t) = Unit hydrograph ordinate (cfs) at time step t
Q(t) = Final hydrograph ordinate (cfs) at time step t
Rai(t)= Accumulated runoff (inches) at time step t for impervious area
Rap(t)= Accumulated runoff (inches) at time step t for pervious area
Rii(t)= Incremental runoff (inches) at time step t for impervious area
Rip(t)= Incremental runoff (inches) at time step t for pervious area
R(t) = Incremental weighted total runoff (inches)
Rtm = Time increment for rainfall table (.RNF file)
Si = S for impervious area: Si = (1000/CNi) - 10
Sp = S for pervious area: Sp = (1000/CNp) - 10
t = Time step (row) number
Tc = Time of concentration
Tb = Time (hrs) of entire unit hydrograph: Tb = Tp + Tr
Tp = Time (hrs) to peak of a unit hydrograph: Tp = (dt/2) + Lag
Tr = Time (hrs) of receding limb of unit hydrograph: Tr = ratio of Tp

SCS UNIT HYDROGRAPH METHOD
(Computational Notes)

PRECIPITATION: ----------

Column (1): Time for time step t
Column (2): D(t) = Point on distribution curve for time step t
Column (3): Pi(t) = Pa(t) - Pa(t-1): Col.(4) - Preceding Col.(4)
Column (4): Pa(t) = D(t) x P: Col.(2) x P

PERVIOUS AREA RUNOFF (using SCS Runoff CN Method) ----------

Column (5): Rap(t) = Accumulated pervious runoff for time step t
If (Pa(t) is <= 0.2Sp) then use: Rap(t) = 0.0
If (Pa(t) is > 0.2Sp) then use:

$$Rap(t) = (Col.(4)-0.2Sp)^2 / (Col.(4)+0.8Sp)$$

Column (6): Rip(t) = Incremental pervious runoff for time step t
Rip(t) = Rap(t) - Rap(t-1)
Rip(t) = Col.(5) for current row - Col.(5) for preceding row.

IMPERVIOUS AREA RUNOFF ----------

Column (7 & 8)... Did not specify to use impervious areas.

INCREMENTAL WEIGHTED RUNOFF: ----------

Column (9): R(t) = (Ap/At) x Rip(t) + (Ai/At) x Rii(t)
R(t) = (Ap/At) x Col.(6) + (Ai/At) x Col.(8)

SCS UNIT HYDROGRAPH METHOD: ----------

Column (10): Q(t) is computed with the SCS unit hydrograph method using R() and Qu().

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100yr year storm
Duration = 24.0000 hrs Rain Depth = 7.5000 in
Rain Dir = D:\ENGINEER\HAESTAD\PPKW\RAINFALL\
Rain File -ID = SCSTYPES.RNF - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = N:\PROJECTS\00\00075\ENGINEER\PONDPAK\
HYG File - ID = WORK_PAD.HYG - DRAINAGE BASIN 100yr
Tc = 1.2600 hrs
Drainage Area = 1218.800 acres Runoff CN= 68

==========
Computational Time Increment = .16800 hrs
Computed Peak Time = 12.6000 hrs
Computed Peak Flow = 2045.31 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.6000 hrs
Peak Flow, Interpolated Output = 2045.31 cfs
==========

DRAINAGE AREA

ID:None Selected
CN = 68
Area = 1218.800 acres
S = 4.7059 in
0.2S = .9412 in

Cumulative Runoff

3.8188 in
387.867 ac-ft

HYG Volume... 387.874 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = 1.26000 hrs (ID: None Selected)
Computational Incr, Tm = .16800 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 1096.00 cfs
Unit peak time Tp = .84000 hrs
Unit receding limb, Tr = 3.36000 hrs
Total unit time, Tb = 4.20000 hrs

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 10yr year storm
Duration = 24.0000 hrs Rain Depth = 5.0000 in
Rain Dir = D:\ENGINEER\HAESTAD\PPKW\RAINFALL\
Rain File -ID = SCSTYPES.RNF - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = N:\PROJECTS\00\00075\ENGINEER\PONDPAK\
HYG File - ID = WORK_PAD.HYG - DRAINAGE BASIN 10yr
Tc = 1.2600 hrs
Drainage Area = 1218.800 acres Runoff CN= 68

==========
Computational Time Increment = .16800 hrs
Computed Peak Time = 12.7680 hrs
Computed Peak Flow = 965.16 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.7500 hrs
Peak Flow, Interpolated Output = 963.65 cfs
==========

DRAINAGE AREA

ID:None Selected
CN = 68
Area = 1218.800 acres
S = 4.7059 in
0.2S = .9412 in

Cumulative Runoff

1.8796 in
190.904 ac-ft

HYG Volume... 190.907 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = 1.26000 hrs (ID: None Selected)
Computational Incr, Tm = .16800 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 1096.00 cfs
Unit peak time Tp = .84000 hrs
Unit receding limb, Tr = 3.36000 hrs
Total unit time, Tb = 4.20000 hrs

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 1yr year storm
Duration = 24.0000 hrs Rain Depth = 3.0000 in
Rain Dir = D:\ENGINEER\HAESTAD\PPKW\RAINFALL\
Rain File -ID = SCSTYPES.RNF - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = N:\PROJECTS\00\00075\ENGINEER\PONDPAK\
HYG File - ID = WORK_PAD.HYG - DRAINAGE BASIN 1yr
Tc = 1.2600 hrs
Drainage Area = 1218.800 acres Runoff CN= 68

==========
Computational Time Increment = .16800 hrs
Computed Peak Time = 12.7680 hrs
Computed Peak Flow = 270.07 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.8000 hrs
Peak Flow, Interpolated Output = 268.56 cfs
==========

DRAINAGE AREA

ID:None Selected
CN = 68
Area = 1218.800 acres
S = 4.7059 in
0.2S = .9412 in

Cumulative Runoff

.6266 in
63.642 ac-ft

HYG Volume... 63.643 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = 1.26000 hrs (ID: None Selected)
Computational Incr, Tm = .16800 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 1096.00 cfs
Unit peak time Tp = .84000 hrs
Unit receding limb, Tr = 3.36000 hrs
Total unit time, Tb = 4.20000 hrs

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 25yr year storm
Duration = 24.0000 hrs Rain Depth = 6.0000 in
Rain Dir = D:\ENGINEER\HAESTAD\PPKW\RAINFALL\
Rain File -ID = SCSTYPES.RNF - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = N:\PROJECTS\00\00075\ENGINEER\PONDPAK\
HYG File - ID = WORK_PAD.HYG - DRAINAGE BASIN 25yr
Tc = 1.2600 hrs
Drainage Area = 1218.800 acres Runoff CN= 68

==========
Computational Time Increment = .16800 hrs
Computed Peak Time = 12.7680 hrs
Computed Peak Flow = 1376.25 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.7500 hrs
Peak Flow, Interpolated Output = 1375.63 cfs
==========

DRAINAGE AREA

ID:None Selected
CN = 68
Area = 1218.800 acres
S = 4.7059 in
0.2S = .9412 in

Cumulative Runoff

2.6208 in
266.190 ac-ft

HYG Volume... 266.194 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = 1.26000 hrs (ID: None Selected)
Computational Incr, Tm = .16800 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 1096.00 cfs
Unit peak time Tp = .84000 hrs
Unit receding limb, Tr = 3.36000 hrs
Total unit time, Tb = 4.20000 hrs

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 2yr year storm
Duration = 24.0000 hrs Rain Depth = 3.5000 in
Rain Dir = D:\ENGINEER\HAESTAD\PPKW\RAINFALL\
Rain File -ID = SCSTYPES.RNF - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = N:\PROJECTS\00\00075\ENGINEER\PONDPAK\
HYG File - ID = WORK_PAD.HYG - DRAINAGE BASIN 2yr
Tc = 1.2600 hrs
Drainage Area = 1218.800 acres Runoff CN= 68

==========
Computational Time Increment = .16800 hrs
Computed Peak Time = 12.7680 hrs
Computed Peak Flow = 420.20 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.7500 hrs
Peak Flow, Interpolated Output = 418.11 cfs
==========

DRAINAGE AREA

ID:None Selected
CN = 68
Area = 1218.800 acres
S = 4.7059 in
0.2S = .9412 in

Cumulative Runoff

.9013 in
91.541 ac-ft

HYG Volume... 91.542 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = 1.26000 hrs (ID: None Selected)
Computational Incr, Tm = .16800 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 1096.00 cfs
Unit peak time Tp = .84000 hrs
Unit receding limb, Tr = 3.36000 hrs
Total unit time, Tb = 4.20000 hrs

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 50yr year storm
Duration = 24.0000 hrs Rain Depth = 6.7000 in
Rain Dir = D:\ENGINEER\HAESTAD\PPKW\RAINFALL\
Rain File -ID = SCSTYPES.RNF - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = N:\PROJECTS\00\00075\ENGINEER\PONDPAK\
HYG File - ID = WORK_PAD.HYG - DRAINAGE BASIN 50yr
Tc = 1.2600 hrs
Drainage Area = 1218.800 acres Runoff CN= 68

