R-11

PRELIMINARY HYDROLOGY FOR RENO CANNON INTERNATIONAL AIRPORT

NOVEMBER 19, 1992

RENO CANNON INTERNATIONAL AIRPORT
RECONSTRUCT & EXTEND RUNWAY 16l-34r
CONSTRUCT SERVICE ROAD & DRAINAGE

Preliminary Hydrologic Study
From
Thirty Percent Design Submittal

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3.0 COMMENT ON DRAINAGE MASTER PLAN

3.1 Introduction

The hydrologic analysis for the Reno Cannon International Airport Drainage System – off-site as well as on-site areas – has been performed as part of the Review of the Drainage Master Plan prepared by SEA, Inc., dated Oct. 1992. This task is included in the 'Agreement for Professional Engineering Services' for 'Runway 16L-34R & Associated Taxiways Final Design.' The Southside Drain is the only major off-site drainage impacting the infield area for which existing hydrologic reports are absent. SEA, Inc. in their Master Plan Drainage Study had used the 'capacity' of the incoming culverts to establish the design discharges for the recommended drainage improvements. Consequently, this hydrologic analysis has been performed to compare the computed flows with the 'capacity' discharges and determine if a revision of the design discharges is necessary.

The hydraulic analysis and design of the infield drainage improvements used the drainage concept recommended in the SEA, Inc. Master Plan Drainage Study as the starting point. However, higher flows, runway and taxiway geometry, and a more detailed analysis of existing topography and constraints necessitated numerous revisions.

3.2 Scope of Work

The scope of work encompasses the performance of an approximate hydrologic analysis to enable a review of the 'capacity' discharges outlined in the SEA, Inc. Master Plan Drainage Study.

The nature of the hydrologic features within the off-site and on-site watersheds did not lend itself to a simple analysis. Existence of several major storage/reservoir areas and relatively complicated hydraulic systems require the use of reservoir and channel routing, as well as split flows/diversions. Under these conditions the Rational Method was judged inadequate and the hydrograph generation and routing procedures within the Corps of Engineers' HEC-1 computer program have been utilized. However, keeping in view the approximate nature of the study, only available information has been utilized without resorting to additional survey.

A detailed hydraulic analysis and design has been done for all drainage facilities. The design shall take into account the phased nature of the construction.

Both the hydrologic analysis and the hydraulic design reflect the amount of effort required for the 30 percent submittal. Consequently, infield hydrology is not final and only main trunk lines and significant structures have been hydraulically analyzed and designed.

3.3 Sources of Information

- 1" = 2,000' scale USGS Topographic Maps for Mt. Rose NE, Nev. (photo revised 1982) and Reno, Nev. (photo revised 1982)
- Soil Survey of Washoe County, Nevada, South Part (1980)
- City of Reno Master Plan (May 29, 1992)
- Master Plan Drainage Study by SEA, Inc. (October 1992)
- Hydrologic Analysis for Thomas Creek, Dry Creek and the Boynton Slough by Nimbus Engineers (November 1991)

- Base Topo Maps for Reno Cannon International Airport from SEA, Inc. (October 1, 1992)

- Utility Maps for Reno Cannon International Airport by Murray McCormick Environmental Group (1974)

- Topo Maps for Reno Cannon International Airport by Murray McCormick Environmental Group (1974)

- As-Built U.S. 395 (I-580) Roadway Plans for Contract 1764 by Nevada DOT (1979)

- Southside Storm Drain Preliminary Design by Truckee Meadows (February 1964)

- Engineering Calculations Southside Storm Drain (February 1964)

- Reno Drainage Study - Analysis of Drainage Deficiency Areas by Winzler & Kelly (May 1985)

- Reno Drainage Study - Analysis of Drainage Deficiency Areas by Winzler & Kelly (December 1984)

- Reno Cannon International Airport Storm Drainage Study by Consulting Engineering Services (December 15, 1983)

- Hydrologic Analysis of the City of Reno's Major Drainage Basins by Summit Engineering Corporation (October 1985)