==========
Computational Time Increment = .16800 hrs
Computed Peak Time = 12.6000 hrs
Computed Peak Flow = 1679.88 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.6000 hrs
Peak Flow, Interpolated Output = 1679.88 cfs
==========

DRAINAGE AREA

ID:None Selected
CN = 68
Area = 1218.800 acres
S = 4.7059 in
0.2S = .9412 in

Cumulative Runoff

3.1691 in
321.878 ac-ft

HYG Volume... 321.884 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = 1.26000 hrs (ID: None Selected)
Computational Incr, Tm = .16800 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 1096.00 cfs
Unit peak time Tp = .84000 hrs
Unit receding limb, Tr = 3.36000 hrs
Total unit time, Tb = 4.20000 hrs

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 5yr year storm
Duration = 24.0000 hrs Rain Depth = 4.5000 in
Rain Dir = D:\ENGINEER\HAESTAD\PPKW\RAINFALL\
Rain File -ID = SCSTYPES.RNF - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = N:\PROJECTS\00\00075\ENGINEER\PONDPAK\
HYG File - ID = WORK_PAD.HYG - DRAINAGE BASIN 5yr
Tc = 1.2600 hrs
Drainage Area = 1218.800 acres Runoff CN= 68

==========
Computational Time Increment = .16800 hrs
Computed Peak Time = 12.7680 hrs
Computed Peak Flow = 771.72 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.7500 hrs
Peak Flow, Interpolated Output = 769.90 cfs
==========

DRAINAGE AREA

ID:None Selected
CN = 68
Area = 1218.800 acres
S = 4.7059 in
0.2S = .9412 in

Cumulative Runoff

1.5324 in
155.646 ac-ft

HYG Volume... 155.648 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = 1.26000 hrs (ID: None Selected)
Computational Incr, Tm = .16800 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 1096.00 cfs
Unit peak time Tp = .84000 hrs
Unit receding limb, Tr = 3.36000 hrs
Total unit time, Tb = 4.20000 hrs

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: PMF year storm
Duration = 6.0000 hrs Rain Depth = 28.5000 in
Rain Dir = D:\ENGINEER\HAESTAD\PPKW\RAINFALL\
Rain File -ID = CUSTOM.RNF - Distribution A
Unit Hyd Type = Default Curvilinear
HYG Dir = N:\PROJECTS\00\00075\ENGINEER\PONDPAK\
HYG File - ID = WORK_PAD.HYG - DRAINAGE BASIN PMF
Tc = 1.2600 hrs
Drainage Area = 1218.800 acres Runoff CN= 68

==========
Computational Time Increment = .16800 hrs
Computed Peak Time = 1.6800 hrs
Computed Peak Flow = 9463.38 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 1.6500 hrs
Peak Flow, Interpolated Output = 9453.03 cfs
==========

DRAINAGE AREA

ID:None Selected
CN = 68
Area = 1218.800 acres
S = 4.7059 in
0.2S = .9412 in

Cumulative Runoff

23.5393 in
2390.809 ac-ft

HYG Volume... 2390.799 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = 1.26000 hrs (ID: None Selected)
Computational Incr, Tm = .16800 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 1096.00 cfs
Unit peak time Tp = .84000 hrs
Unit receding limb, Tr = 3.36000 hrs
Total unit time, Tb = 4.20000 hrs

Index of Starting Page Numbers for ID Names

Job File: N:\PROJECTS\00\00075\ENGINEER\PONDPAK\DESIGN.PPW
Rain Dir: D:\ENGINEER\HAESTAD\PPKW\RAINFALL\

==========
JOB TITLE
==========

Wood's End Facility

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File.... D:\ENGINEER\HAESTAD\PPKW\RAINFALL\BOBBY.RNQ
Title...

JOB TITLE NOT SPECIFIED
Press Units & Storm button (main menu screen) to
enter title.

DESIGN STORMS SUMMARY

Design Storm File,ID = BOBBY.RNQ Roanoke

Storm Tag Name = PMF
Description: 6 Hour PMF

Data Type, File, ID = Synthetic Storm CUSTOM.RNF Distribution A
Storm Frequency = PMF yr
Total Rainfall Depth= 28.5000 in
Duration Multiplier = 6
Resulting Duration = 6.0000 hrs
Resulting Start Time= .0000 hrs Step= .3000 hrs End= 6.0000 hrs

Storm Tag Name = 1yr
Description: 1-year storm

Data Type, File, ID = Synthetic Storm SCSTYPES.RNF TypeII 24hr
Storm Frequency = 1yr yr
Total Rainfall Depth= 3.0000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

Storm Tag Name = 2yr
Description: 2-year storm

Data Type, File, ID = Synthetic Storm SCSTYPES.RNF TypeII 24hr
Storm Frequency = 2yr yr
Total Rainfall Depth= 3.5000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

Storm Tag Name = 5yr
Description: 5-year storm

Data Type, File, ID = Synthetic Storm SCSTYPES.RNF TypeII 24hr
Storm Frequency = 5yr yr

Total Rainfall Depth= 4.5000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

File.... D:\ENGINEER\HAESTAD\PPKW\RAINFALL\BOBBY.RNQ
Title...

JOB TITLE NOT SPECIFIED
Press Units & Storm button (main menu screen) to
enter title.

DESIGN STORMS SUMMARY

Design Storm File,ID = BOBBY.RNQ Roanoke

Storm Tag Name = 10yr
Description: 10-year storm

Data Type, File, ID = Synthetic Storm SCSTYPES.RNF TypeII 24hr
Storm Frequency = 10yr yr
Total Rainfall Depth= 5.0000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

Storm Tag Name = 25yr
Description: 25-year storm

Data Type, File, ID = Synthetic Storm SCSTYPES.RNF TypeII 24hr
Storm Frequency = 25yr yr
Total Rainfall Depth= 6.0000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

Storm Tag Name = 50yr
Description: 50-year storm

Data Type, File, ID = Synthetic Storm SCSTYPES.RNF TypeII 24hr
Storm Frequency = 50yr yr
Total Rainfall Depth= 6.7000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

Storm Tag Name = 100yr
Description: 100-year storm

Data Type, File, ID = Synthetic Storm SCSTYPES.RNF TypeII 24hr
Storm Frequency = 100yr yr

Total Rainfall Depth= 7.5000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

Type.... Vol: Planimeter
Name.... TOTAL VOLUME

File.... N:\PROJECTS\00\00075\ENGINEER\PONDPAK\DESIGN.PPW

POND VOLUME CALCULATIONS

Planimeter scale: 1.00 ft/in

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
1095.50	.000	.0000	.0000	.000	.000
1096.00	237.400	.0054	.0054	.001	.001
1098.00	3448.900	.0792	.1054	.070	.071
1100.00	12346.400	.2834	.5124	.342	.413
1102.00	42147.500	.9676	1.7747	1.183	1.596
1104.00	67405.500	1.5474	3.7386	2.492	4.088
1106.00	99408.300	2.2821	5.7087	3.806	7.894
1108.00	130635.700	2.9990	7.8972	5.265	13.159
1110.00	153457.700	3.5229	9.7723	6.515	19.674
1112.00	174184.600	3.9987	11.2749	7.517	27.190
1114.00	195143.100	4.4799	12.7111	8.474	35.664
1116.00	216531.200	4.9709	14.1697	9.446	45.111
1118.00	245234.200	5.6298	15.8908	10.594	55.705
1120.00	297063.800	6.8196	18.6457	12.430	68.135
1122.00	416937.500	9.5716	24.4705	16.314	84.449
1124.00	501254.100	11.5072	31.5736	21.049	105.498
1126.00	573525.700	13.1663	36.9824	24.655	130.153
1128.00	634965.500	14.5768	41.5968	27.731	157.884
1130.00	713025.200	16.3688	46.3925	30.928	188.812
1132.00	762151.900	17.4966	50.7887	33.859	222.672

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POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

where: EL1, EL2 = Lower and upper elevations of the increment
Area1,Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2

REQUESTED POND WS ELEVATIONS:

Min. Elev.= 1095.50 ft
Increment = .50 ft
Max. Elev.= 1132.00 ft

Spot Elevations, ft
1124.60
1127.60

****
OUTLET CONNECTIVITY
****

---> Forward Flow Only (UpStream to DnStream)
<--- Reverse Flow Only (DnStream to UpStream)
<---> Forward and Reverse Both Allowed

Structure	No.		Outfall	E1, ft	E2, ft
Orifice-Circular	or	--->	tw	1095.500	1132.000
Culvert-Circular	cv	--->	TW	1110.500	1132.000
Weir-XY Points	wr	--->	TW	1124.600	1132.000

TW SETUP, DS Channel

OUTLET STRUCTURE INPUT DATA

Structure ID	=	or
Structure Type	=	Orifice-Circular
# of Openings	=	1
Invert Elev.	=	1095.50 ft
Diameter	=	1.5000 ft
Orifice Coeff.	=	.600

OUTLET STRUCTURE INPUT DATA

Structure ID	=	cv	
Structure Type	=	Culvert-Circular	
No. Barrels	=	3	
Barrel Diameter	=	12.5000	ft
Upstream Invert	=	1110.50	ft
Dnstream Invert	=	1104.00	ft
Horiz. Length	=	154.00	ft
Barrel Length	=	154.14	ft
Barrel Slope	=	.04221	ft/ft

OUTLET CONTROL DATA...