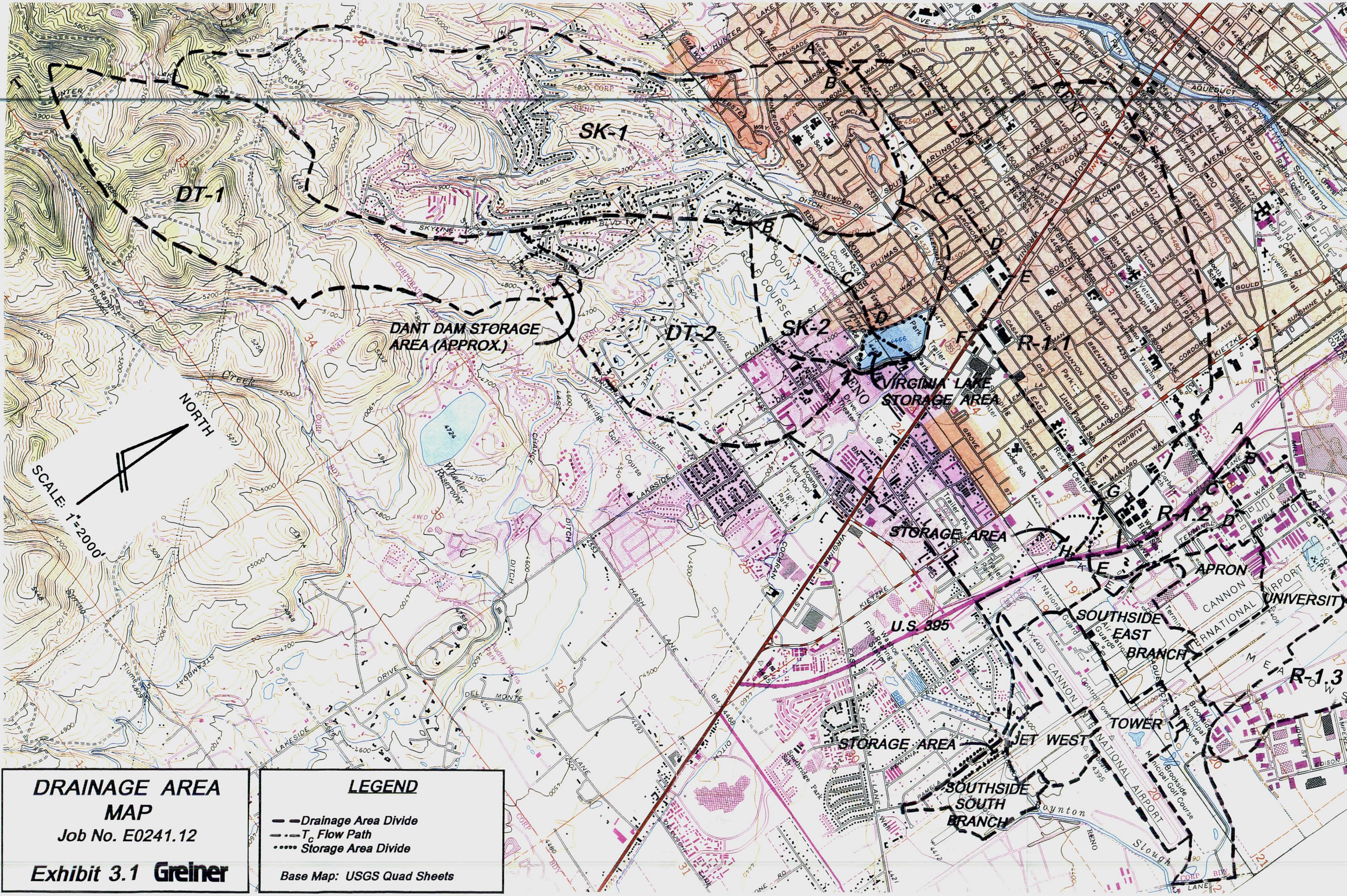
- Supplemental Engineering Report for Plumas/Moana Storm Drain by Kennedy/Jenks/Chilton (March 1989)
- Brookside Ditch Relocation Feasibility Study (January 12, 1987)
- Southside Storm Drain Plans by Truckee Meadows (January 1965)
- Southside Storm Drain from Kietzke Lane to Harvard Way Plans by City of Reno (January 1979)
- Box Culvert Southside Storm Drain at Harvard Way Plans by City of Reno (February 1972)
- Plumas/Moana Storm Drain Plans by City of Reno (August 1990)
- Gentry Storm Drain Plans by City of Reno (January 1992)
- NOAA Atlas 2: Precipitation-Frequency Atlas of the Western United States Volume VII - Nevada by National Oceanic and Atmospheric Administration (1973)
- HEC-1 Flood Hydrograph Package by Corps of Engineers (September 1990)
- Urban Hydrology for Small Watersheds (Technical Release 55) by Soil Conservation Service (June 1986)
- Design of Small Dams by Bureau of Reclamation (1973)
- Field Trip to the Watershed (October 1992)

- Personal Communications with Frank Alverson of SEA, Inc. (November 1992)
- Personal Communications with Thor Dyson and Bill Hange of Nevada DOT in Reno District Office (October/November 1992)
- Personal Communications with Amir of Nevada DOT Hydraulics Division in Carson City (October 1992)
- Personal Communications with Chris Robinson, Glen Daly, Barney Davidson and Fran Valentine of City of Reno (October 1992)
- Personal Communications with Eric Buck of Baker Engineering for FEMA in Virginia (November 1992)
- Personal Communications with Peggy Bowker, Paul Frost and Yong Song of Nimbus Engineers (November 1992)

3.4 Hydrologic Analysis

3.4.1 Off-Site Hydrology

Significant features of the off-site hydrology are described within this section with reference to Exhibits 3.1 through 3.3 and Tables 3.1 and 3.3. Our research did not uncover any existing drainage studies which address the hydrologic conditions described below.