Mannings n	=	.0240	
Ke	=	.5000	(forward entrance loss)
Kb	=	.003674	(per ft of full flow)
Kr	=	.5000	(reverse entrance loss)
HW Convergence	=	.001	+/- ft

INLET CONTROL DATA...

Equation form	=	1	
Inlet Control K	=	.0098	
Inlet Control M	=	2.0000	
Inlet Control c	=	.03980	
Inlet Control Y	=	.6700	
T1 ratio (HW/D)	=	1.139	
T2 ratio (HW/D)	=	1.286	
Slope Factor	=	-.500	

Use unsubmerged inlet control Form 1 equ. below T1 elev.
Use submerged inlet control Form 1 equ. above T2 elev.

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...
At T1 Elev = 1124.74 ft ---> Flow = 1518.56 cfs
At T2 Elev = 1126.57 ft ---> Flow = 1735.50 cfs

OUTLET STRUCTURE INPUT DATA

Structure ID = wr
Structure Type = Weir-XY Points

# of Openings = 1
WEIR X-Y GROUND POINTS

X, ft	Elev, ft
.00	1132.30
25.00	1130.50
50.00	1128.90
75.00	1127.60
100.00	1126.50
125.00	1125.60
150.00	1125.00
175.00	1124.70
200.00	1124.60
225.00	1124.70
250.00	1125.10
275.00	1125.80
300.00	1126.70
325.00	1127.80
350.00	1129.20
375.00	1130.80
400.00	1132.70

Lowest Elev. = 1124.60 ft

Weir Coeff. = 3.300000

Weir TW effects (Use adjustment equation)

OUTLET STRUCTURE INPUT DATA

Structure ID = TW
Structure Type = TW SETUP, DS Channel

USE DOWNSTREAM CHANNEL NORMAL DEPTH FOR TW...
Channel Type: Elev-Flow
Channel ID: tailwater

CONVERGENCE TOLERANCES...
Maximum Iterations= 30
Min. TW tolerance = .01 ft
Max. TW tolerance = .01 ft
Min. HW tolerance = .01 ft
Max. HW tolerance = .01 ft
Min. Q tolerance = .10 cfs
Max. Q tolerance = .10 cfs

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USE DOWNSTREAM CHANNEL NORMAL DEPTH FOR TW...
Channel Type: Elev-Flow
Channel ID: tailwater

Solution to Mannings Open Channel Flow Equation
(Computed values are based on normal depth.)

Slope = .000000 ft/ft
Mannings n = 0.00000
Invert Elev. = 1093.50 ft
Top of Channel = 1108.00 ft

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = or (Orifice-Circular)

Upstream ID = (Pond Water Surface)
DNstream ID = TW (Pond Outfall)

WS Elev,Device Q Tail Water Notes

WS Elev. ft	Q cfs	TW Elev ft	Converge +/-ft	Computation Messages
1095.50	.00	1093.50	.000	Upstream HW & DNstream TW < Inv.El
1096.00	.98	1093.51	.000	CRIT.DEPTH CONTROL Vh= .131ft Dcr= .369ft CRIT.DEPTH
1096.50	3.55	1093.52	.000	CRIT.DEPTH CONTROL Vh= .279ft Dcr= .720ft CRIT.DEPTH
1097.00	7.37	1093.55	.000	H =.75
1097.50	9.51	1093.56	.000	H =1.25
1098.00	11.25	1093.57	.000	H =1.75
1098.50	12.76	1093.58	.000	H =2.25
1099.00	14.10	1093.59	.000	H =2.75
1099.50	15.33	1093.59	.000	H =3.25
1100.00	16.47	1093.60	.000	H =3.75
1100.50	17.53	1093.61	.000	H =4.25
1101.00	18.54	1093.61	.000	H =4.75
1101.50	19.49	1093.62	.000	H =5.25
1102.00	20.40	1093.63	.000	H =5.75
1102.50	21.26	1093.63	.000	H =6.25
1103.00	22.10	1093.64	.000	H =6.75
1103.50	22.90	1093.64	.000	H =7.25
1104.00	23.68	1093.65	.000	H =7.75
1104.50	24.43	1093.65	.000	H =8.25
1105.00	25.16	1093.66	.000	H =8.75
1105.50	25.87	1093.66	.000	H =9.25
1106.00	26.56	1093.66	.000	H =9.75
1106.50	27.23	1093.67	.000	H =10.25
1107.00	27.89	1093.67	.000	H =10.75
1107.50	28.53	1093.68	.000	H =11.25
1108.00	29.15	1093.68	.000	H =11.75
1108.50	29.77	1093.68	.000	H =12.25
1109.00	30.37	1093.69	.000	H =12.75
1109.50	30.96	1093.69	.000	H =13.25
1110.00	31.54	1093.69	.000	H =13.75
1110.50	32.11	1093.70	.000	H =14.25
1111.00	32.67	1093.75	.000	H =14.75
1111.50	33.21	1093.88	.000	H =15.25
1112.00	33.75	1094.10	.000	H =15.75

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RATING TABLE FOR ONE OUTLET TYPE

Structure ID = or (Orifice-Circular)

Upstream ID = (Pond Water Surface)
DNstream ID = TW (Pond Outfall)

WS Elev,Device Q | Tail Water | Notes

WS Elev. ft	Q cfs	TW Elev ft	Converge +/-ft	Computation Messages
1112.50	34.29	1094.40	.000	H =16.25
1113.00	34.81	1094.78	.000	H =16.75
1113.50	35.33	1095.24	.000	H =17.25
1114.00	35.83	1095.77	.000	H =17.75
1114.50	36.21	1096.38	.001	H =18.12
1115.00	36.03	1097.05	.004	H =17.95
1115.50	35.80	1097.79	.005	H =17.71
1116.00	35.50	1098.58	.005	H =17.42
1116.50	35.13	1099.44	.005	H =17.06
1117.00	34.70	1100.35	.006	H =16.65
1117.50	34.21	1101.33	.006	H =16.17
1118.00	33.65	1102.34	.007	H =15.66
1118.50	33.04	1103.41	.007	H =15.09
1119.00	32.36	1104.52	.008	H =14.48
1119.50	31.62	1105.68	.008	H =13.82
1120.00	31.81	1106.01	.000	H =13.99
1120.50	32.36	1106.02	.000	H =14.48
1121.00	32.90	1106.04	.000	H =14.96
1121.50	33.43	1106.05	.000	H =15.45
1122.00	33.95	1106.07	.000	H =15.93
1122.50	34.46	1106.09	.000	H =16.42
1123.00	34.96	1106.10	.000	H =16.90
1123.50	35.46	1106.12	.000	H =17.38
1124.00	35.95	1106.13	.000	H =17.87
1124.50	36.44	1106.15	.000	H =18.35
1124.60	36.53	1106.15	.000	H =18.45
1125.00	36.91	1106.17	.000	H =18.83
1125.50	37.37	1106.20	.000	H =19.30
1126.00	37.81	1106.24	.000	H =19.76
1126.50	38.24	1106.28	.000	H =20.22
1127.00	38.66	1106.34	.000	H =20.66
1127.50	39.06	1106.41	.000	H =21.09
1127.60	39.14	1106.43	.000	H =21.18
1128.00	39.45	1106.49	.000	H =21.51

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = or (Orifice-Circular)

Upstream ID = (Pond Water Surface)
DNstream ID = TW (Pond Outfall)

WS Elev, Device Q		Tail Water		Notes
WS Elev. ft	Q cfs	TW Elev ft	Converge +/-ft	Computation Messages
1128.50	39.83	1106.57	.000	H =21.93
1129.00	40.20	1106.66	.000	H =22.34
1129.50	40.55	1106.77	.000	H =22.74
1130.00	40.90	1106.88	.000	H =23.12
1130.50	41.23	1107.00	.000	H =23.50
1131.00	41.56	1107.13	.000	H =23.87
1131.50	41.87	1107.27	.000	H =24.23
1132.00	42.17	1107.42	.000	H =24.58

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = cv (Culvert-Circular)

Mannings open channel maximum capacity: 3589.09 cfs
Upstream ID = (Pond Water Surface)
DNstream ID = TW (Pond Outfall)