DRAINAGE AREA MAP

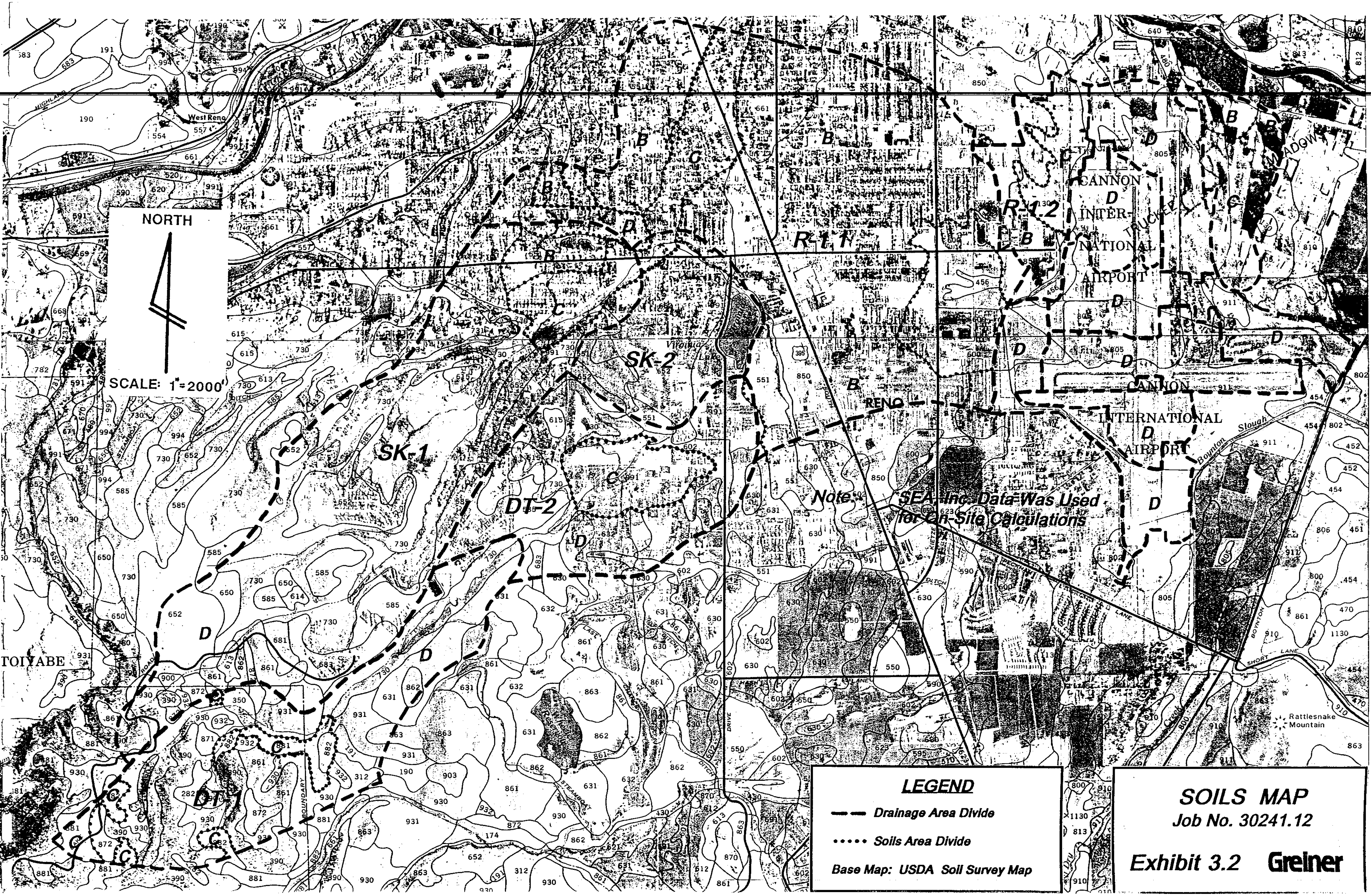
Job No. E0241.12

Exhibit 3.1 **Greiner**

LEGEND

- — — Drainage Area Divide
- —·— T_c Flow Path
- ····· Storage Area Divide

Base Map: USGS Quad Sheets



LEGEND

- - - Drainage Area Divide

••••• Soils Area Divide

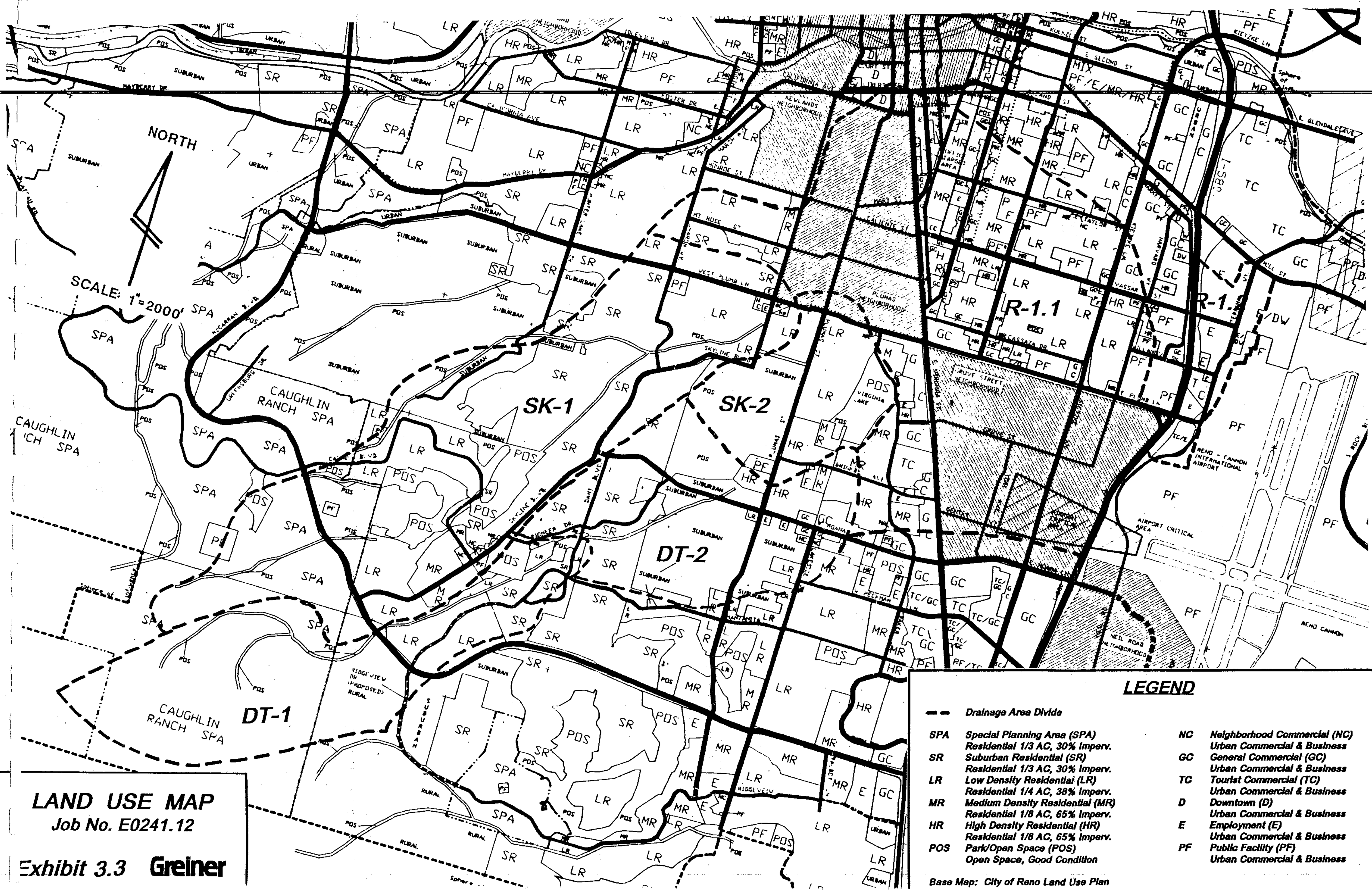
Base Map: USDA Soil Survey Map

SOILS MAP

Job No. 30241.12

Exhibit 3.2

Greiner



LAND USE MAP

Job No. E0241.12

Exhibit 3.3 **Greiner**

LEGEND

- - - Drainage Area Divide

SPA	Special Planning Area (SPA) Residential 1/3 AC, 30% Imperv.
SR	Suburban Residential (SR) Residential 1/3 AC, 30% Imperv.
LR	Low Density Residential (LR) Residential 1/4 AC, 38% Imperv.
MR	Medium Density Residential (MR) Residential 1/8 AC, 65% Imperv.
HR	High Density Residential (HR) Residential 1/8 AC, 65% Imperv.
POS	Park/Open Space (POS) Open Space, Good Condition
NC	Neighborhood Commercial (NC) Urban Commercial & Business
GC	General Commercial (GC) Urban Commercial & Business
TC	Tourist Commercial (TC) Urban Commercial & Business
D	Downtown (D) Urban Commercial & Business
E	Employment (E) Urban Commercial & Business
PF	Public Facility (PF) Urban Commercial & Business

Base Map: City of Reno Land Use Plan

TABLE 3.1: SUMMARY OF HYDROLOGIC PARAMETERS FOR OFF-SITE DRAINAGE AREAS

DRAINAGE SUB-AREA	AREA (SQ. MI.)	RUNOFF CURVE NO.	TIME OF CONCENTRATION (HRS.)
OFF-SITE DRAINAGE AREAS			
DT-1[1]	1.21	85	0.70
DT-2[1]	0.94	85	0.55
SK-1[1]	2.20	85	0.80
SK-2	0.51	89	0.69
R-1.1	2.79	88	2.56
R-1.2	0.33	93	0.97
R-1.3	0.26	94	1.67

NOTE:

1. Hydrologic parameters for these areas are obtained from the hydrologic analysis for Thomas Creek, Dry Creek and the Boynton Slough by Nimbus Engineers.

TABLE 3.2: SUMMARY OF HYDROLOGIC PARAMETERS FOR INFIELD DRAINAGE AREAS

DRAINAGE SUB-AREA	*AREA (SQ. MI.)*	*RUNOFF CURVE NO.*	*TIME OF CONCENTRATION (HRS.)*
SOUTHSIDE DRAIN SOUTH BRANCH[1]			
SSBA	.020	86	0.12
SSBB	.077	92	0.31
SSBC	.000	—	—
SSBD	.005	85	0.07
SSBE	.035	88	0.18
SOUTHSIDE DRAIN EAST BRANCH[1]			