NUMBER OF BARRELS = 3
EACH FLOW = SUM OF BARRELS x FLOW FOR ONE BARREL

WS Elev, Device Q		Tail Water		Notes
WS Elev. ft	Q cfs	TW Elev Converge ft	+/-ft	Computation Messages
1095.50	.00	1093.50	.000	Upstream HW & DNstream TW < Inv.El
1096.00	.00	1093.51	.000	Upstream HW & DNstream TW < Inv.El
1096.50	.00	1093.52	.000	Upstream HW & DNstream TW < Inv.El
1097.00	.00	1093.55	.000	Upstream HW & DNstream TW < Inv.El
1097.50	.00	1093.56	.000	Upstream HW & DNstream TW < Inv.El
1098.00	.00	1093.57	.000	Upstream HW & DNstream TW < Inv.El
1098.50	.00	1093.58	.000	Upstream HW & DNstream TW < Inv.El
1099.00	.00	1093.59	.000	Upstream HW & DNstream TW < Inv.El
1099.50	.00	1093.59	.000	Upstream HW & DNstream TW < Inv.El
1100.00	.00	1093.60	.000	Upstream HW & DNstream TW < Inv.El
1100.50	.00	1093.61	.000	Upstream HW & DNstream TW < Inv.El
1101.00	.00	1093.61	.000	Upstream HW & DNstream TW < Inv.El
1101.50	.00	1093.62	.000	Upstream HW & DNstream TW < Inv.El
1102.00	.00	1093.63	.000	Upstream HW & DNstream TW < Inv.El
1102.50	.00	1093.63	.000	Upstream HW & DNstream TW < Inv.El

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = cv (Culvert-Circular)

Mannings open channel maximum capacity: 3589.09 cfs
Upstream ID = (Pond Water Surface)
DNstream ID = TW (Pond Outfall)

NUMBER OF BARRELS = 3
EACH FLOW = SUM OF BARRELS x FLOW FOR ONE BARREL

WS Elev, Device Q		Tail Water		Notes
WS Elev. ft	Q cfs	TW Elev ft	Converge +/-ft	Computation Messages
1103.00	.00	1093.64	.000	Upstream HW & DNstream TW < Inv.El
1103.50	.00	1093.64	.000	Upstream HW & DNstream TW < Inv.El
1104.00	.00	1093.65	.000	Upstream HW & DNstream TW < Inv.El
1104.50	.00	1093.65	.000	Upstream HW & DNstream TW < Inv.El
1105.00	.00	1093.66	.000	Upstream HW & DNstream TW < Inv.El
1105.50	.00	1093.66	.000	Upstream HW & DNstream TW < Inv.El
1106.00	.00	1093.66	.000	Upstream HW & DNstream TW < Inv.El
1106.50	.00	1093.67	.000	Upstream HW & DNstream TW < Inv.El
1107.00	.00	1093.67	.000	Upstream HW & DNstream TW < Inv.El
1107.50	.00	1093.68	.000	Upstream HW & DNstream TW < Inv.El
1108.00	.00	1093.68	.000	Upstream HW & DNstream TW < Inv.El
1108.50	.00	1093.68	.000	Upstream HW & DNstream TW < Inv.El
1109.00	.00	1093.69	.000	Upstream HW & DNstream TW < Inv.El
1109.50	.00	1093.69	.000	Upstream HW & DNstream TW < Inv.El
1110.00	.00	1093.69	.000	Upstream HW & DNstream TW < Inv.El

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RATING TABLE FOR ONE OUTLET TYPE

Structure ID = cv (Culvert-Circular)

Mannings open channel maximum capacity: 3589.09 cfs
Upstream ID = (Pond Water Surface)
DNstream ID = TW (Pond Outfall)

NUMBER OF BARRELS = 3
EACH FLOW = SUM OF BARRELS x FLOW FOR ONE BARREL

WS Elev, Device Q		Tail Water		Notes		
WS Elev. ft	Q cfs	TW Elev ft	Converge +/-ft	Computation Messages		
1110.50	.00	1093.70	.000			
	Upstream HW & DNstream TW < Inv.El					
1111.00	7.20	1093.75	.000			
	CRIT.DEPTH CONTROL	Vh= .111ft	Dcr= .333ft	CRIT.DEPTH		
1111.50	28.64	1093.88	.000			
	CRIT.DEPTH CONTROL	Vh= .224ft	Dcr= .665ft	CRIT.DEPTH		
1112.00	63.79	1094.10	.000			
	CRIT.DEPTH CONTROL	Vh= .337ft	Dcr= .995ft	CRIT.DEPTH		
1112.50	112.13	1094.40	.000			
	CRIT.DEPTH CONTROL	Vh= .451ft	Dcr= 1.323ft	CRIT.DEPTH		
1113.00	173.57	1094.78	.000			
	CRIT.DEPTH CONTROL	Vh= .566ft	Dcr= 1.650ft	CRIT.DEPTH		
1113.50	247.67	1095.24	.000			
	CRIT.DEPTH CONTROL	Vh= .683ft	Dcr= 1.976ft	CRIT.DEPTH		
1114.00	333.66	1095.77	.000			
	CRIT.DEPTH CONTROL	Vh= .800ft	Dcr= 2.300ft	CRIT.DEPTH		
1114.50	431.35	1096.38	.001			
	CRIT.DEPTH CONTROL	Vh= .919ft	Dcr= 2.622ft	CRIT.DEPTH		
1115.00	540.55	1097.05	.004			
	CRIT.DEPTH CONTROL	Vh= 1.039ft	Dcr= 2.943ft	CRIT.DEPTH		
1115.50	660.14	1097.79	.005			
	CRIT.DEPTH CONTROL	Vh= 1.160ft	Dcr= 3.260ft	CRIT.DEPTH		
1116.00	789.95	1098.58	.005			
	CRIT.DEPTH CONTROL	Vh= 1.283ft	Dcr= 3.576ft	CRIT.DEPTH		
1116.50	929.55	1099.44	.005			
	CRIT.DEPTH CONTROL	Vh= 1.407ft	Dcr= 3.889ft	CRIT.DEPTH		
1117.00	1078.59	1100.35	.006			
	CRIT.DEPTH CONTROL	Vh= 1.533ft	Dcr= 4.200ft	CRIT.DEPTH		
1117.50	1236.88	1101.33	.006			
	CRIT.DEPTH CONTROL	Vh= 1.661ft	Dcr= 4.509ft	CRIT.DEPTH		

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = cv (Culvert-Circular)

Mannings open channel maximum capacity: 3589.09 cfs
Upstream ID = (Pond Water Surface)
DNstream ID = TW (Pond Outfall)

NUMBER OF BARRELS = 3
EACH FLOW = SUM OF BARRELS x FLOW FOR ONE BARREL

WS Elev, Device Q		Tail Water		Notes			
WS Elev. ft	Q cfs	TW Elev ft	Converge +/-ft	Computation Messages			
1118.00	1403.03	1102.34	.007				
	CRIT.DEPTH	CONTROL	Vh= 1.791ft	Dcr= 4.814ft	CRIT.DEPTH		
1118.50	1577.14	1103.41	.007				
	CRIT.DEPTH	CONTROL	Vh= 1.923ft	Dcr= 5.116ft	CRIT.DEPTH		
1119.00	1758.49	1104.52	.008				
	CRIT.DEPTH	CONTROL	Vh= 2.057ft	Dcr= 5.415ft	CRIT.DEPTH		
1119.50	1946.73	1105.68	.008				
	CRIT.DEPTH	CONTROL	Vh= 2.193ft	Dcr= 5.710ft	CRIT.DEPTH		
1120.00	2141.04	1106.01	.000				
	CRIT.DEPTH	CONTROL	Vh= 2.332ft	Dcr= 6.002ft	CRIT.DEPTH		
1120.50	2340.80	1106.02	.000				
	CRIT.DEPTH	CONTROL	Vh= 2.474ft	Dcr= 6.289ft	CRIT.DEPTH		
1121.00	2545.93	1106.04	.000				
	CRIT.DEPTH	CONTROL	Vh= 2.619ft	Dcr= 6.572ft	CRIT.DEPTH		
1121.50	2755.52	1106.05	.000				
	CRIT.DEPTH	CONTROL	Vh= 2.766ft	Dcr= 6.850ft	CRIT.DEPTH		
1122.00	2969.65	1106.07	.000				
	CRIT.DEPTH	CONTROL	Vh= 2.918ft	Dcr= 7.123ft	CRIT.DEPTH		
1122.50	3186.29	1106.09	.000				
	CRIT.DEPTH	CONTROL	Vh= 3.073ft	Dcr= 7.390ft	CRIT.DEPTH		
1123.00	3406.50	1106.10	.000				
	CRIT.DEPTH	CONTROL	Vh= 3.232ft	Dcr= 7.652ft	CRIT.DEPTH		
1123.50	3628.77	1106.12	.000				
	CRIT.DEPTH	CONTROL	Vh= 3.395ft	Dcr= 7.908ft	CRIT.DEPTH		
1124.00	3852.38	1106.13	.000				
	CRIT.DEPTH	CONTROL	Vh= 3.562ft	Dcr= 8.156ft	CRIT.DEPTH		
1124.50	4077.63	1106.15	.000				
	CRIT.DEPTH	CONTROL	Vh= 3.735ft	Dcr= 8.399ft	CRIT.DEPTH		
1124.60	4122.48	1106.15	.000				
	CRIT.DEPTH	CONTROL	Vh= 3.770ft	Dcr= 8.446ft	CRIT.DEPTH		