SEBA	.062	90	0.19
SEBB	.091	98	0.23
SEBC	.049	89	0.31
SEED	.019	87	0.21
SEBE	.023	96	0.18
SEBF	.125	96	0.43
TOWER[1]			
TA	.092	95	0.60
TB	.019	91	0.14
TC	.068	88	0.42
TD	.060	92	0.38
JET WEST[1]			
JWA	.050	89	0.38
JWB	.042	96	0.31
JWC	.061	92	0.17
JWD	.049	92	0.21
JWE	.005	89	0.10

TABLE 3.2: SUMMARY OF HYDROLOGIC PARAMETERS FOR INFIELD DRAINAGE AREAS

DRAINAGE SUB-AREA	*AREA (SQ. MI.)*	*RUNOFF CURVE NO.*	*TIME OF CONCENTRATION (HRS.)*
APRON[1]			
AA	.105	98	0.26
AB	.042	98	0.17
AC	.015	91	0.52
AD	.031	89	0.60
UNIVERSITY[1]			
UA	.040	74	0.55
UB	.026	90	0.23
UC	.081	89	0.27
UD	.031	88	0.19
UE	.070	91	0.45
UF	.027	98	0.24

NOTE:

1. Hydrologic parameters for these areas were developed by SEA, Inc. and have been incorporated within the Greiner model after a brief review. However, the Jet West area, JWA, has been increased; Manning's "n" used for the channel routings within the University Watershed has been changed from 0.3 to 0.03.

TABLE 3.3: SIGNIFICANT PEAK FLOWS FOR OFF-SITE DRAINAGE AREAS

LOCATION	25-YR PEAK FLOW (CFS)	100-YR PEAK FLOW (CFS)
Inflow at Virginia Lake	1283	2035
Outflow from Virginia Lake	908	1503
Inflow West of U.S. 395 (Southside Drain)	1216	1933
Outflow East of U.S. 395 to Southside Drain East Branch	486	527
Outflow East of U.S. 395 to Southside Drain South Branch	517	590
Overflow from Terminal Way to Apron Drainage System via Pilot Way	62	95

3.4.1.1 Skyline and Dant Watersheds SK-1, SK-2, DT-1 and DT-2

These watersheds originate in the foothills of the Sierra Mountains and include the western fringes of the City of Reno. In spite of steep slopes, these areas have been urbanized with mostly residential and supporting commercial development. Dant Dam at the downstream end of DT-1 is a major flood control structure. For the most part, flows are conveyed in natural channels outside the city limits. However, storm drain systems are present in the lower and relatively flat portions of the watershed (eastern SK-1, SK-2 and DT-2).