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = cv (Culvert-Circular)

Mannings open channel maximum capacity: 3589.09 cfs
Upstream ID = (Pond Water Surface)
DNstream ID = TW (Pond Outfall)

NUMBER OF BARRELS = 3
EACH FLOW = SUM OF BARRELS x FLOW FOR ONE BARREL

WS Elev, ft	Device Q, cfs	Tail Water TW Elev, ft	Converge +/-ft	Notes / Computation Messages
1125.00	4302.75	1106.17	.000	CRIT.DEPTH CONTROL Vh= 3.912ft Dcr= 8.633ft CRIT.DEPTH
1125.50	4528.44	1106.20	.000	CRIT.DEPTH CONTROL Vh= 4.094ft Dcr= 8.859ft CRIT.DEPTH
1126.00	4753.15	1106.24	.000	CRIT.DEPTH CONTROL Vh= 4.281ft Dcr= 9.077ft CRIT.DEPTH
1126.50	4977.55	1106.28	.000	CRIT.DEPTH CONTROL Vh= 4.475ft Dcr= 9.287ft CRIT.DEPTH
1127.00	5200.12	1106.34	.000	CRIT.DEPTH CONTROL Vh= 4.674ft Dcr= 9.488ft CRIT.DEPTH
1127.50	5421.16	1106.41	.000	CRIT.DEPTH CONTROL Vh= 4.880ft Dcr= 9.680ft CRIT.DEPTH
1127.60	5465.11	1106.43	.000	CRIT.DEPTH CONTROL Vh= 4.922ft Dcr= 9.718ft CRIT.DEPTH
1128.00	5639.34	1106.49	.000	CRIT.DEPTH CONTROL Vh= 5.091ft Dcr= 9.863ft CRIT.DEPTH
1128.50	5803.30	1106.57	.000	INLET CONTROL... Submerged: HW =18.00
1129.00	5948.07	1106.66	.000	INLET CONTROL... Submerged: HW =18.50
1129.50	6089.40	1106.77	.000	INLET CONTROL... Submerged: HW =19.00
1130.00	6227.88	1106.88	.000	INLET CONTROL... Submerged: HW =19.50
1130.50	6362.92	1107.00	.000	INLET CONTROL... Submerged: HW =20.00
1131.00	6495.38	1107.13	.000	INLET CONTROL... Submerged: HW =20.50
1131.50	6624.98	1107.27	.000	INLET CONTROL... Submerged: HW =21.00

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RATING TABLE FOR ONE OUTLET TYPE

Structure ID = cv (Culvert-Circular)

Mannings open channel maximum capacity: 3589.09 cfs
Upstream ID = (Pond Water Surface)
DNstream ID = TW (Pond Outfall)

NUMBER OF BARRELS = 3
EACH FLOW = SUM OF BARRELS x FLOW FOR ONE BARREL

WS Elev, Device Q	Tail Water	Notes

WS Elev. ft	Q cfs	TW Elev ft	Converge +/-ft	Computation Messages
1132.00	6752.59	1107.42	.000	INLET CONTROL... Submerged: HW =21.50

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = wr (Weir-XY Points)

Upstream ID = (Pond Water Surface)
DNstream ID = TW (Pond Outfall)

WS Elev, Device Q		Tail Water		Notes
WS Elev. ft	Q cfs	TW Elev ft	Converge +/-ft	Computation Messages
1095.50	.00	1093.50	.000	
	E < Y min=1124.60			
1096.00	.00	1093.51	.000	
	E < Y min=1124.60			
1096.50	.00	1093.52	.000	
	E < Y min=1124.60			
1097.00	.00	1093.55	.000	
	E < Y min=1124.60			
1097.50	.00	1093.56	.000	
	E < Y min=1124.60			
1098.00	.00	1093.57	.000	
	E < Y min=1124.60			
1098.50	.00	1093.58	.000	
	E < Y min=1124.60			
1099.00	.00	1093.59	.000	
	E < Y min=1124.60			
1099.50	.00	1093.59	.000	
	E < Y min=1124.60			
1100.00	.00	1093.60	.000	
	E < Y min=1124.60			
1100.50	.00	1093.61	.000	
	E < Y min=1124.60			
1101.00	.00	1093.61	.000	
	E < Y min=1124.60			
1101.50	.00	1093.62	.000	
	E < Y min=1124.60			
1102.00	.00	1093.63	.000	
	E < Y min=1124.60			
1102.50	.00	1093.63	.000	
	E < Y min=1124.60			
1103.00	.00	1093.64	.000	
	E < Y min=1124.60			
1103.50	.00	1093.64	.000	
	E < Y min=1124.60			

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = wr (Weir-XY Points)

Upstream ID = (Pond Water Surface)
DNstream ID = TW (Pond Outfall)

WS Elev, Device Q		Tail Water		Notes
WS Elev. ft	Q cfs	TW Elev ft	Converge +/-ft	Computation Messages
1104.00	.00	1093.65	.000	
	E < Y min=1124.60			
1104.50	.00	1093.65	.000	
	E < Y min=1124.60			
1105.00	.00	1093.66	.000	
	E < Y min=1124.60			
1105.50	.00	1093.66	.000	
	E < Y min=1124.60			
1106.00	.00	1093.66	.000	
	E < Y min=1124.60			
1106.50	.00	1093.67	.000	
	E < Y min=1124.60			
1107.00	.00	1093.67	.000	
	E < Y min=1124.60			
1107.50	.00	1093.68	.000	
	E < Y min=1124.60			
1108.00	.00	1093.68	.000	
	E < Y min=1124.60			
1108.50	.00	1093.68	.000	
	E < Y min=1124.60			
1109.00	.00	1093.69	.000	
	E < Y min=1124.60			
1109.50	.00	1093.69	.000	
	E < Y min=1124.60			
1110.00	.00	1093.69	.000	
	E < Y min=1124.60			
1110.50	.00	1093.70	.000	
	E < Y min=1124.60			
1111.00	.00	1093.75	.000	
	E < Y min=1124.60			
1111.50	.00	1093.88	.000	
	E < Y min=1124.60			
1112.00	.00	1094.10	.000	
	E < Y min=1124.60			

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = wr (Weir-XY Points)

Upstream ID = (Pond Water Surface)
DNstream ID = TW (Pond Outfall)

WS Elev,Device Q Tail Water Notes

WS Elev. ft	Q cfs	TW Elev ft	Converge +/-ft	Computation Messages
1112.50	.00	1094.40	.000	
	E < Y min=1124.60			
1113.00	.00	1094.78	.000	
	E < Y min=1124.60			
1113.50	.00	1095.24	.000	
	E < Y min=1124.60			
1114.00	.00	1095.77	.000	
	E < Y min=1124.60			
1114.50	.00	1096.38	.001	
	E < Y min=1124.60			
1115.00	.00	1097.05	.004	
	E < Y min=1124.60			
1115.50	.00	1097.79	.005	
	E < Y min=1124.60			
1116.00	.00	1098.58	.005	
	E < Y min=1124.60			
1116.50	.00	1099.44	.005	
	E < Y min=1124.60			
1117.00	.00	1100.35	.006	
	E < Y min=1124.60			
1117.50	.00	1101.33	.006	
	E < Y min=1124.60			
1118.00	.00	1102.34	.007	
	E < Y min=1124.60			
1118.50	.00	1103.41	.007	
	E < Y min=1124.60			
1119.00	.00	1104.52	.008	
	E < Y min=1124.60			
1119.50	.00	1105.68	.008	
	E < Y min=1124.60			
1120.00	.00	1106.01	.000	
	E < Y min=1124.60			
1120.50	.00	1106.02	.000	
	E < Y min=1124.60			

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = wr (Weir-XY Points)

Upstream ID = (Pond Water Surface)
DNstream ID = TW (Pond Outfall)

WS Elev, Device Q		Tail Water		Notes
WS Elev. ft	Q cfs	TW Elev ft	Converge +/-ft	Computation Messages
1121.00	.00	1106.04	.000	
	E < Y min=1124.60			
1121.50	.00	1106.05	.000	
	E < Y min=1124.60			
1122.00	.00	1106.07	.000	
	E < Y min=1124.60			
1122.50	.00	1106.09	.000	
	E < Y min=1124.60			
1123.00	.00	1106.10	.000	
	E < Y min=1124.60			
1123.50	.00	1106.12	.000	
	E < Y min=1124.60			
1124.00	.00	1106.13	.000	
	E < Y min=1124.60			
1124.50	.00	1106.15	.000	
	E < Y min=1124.60			
1124.60	.00	1106.15	.000	
	E = Y min=1124.60			
1125.00	42.57	1106.17	.000	
	Max.H=.40; Max.Htw=-18.43;; W(ft)=93.75			
1125.50	223.72	1106.20	.000	
	Max.H=.90; Max.Htw=-18.40;; W(ft)=135.12			
1126.00	541.60	1106.24	.000	
	Max.H=1.40; Max.Htw=-18.36;; W(ft)=166.67			
1126.50	992.46	1106.28	.000	
	Max.H=1.90; Max.Htw=-18.32;; W(ft)=194.45			
1127.00	1583.65	1106.34	.000	
	Max.H=2.40; Max.Htw=-18.26;; W(ft)=218.18			
1127.50	2308.10	1106.41	.000	
	Max.H=2.90; Max.Htw=-18.19;; W(ft)=240.91			
1127.60	2468.77	1106.43	.000	
	Max.H=3.00; Max.Htw=-18.18;; W(ft)=245.45			
1128.00	3173.50	1106.49	.000	
	Max.H=3.40; Max.Htw=-18.11;; W(ft)=261.26			

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = wr (Weir-XY Points)

Upstream ID = (Pond Water Surface)
DNstream ID = TW (Pond Outfall)

WS Elev, Device Q		Tail Water		Notes
WS Elev. ft	Q cfs	TW Elev ft	Converge +/-ft	Computation Messages
1128.50	4176.97	1106.57	.000	
	Max.H=3.90; Max.Htw=-18.03;; W(ft)=279.81			
1129.00	5314.79	1106.66	.000	
	Max.H=4.40; Max.Htw=-17.94;; W(ft)=297.99			
1129.50	6596.77	1106.77	.000	
	Max.H=4.90; Max.Htw=-17.84;; W(ft)=314.06			
1130.00	8014.71	1106.88	.000	
	Max.H=5.40; Max.Htw=-17.72;; W(ft)=329.69			
1130.50	9565.74	1107.00	.000	
	Max.H=5.90; Max.Htw=-17.60;; W(ft)=345.31			
1131.00	11262.58	1107.13	.000	
	Max.H=6.40; Max.Htw=-17.47;; W(ft)=359.58			
1131.50	13097.86	1107.27	.000	
	Max.H=6.90; Max.Htw=-17.33;; W(ft)=373.10			
1132.00	15066.59	1107.42	.000	
	Max.H=7.40; Max.Htw=-17.18;; W(ft)=386.62			

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***** COMPOSITE OUTFLOW SUMMARY ****

CUMULATIVE HGL CONVERGENCE ERROR .008 (+/- ft)
FLOW PATH: Elev= 1119.5; Branch: wr-TW

* Max. convergence errors shown may also occur for flow paths other than the ones listed above.

WS Elev, Total Q		Converge		Notes
Elev. ft	Q cfs	TW Elev ft	Error +/-ft	Contributing Structures
1095.50	.00	1093.50	.000	None contributing
1096.00	.98	1093.51	.000	or
1096.50	3.55	1093.52	.000	or
1097.00	7.37	1093.55	.000	or
1097.50	9.51	1093.56	.000	or
1098.00	11.25	1093.57	.000	or
1098.50	12.76	1093.58	.000	or
1099.00	14.10	1093.59	.000	or
1099.50	15.33	1093.59	.000	or
1100.00	16.47	1093.60	.000	or
1100.50	17.53	1093.61	.000	or
1101.00	18.54	1093.61	.000	or
1101.50	19.49	1093.62	.000	or
1102.00	20.40	1093.63	.000	or
1102.50	21.26	1093.63	.000	or
1103.00	22.10	1093.64	.000	or
1103.50	22.90	1093.64	.000	or
1104.00	23.68	1093.65	.000	or
1104.50	24.43	1093.65	.000	or
1105.00	25.16	1093.66	.000	or
1105.50	25.87	1093.66	.000	or
1106.00	26.56	1093.66	.000	or
1106.50	27.23	1093.67	.000	or
1107.00	27.89	1093.67	.000	or
1107.50	28.53	1093.68	.000	or
1108.00	29.15	1093.68	.000	or
1108.50	29.77	1093.68	.000	or
1109.00	30.37	1093.69	.000	or
1109.50	30.96	1093.69	.000	or
1110.00	31.54	1093.69	.000	or
1110.50	32.11	1093.70	.000	or
1111.00	39.86	1093.75	.000	or +cv
1111.50	61.86	1093.88	.000	or +cv
1112.00	97.55	1094.10	.000	or +cv

Type.... Composite Rating Curve
Name.... USE 12-1/2' DIA.

File.... N:\PROJECTS\00\00075\ENGINEER\PONDPAK\DESIGN.PPW

***** COMPOSITE OUTFLOW SUMMARY ****

CUMULATIVE HGL CONVERGENCE ERROR .008 (+/- ft)
FLOW PATH: Elev= 1119.5; Branch: wr-TW

* Max. convergence errors shown may also occur for flow paths other than the ones listed above.

WS Elev, Total Q		Converge		Notes
Elev. ft	Q cfs	TW Elev ft	Error +/-ft	Contributing Structures
1112.50	146.41	1094.40	.000	or +cv
1113.00	208.38	1094.78	.000	or +cv
1113.50	283.00	1095.24	.000	or +cv
1114.00	369.49	1095.77	.000	or +cv
1114.50	467.56	1096.38	.001	or +cv
1115.00	576.58	1097.05	.004	or +cv
1115.50	695.93	1097.79	.005	or +cv
1116.00	825.45	1098.58	.005	or +cv
1116.50	964.68	1099.44	.005	or +cv
1117.00	1113.29	1100.35	.006	or +cv
1117.50	1271.08	1101.33	.006	or +cv
1118.00	1436.68	1102.34	.007	or +cv
1118.50	1610.17	1103.41	.007	or +cv
1119.00	1790.85	1104.52	.008	or +cv
1119.50	1978.36	1105.68	.008	or +cv
1120.00	2172.85	1106.01	.000	or +cv
1120.50	2373.16	1106.02	.000	or +cv
1121.00	2578.82	1106.04	.000	or +cv
1121.50	2788.95	1106.05	.000	or +cv
1122.00	3003.60	1106.07	.000	or +cv
1122.50	3220.75	1106.09	.000	or +cv
1123.00	3441.47	1106.10	.000	or +cv
1123.50	3664.23	1106.12	.000	or +cv
1124.00	3888.33	1106.13	.000	or +cv
1124.50	4114.07	1106.15	.000	or +cv
1124.60	4159.01	1106.15	.000	or +cv +wr
1125.00	4382.23	1106.17	.000	or +cv +wr
1125.50	4789.54	1106.20	.000	or +cv +wr
1126.00	5332.57	1106.24	.000	or +cv +wr
1126.50	6008.25	1106.28	.000	or +cv +wr
1127.00	6822.42	1106.34	.000	or +cv +wr
1127.50	7768.31	1106.41	.000	or +cv +wr
1127.60	7973.02	1106.43	.000	or +cv +wr
1128.00	8852.29	1106.49	.000	or +cv +wr

File.... N:\PROJECTS\00\00075\ENGINEER\PONDPAK\DESIGN.PPW

***** COMPOSITE OUTFLOW SUMMARY ****

CUMULATIVE HGL CONVERGENCE ERROR .008 (+/- ft)
FLOW PATH: Elev= 1119.5; Branch: wr-TW

* Max. convergence errors shown may also occur for flow paths other than the ones listed above.

WS Elev, Total Q		Converge		Notes
Elev. ft	Q cfs	TW Elev ft	Error +/-ft	Contributing Structures
1128.50	10020.09	1106.57	.000	or +cv +wr
1129.00	11303.05	1106.66	.000	or +cv +wr
1129.50	12726.73	1106.77	.000	or +cv +wr
1130.00	14283.49	1106.88	.000	or +cv +wr
1130.50	15969.89	1107.00	.000	or +cv +wr
1131.00	17799.52	1107.13	.000	or +cv +wr
1131.50	19764.71	1107.27	.000	or +cv +wr
1132.00	21861.35	1107.42	.000	or +cv +wr

LEVEL POOL ROUTING SUMMARY

HYG Dir = N:\PROJECTS\00\00075\ENGINEER\PONDPAK\
Inflow HYG file = ROCO.HYG - REG. FACILITYIN 100yr
Outflow HYG file = ROCO.HYG - REG. FACILITYOUT 100yr

Pond Node Data = REG. FACILITY
Pond Volume Data = Total Volume
Pond Outlet Data = USE 12-1/2' DIA.

No Infiltration

INITIAL CONDITIONS

Starting WS Elev	= 1095.50	ft
Starting Volume	= .000	ac-ft
Starting Outflow	= .00	cfs
Starting Infiltr.	= .00	cfs
Starting Total Qout	= .00	cfs
Time Increment	= .0100	hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

Peak Inflow	= 2428.90	cfs	at	12.6000 hrs
Peak Outflow	= 2240.04	cfs	at	12.8800 hrs
Peak Elevation	= 1120.17	ft		
Peak Storage	= 69.297	ac-ft		

MASS BALANCE (ac-ft)

+ Initial Vol	= .000	
+ HYG Vol IN	= 453.981	
- Infiltration	= .000	
- HYG Vol OUT	= 436.382	
- Retained Vol	= 17.594	
Unrouted Vol	= -.005	ac-ft (.001% of Inflow Volume)

WARNING: Outflow hydrograph truncated on right side.