The HEC-1 model for these watersheds, with the exception of area SK-2, was originally developed in the Supplemental Engineering Report for the Plumas/Moana Storm Drain by Kennedy/Jenks/Chilton (March 1989) and subsequently included within the Hydrologic Analysis for Thomas Creek, Dry Creek and the Boynton Slough by Nimbus Engineers (November 1991). The latter report has been tentatively approved by Baker Engineering for FEMA. The HEC-1 model for these areas has been incorporated "as is" within Greiner's HEC-1 model, after verification of the runoff curve numbers. Hydrologic parameters for SK-2 were developed by Greiner and are included with the backup documentation.

3.4.1.2 Virginia Lake

Flows from the Skyline and Dant Watersheds end up in Virginia Lake. The lake is a significant flood control and recreation facility (surface area 23.4 acres as determined from the USGS map). A morning glory (principal spillway) inside the lake and an emergency spillway at the northeastern edge of the lake convey flows into the Southside Drain – headed east. An outlet for irrigation water to the Cochran Ditch is also present – it was closed at the time of the field visit.

The USGS map and field observations were used to determine storage. The Southside Storm Drain Plans by Truckee Meadows (January 1965) and a field investigation by Nimbus Engineers were used to develop a discharge rating curve. (Refer to maps and backup documentation.) The outflow from Virginia Lake was routed to the Southside Drain crossings at U.S. 395.

3.4.1.3 Reno Watersheds R-1.1, R-1.2 and R-1.3

The Soil Survey of Washoe County, Nevada, South Part (1980) and the City of Reno Master Plan (May 29, 1992) soil and land use maps were used to determine the runoff curve numbers. Time of concentration was developed using Technical Release 55 by the Soil Conservation Service (June 1986). Flow is mostly over streets at very flat slopes.

3.4.1.4 Ponding Along East Side of U.S. 395 at the Southside Drain Box Culverts (Under U.S. 395)

The routed flow from Virginia Lake combines with flow from area R-1.1 upstream of U.S. 395 and area R-1.2 downstream of U.S. 395. The Southside Drain flow is conveyed in closed conduits up to Harvard Way. An open channel with riprap on side slopes conveys the flow to a diversion structure (which is basically a vertical wall in the middle of the channel) southeast of the Costco Shopping Center. The flow splits and heads toward the Southside Drain East and South Branch box culverts under U.S. 395.

The ponded area along the east side of U.S. 395 is the third major storage 'reservoir' on the drainage system. Storage rating data were computed with the aid of the USGS map, field observations and Southside Drain plans. In the absence of detailed contour information, this determination is very approximate. A composite headwater-discharge table was developed for the 12'x4' box culvert (under U.S. 395) for the Southside Drain East Branch and the 10'x5' box culvert (under U.S. 395) for the Southside Drain South

Branch with the information provided by Nevada DOT and the SEA, Inc. base topo maps. There is a discrepancy of approximately 3.4 feet between the Nevada DOT and SEA, Inc. elevations, with SEA, Inc. elevations being higher.

After routing through the reservoir, the flow was split into the Southside Drain East and South Branches using the diversion option within HEC-1.

3.4.2 Infield Hydrology

The pattern of flow within the infield area is based on the concept outlined within the Master Plan Drainage Study prepared by SEA, Inc. (see Exhibits 3.4 through 3.6 and Table 3.2). Significant points of departure are noted below and in Section 5.0 and described on Exhibit 3.4.

3.4.2.1 Infield Southside Drain South Branch Drainage System

The off-site flow from the Southside Drain South Branch box culvert (under U.S. 395) is conveyed southeast in an open channel to the two culverts crossing the runways (beginning at Concentration Points SSB-4 and SSB-6). Along the way, major additional flows are picked up at Concentration Points 'H' (from the Gentry Storm Drain) and 'I' (from the Moana Lane/Fish Hatchery Drain). Also, Drainage Areas SSBA through SSBF along the Southside Drain South Branch channel also contribute to flow within the channel.

The infield system was analyzed in the Master Plan Drainage Study by SEA, Inc. (October 1992) by adding in the off-site 'capacity' flows for the Southside South Branch box culvert (under U.S. 395).