LEVEL POOL ROUTING SUMMARY

HYG Dir = N:\PROJECTS\00\00075\ENGINEER\PONDPAK\
Inflow HYG file = ROCO.HYG - REG. FACILITYIN 10yr
Outflow HYG file = ROCO.HYG - REG. FACILITYOUT 10yr

Pond Node Data = REG. FACILITY
Pond Volume Data = Total Volume
Pond Outlet Data = USE 12-1/2' DIA.

No Infiltration

INITIAL CONDITIONS

Starting WS Elev	= 1095.50	ft
Starting Volume	= .000	ac-ft
Starting Outflow	= .00	cfs
Starting Infiltr.	= .00	cfs
Starting Total Qout	= .00	cfs
Time Increment	= .0100	hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

Peak Inflow	= 1248.00	cfs	at	12.6000 hrs
Peak Outflow	= 1085.79	cfs	at	12.9900 hrs
Peak Elevation	= 1116.91	ft		
Peak Storage	= 49.755	ac-ft		

MASS BALANCE (ac-ft)

+ Initial Vol	= .000	
+ HYG Vol IN	= 239.268	
- Infiltration	= .000	
- HYG Vol OUT	= 224.588	
- Retained Vol	= 14.679	
Unrouted Vol	= -.000	ac-ft (.000% of Inflow Volume)

WARNING: Outflow hydrograph truncated on right side.

LEVEL POOL ROUTING SUMMARY

HYG Dir = N:\PROJECTS\00\00075\ENGINEER\PONDPAK\
Inflow HYG file = ROCO.HYG - REG. FACILITYIN 1yr
Outflow HYG file = ROCO.HYG - REG. FACILITYOUT 1yr

Pond Node Data = REG. FACILITY
Pond Volume Data = Total Volume
Pond Outlet Data = USE 12-1/2' DIA.

No Infiltration

INITIAL CONDITIONS

Starting WS Elev	=	1095.50 ft
Starting Volume	=	.000 ac-ft
Starting Outflow	=	.00 cfs
Starting Infiltr.	=	.00 cfs
Starting Total Qout	=	.00 cfs
Time Increment	=	.0100 hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

Peak Inflow	=	441.00 cfs	at	12.7700 hrs
Peak Outflow	=	220.73 cfs	at	13.5900 hrs
Peak Elevation	=	1113.08 ft		
Peak Storage	=	31.659 ac-ft		

MASS BALANCE (ac-ft)

+ Initial Vol	=	.000
+ HYG Vol IN	=	91.720
- Infiltration	=	.000
- HYG Vol OUT	=	85.154
- Retained Vol	=	6.557
Unrouted Vol	=	-.009 ac-ft (.009% of Inflow Volume)

WARNING: Outflow hydrograph truncated on right side.

LEVEL POOL ROUTING SUMMARY

HYG Dir = N:\PROJECTS\00\00075\ENGINEER\PONDPAK\
Inflow HYG file = ROCO.HYG - REG. FACILITYIN 25yr
Outflow HYG file = ROCO.HYG - REG. FACILITYOUT 25yr

Pond Node Data = REG. FACILITY
Pond Volume Data = Total Volume
Pond Outlet Data = USE 12-1/2' DIA.

No Infiltration

INITIAL CONDITIONS

Starting WS Elev	=	1095.50 ft
Starting Volume	=	.000 ac-ft
Starting Outflow	=	.00 cfs
Starting Infiltr.	=	.00 cfs
Starting Total Qout	=	.00 cfs
Time Increment	=	.0100 hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

Peak Inflow	=	1708.31 cfs	at	12.6000 hrs
Peak Outflow	=	1550.19 cfs	at	12.9200 hrs
Peak Elevation	=	1118.33 ft		
Peak Storage	=	57.577 ac-ft		

MASS BALANCE (ac-ft)

+ Initial Vol	=	.000
+ HYG Vol IN	=	322.488
- Infiltration	=	.000
- HYG Vol OUT	=	305.468
- Retained Vol	=	17.013
Unrouted Vol	=	-.008 ac-ft (.002% of Inflow Volume)

WARNING: Outflow hydrograph truncated on right side.

LEVEL POOL ROUTING SUMMARY

HYG Dir = N:\PROJECTS\00\00075\ENGINEER\PONDPAK\
Inflow HYG file = ROCO.HYG - REG. FACILITYIN 2yr
Outflow HYG file = ROCO.HYG - REG. FACILITYOUT 2yr

Pond Node Data = REG. FACILITY
Pond Volume Data = Total Volume
Pond Outlet Data = USE 12-1/2' DIA.

No Infiltration

INITIAL CONDITIONS

Starting WS Elev	=	1095.50 ft
Starting Volume	=	.000 ac-ft
Starting Outflow	=	.00 cfs
Starting Infiltr.	=	.00 cfs
Starting Total Qout	=	.00 cfs
Time Increment	=	.0100 hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

Peak Inflow	=	625.29 cfs	at	12.7600 hrs
Peak Outflow	=	413.75 cfs	at	13.2700 hrs
Peak Elevation	=	1114.23 ft		
Peak Storage	=	36.682 ac-ft		

MASS BALANCE (ac-ft)

+ Initial Vol	=	.000
+ HYG Vol IN	=	125.312
- Infiltration	=	.000
- HYG Vol OUT	=	116.251
- Retained Vol	=	9.060
Unrouted Vol	=	-.001 ac-ft (.001% of Inflow Volume)

WARNING: Outflow hydrograph truncated on right side.

LEVEL POOL ROUTING SUMMARY

HYG Dir = N:\PROJECTS\00\00075\ENGINEER\PONDPAK\
Inflow HYG file = ROCO.HYG - REG. FACILITYIN 50yr
Outflow HYG file = ROCO.HYG - REG. FACILITYOUT 50yr

Pond Node Data = REG. FACILITY
Pond Volume Data = Total Volume
Pond Outlet Data = USE 12-1/2' DIA.

No Infiltration

INITIAL CONDITIONS

Starting WS Elev	=	1095.50 ft
Starting Volume	=	.000 ac-ft
Starting Outflow	=	.00 cfs
Starting Infiltr.	=	.00 cfs
Starting Total Qout	=	.00 cfs
Time Increment	=	.0100 hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

Peak Inflow	=	2041.15 cfs	at	12.6000 hrs
Peak Outflow	=	1873.43 cfs	at	12.8900 hrs
Peak Elevation	=	1119.22 ft		
Peak Storage	=	63.005 ac-ft		

MASS BALANCE (ac-ft)

+ Initial Vol	=	.000
+ HYG Vol IN	=	383.034
- Infiltration	=	.000
- HYG Vol OUT	=	365.718
- Retained Vol	=	17.308
Unrouted Vol	=	-.008 ac-ft (.002% of Inflow Volume)

WARNING: Outflow hydrograph truncated on right side.

LEVEL POOL ROUTING SUMMARY

HYG Dir = N:\PROJECTS\00\00075\ENGINEER\PONDPAK\
Inflow HYG file = ROCO.HYG - REG. FACILITYIN 5yr
Outflow HYG file = ROCO.HYG - REG. FACILITYOUT 5yr

Pond Node Data = REG. FACILITY
Pond Volume Data = Total Volume
Pond Outlet Data = USE 12-1/2' DIA.

No Infiltration

INITIAL CONDITIONS

Starting WS Elev	=	1095.50 ft
Starting Volume	=	.000 ac-ft
Starting Outflow	=	.00 cfs
Starting Infiltr.	=	.00 cfs
Starting Total Qout	=	.00 cfs
Time Increment	=	.0100 hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

Peak Inflow	=	1031.39 cfs	at	12.7600 hrs
Peak Outflow	=	855.29 cfs	at	13.0400 hrs
Peak Elevation	=	1116.11 ft		
Peak Storage	=	45.646 ac-ft		

MASS BALANCE (ac-ft)

+ Initial Vol	=	.000
+ HYG Vol IN	=	199.535
- Infiltration	=	.000
- HYG Vol OUT	=	186.480
- Retained Vol	=	13.052
Unrouted Vol	=	-.003 ac-ft (.001% of Inflow Volume)

WARNING: Outflow hydrograph truncated on right side.

LEVEL POOL ROUTING SUMMARY

HYG Dir = N:\PROJECTS\00\00075\ENGINEER\PONDPAK\
Inflow HYG file = ROCO.HYG - REG. FACILITYIN PMF
Outflow HYG file = ROCO.HYG - REG. FACILITYOUT PMF

Pond Node Data = REG. FACILITY
Pond Volume Data = Total Volume
Pond Outlet Data = USE 12-1/2' DIA.