MODIFIED DRAINAGE AREAS

Job No. E0241.12

Exhibit 3.4 **Greiner**

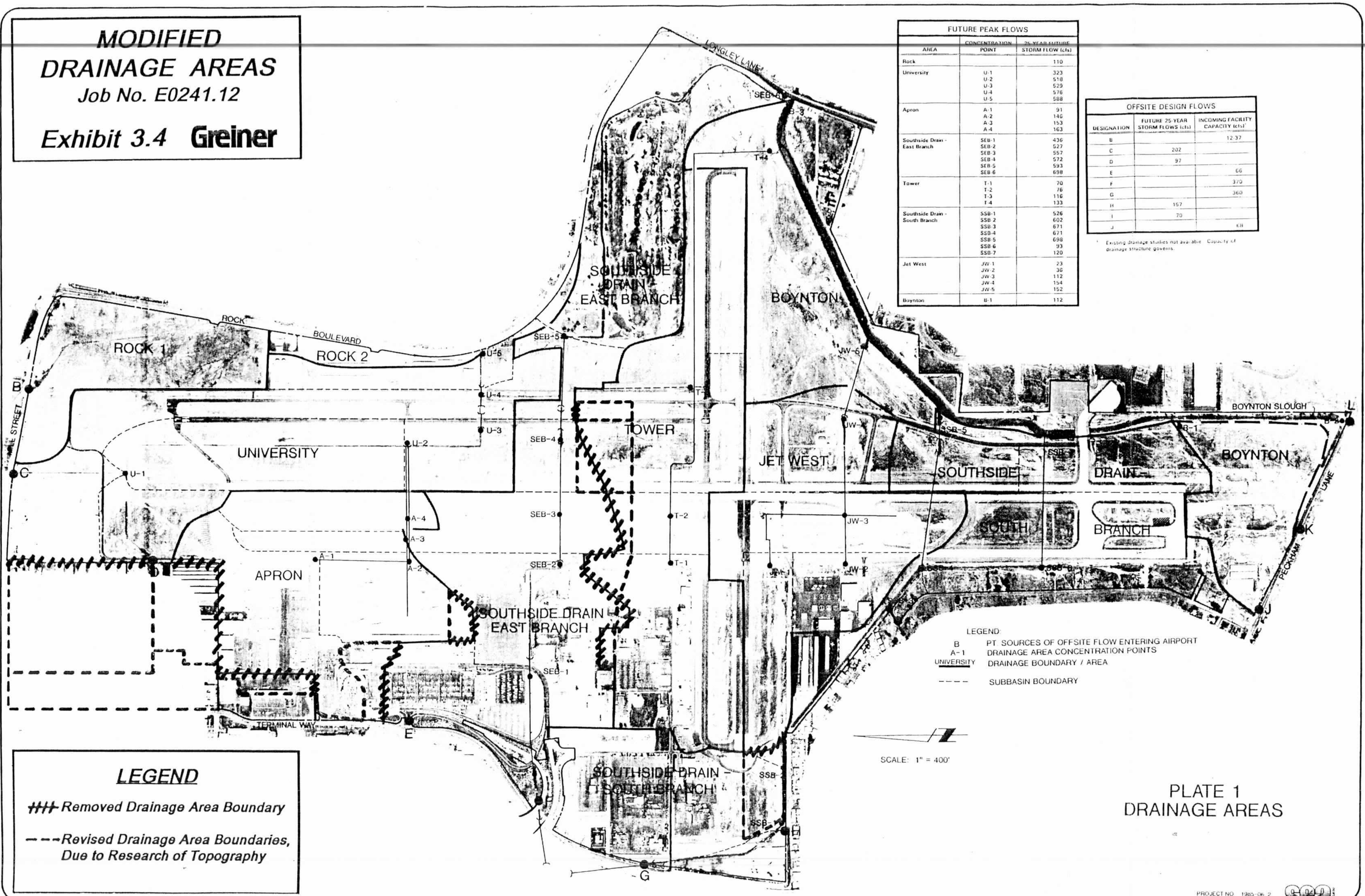


PLATE 1
DRAINAGE AREAS

FUTURE PEAK FLOWS		
AREA	CONCENTRATION POINT	25-YEAR FUTURE STORM FLOW (cfs)
Rock		110
University	U-1 U-2 U-3 U-4 U-5	323 518 529 576 588
Apron	A-1 A-2 A-3 A-4	91 146 153 163
Southside Drain - East Branch	SEB-1 SEB-2 SEB-3 SEB-4 SEB-5 SEB-6	436 527 557 572 593 698
Tower	T-1 T-2 T-3 T-4	70 76 116 133
Southside Drain - South Branch	SSB-1 SSB-2 SSB-3 SSB-4 SSB-5 SSB-6 SSB-7	526 602 671 671 698 93 120
Jet West	JW-1 JW-2 JW-3 JW-4 JW-5	23 36 112 154 152
Boynton	B-1	112

OFFSITE DESIGN FLOWS		
DESIGNATION	FUTURE 25-YEAR STORM FLOWS (cfs)	INCOMING FACILITY CAPACITY (cfs)[1]
B		12-37
C	202	
D	97	
E		66
F		370
G		360
H	157	
I	70	
J		68

[1] Existing drainage studies not available. Capacity of drainage structure governs.

LEGEND

- ╫╫╫ Removed Drainage Area Boundary
- - - - Revised Drainage Area Boundaries, Due to Research of Topography