No Infiltration

INITIAL CONDITIONS

Starting WS Elev	= 1095.50	ft
Starting Volume	= .000	ac-ft
Starting Outflow	= .00	cfs
Starting Infiltr.	= .00	cfs
Starting Total Qout	= .00	cfs
Time Increment	= .0100	hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

Peak Inflow	= 10077.31	cfs	at	1.5200 hrs
Peak Outflow	= 10025.38	cfs	at	1.6800 hrs
Peak Elevation	= 1128.50	ft		
Peak Storage	= 165.313	ac-ft		

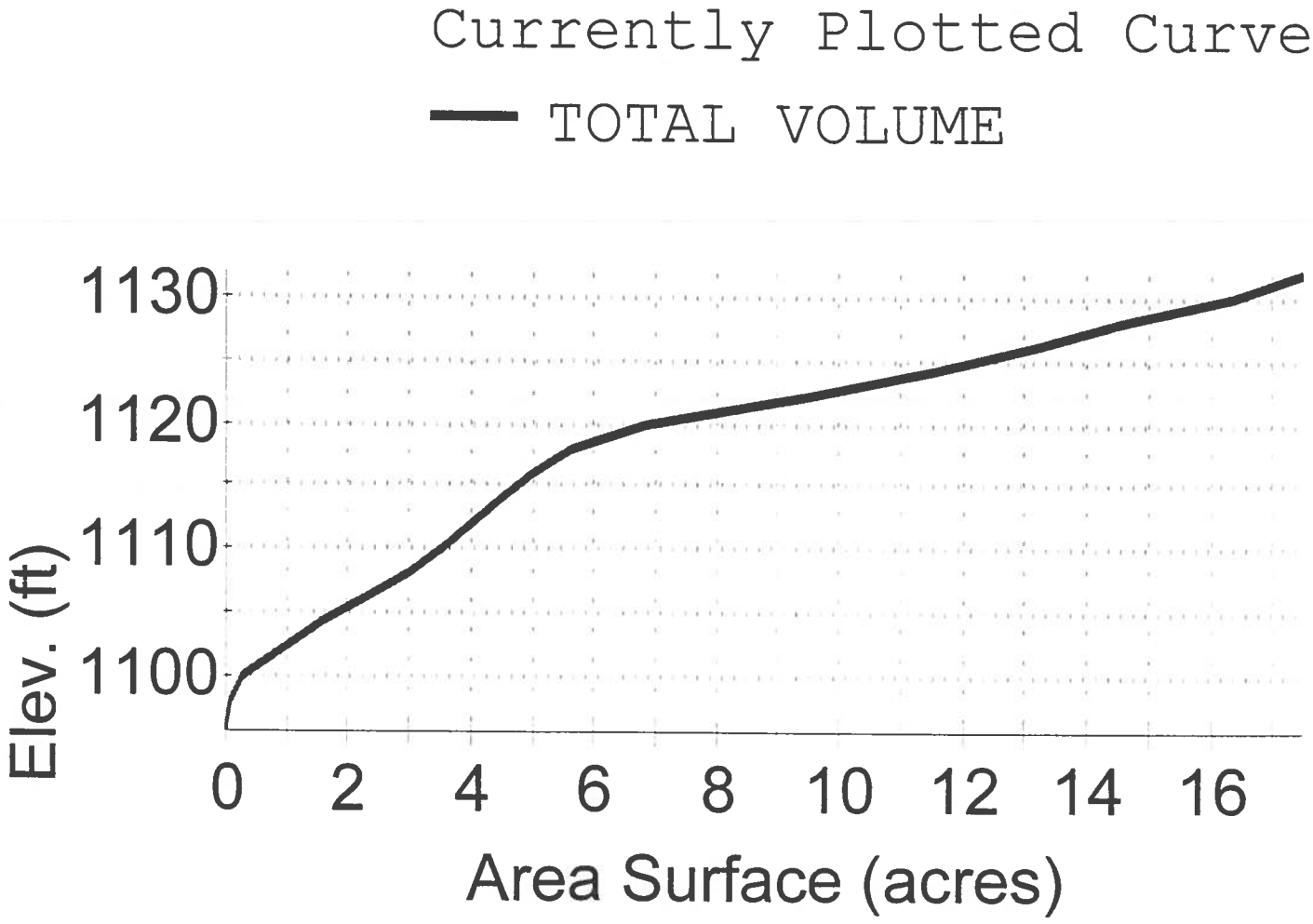
MASS BALANCE (ac-ft)

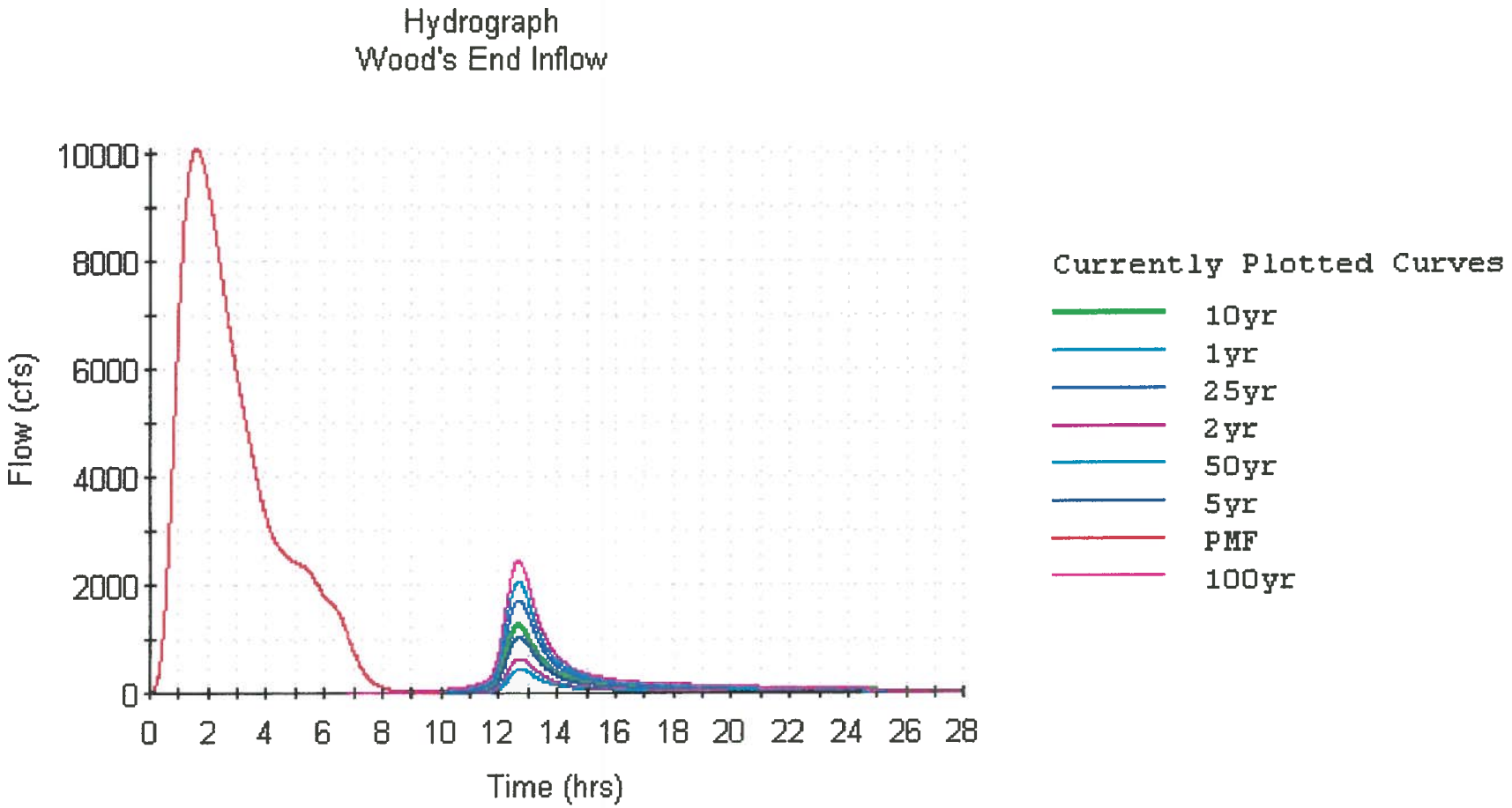
+ Initial Vol	= .000	
+ HYG Vol IN	= 2504.627	
- Infiltration	= .000	
- HYG Vol OUT	= 2504.546	
- Retained Vol	= .080	
Unrouted Vol	= -.001	ac-ft (.000% of Inflow Volume)

WARNING: Outflow hydrograph truncated on right side.

Index of Starting Page Numbers for ID Names

Elev. vs. Area Surface
TOTAL VOLUME




Hydrograph
Wood's End Inflow
Flow (cfs)
10000
8000
6000
4000
2000
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28
Time (hrs)
Currently Plotted Curves
10yr
1yr
25yr
2yr
50yr
5yr
PMF
100yr