Exhibit 3.5

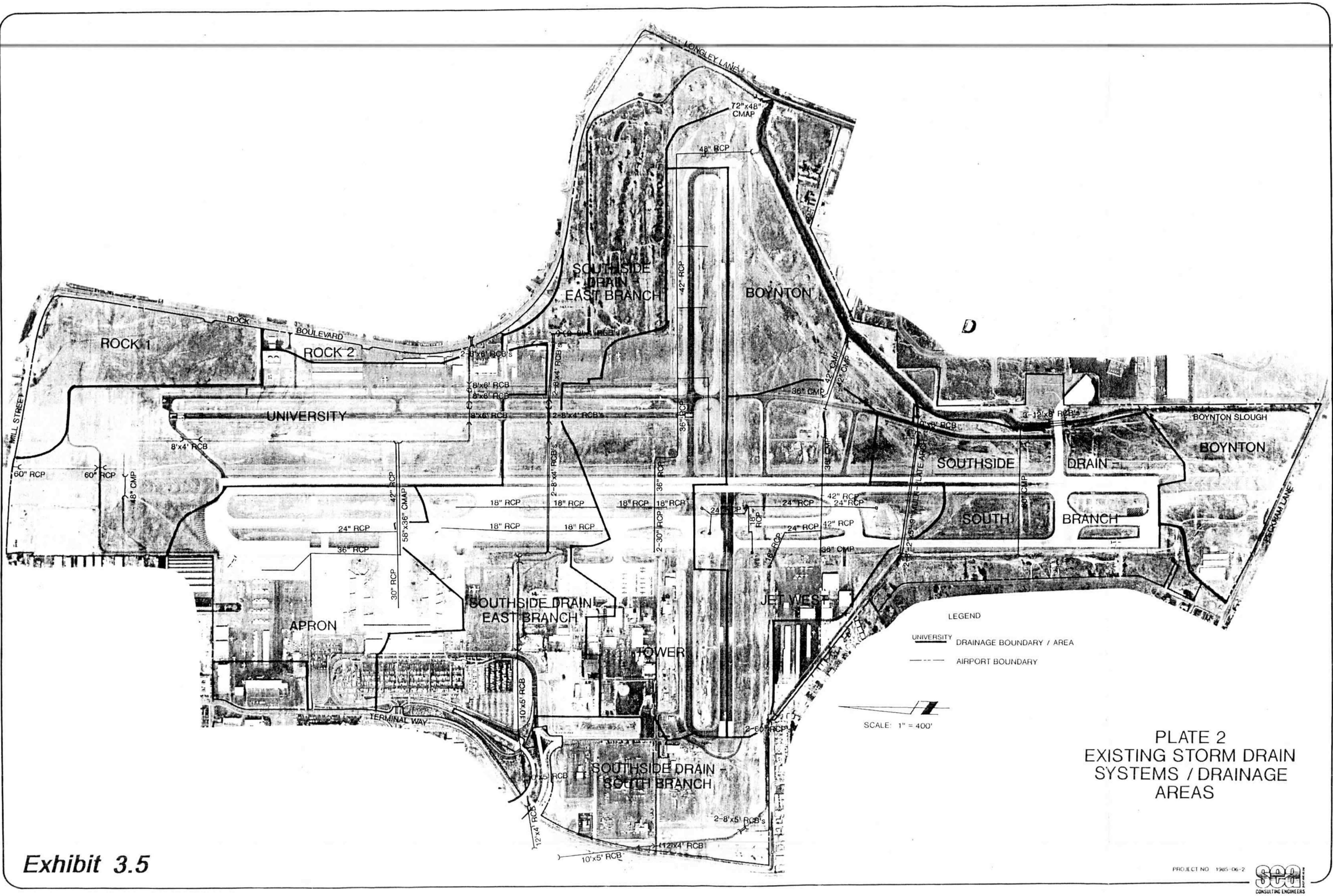


PLATE 2
EXISTING STORM DRAIN
SYSTEMS / DRAINAGE
AREAS

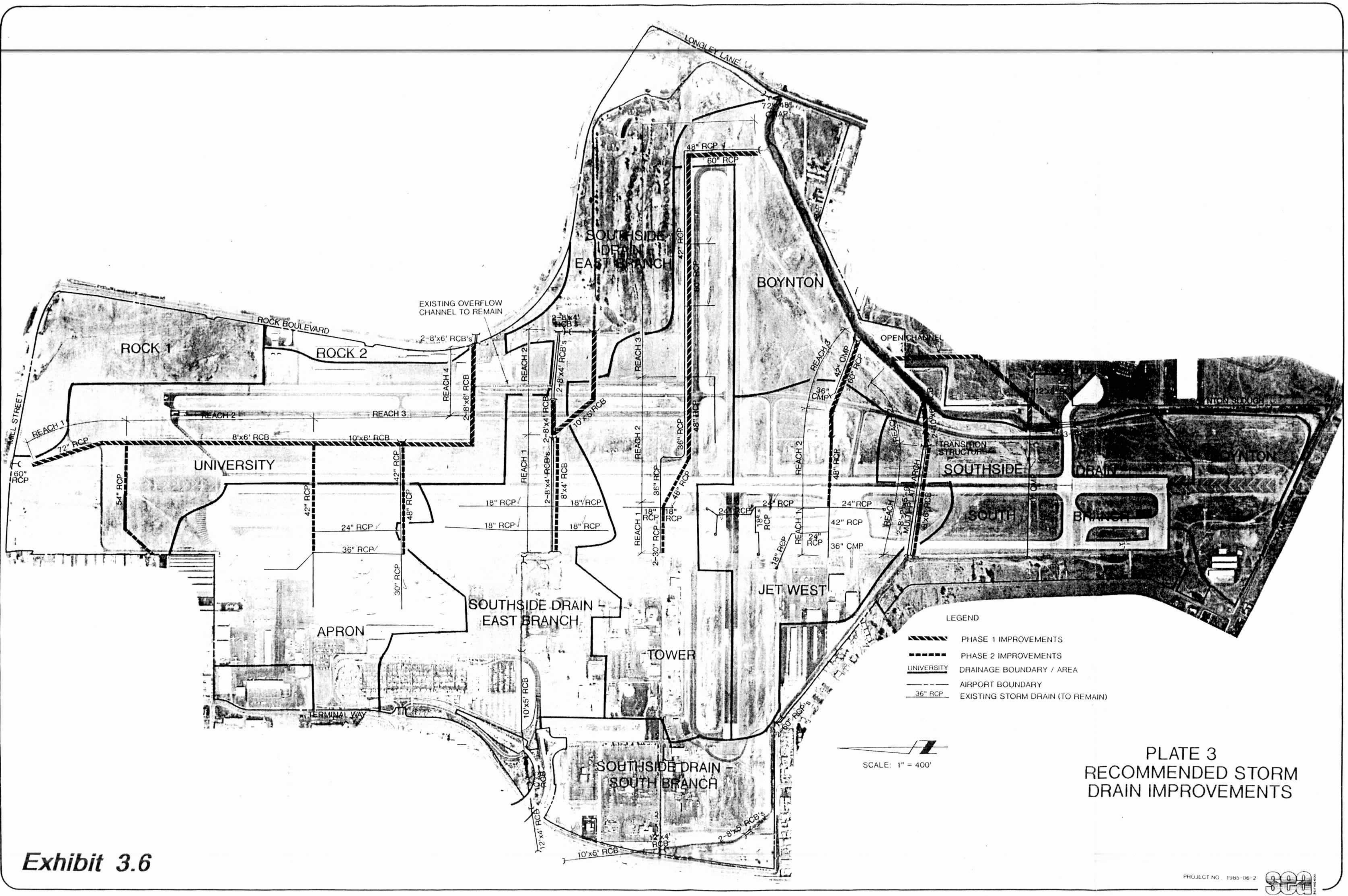


PLATE 3
RECOMMENDED STORM
DRAIN IMPROVEMENTS

Exhibit 3.6

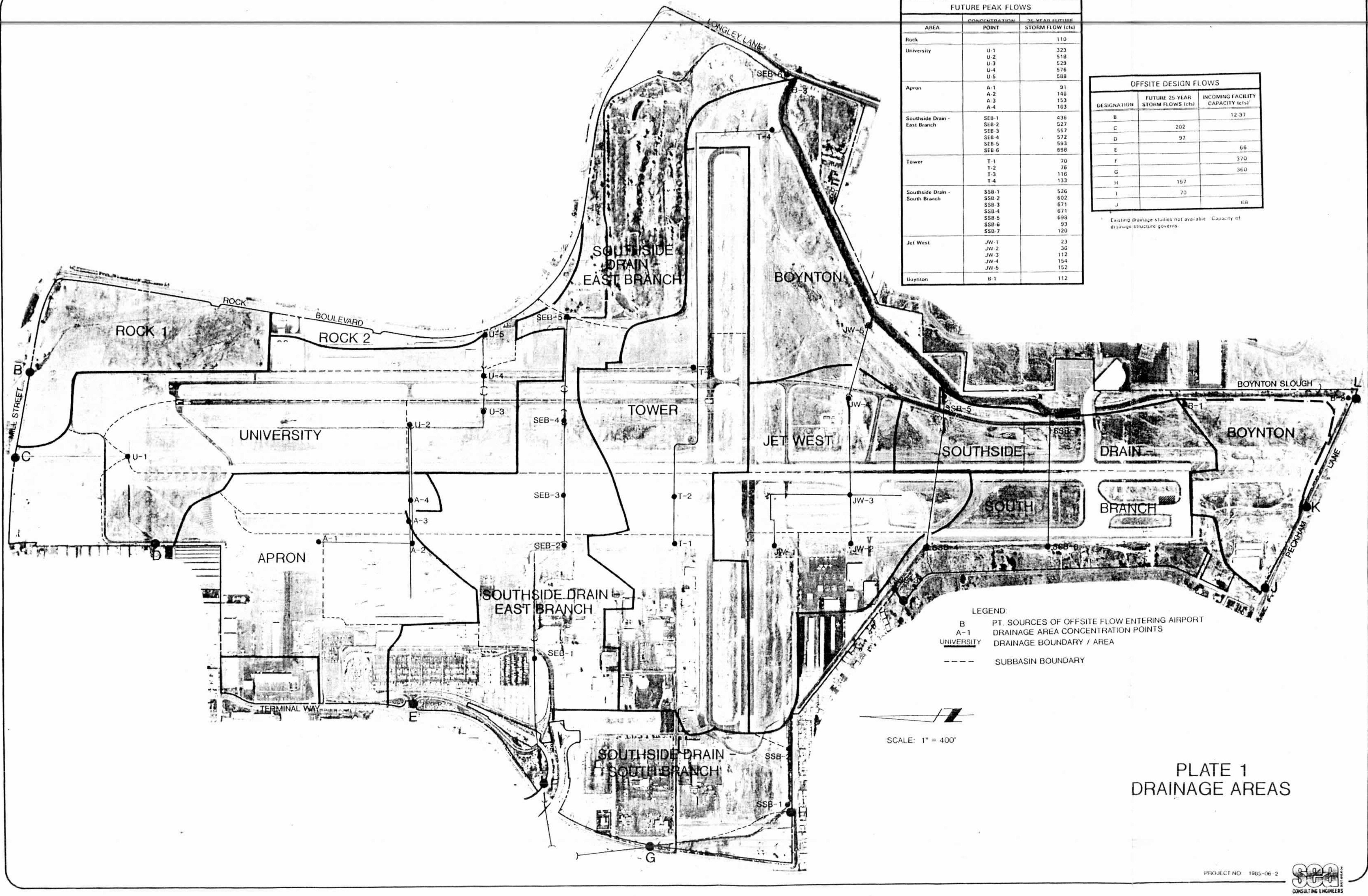


PLATE 1
DRAINAGE AREAS

FUTURE PEAK FLOWS

AREA	CONCENTRATION POINT	25-YEAR FUTURE STORM FLOW (cfs)
Rock		110
University	U-1	323
	U-2	518
	U-3	529
	U-4	576
	U-5	588
Apron	A-1	91
	A-2	146
	A-3	153
	A-4	163
Southside Drain - East Branch	SEB-1	436
	SEB-2	527
	SEB-3	557
	SEB-4	572
	SEB-5	593
	SEB-6	698
Tower	T-1	70
	T-2	76
	T-3	116
	T-4	133
Southside Drain - South Branch	SSB-1	526
	SSB-2	602
	SSB-3	671
	SSB-4	671
	SSB-5	698
	SSB-6	93
	SSB-7	120
Jet West	JW-1	23
	JW-2	36
	JW-3	112
	JW-4	154
	JW-5	152
Boynton	B-1	112

OFFSITE DESIGN FLOWS

DESIGNATION	FUTURE 25-YEAR STORM FLOWS (cfs)	INCOMING FACILITY CAPACITY (cfs)[1]
B		12-37
C	202	
D	97	
E		66
F		370
G		360
H	157	
I	70	
J		68

[1] Existing drainage studies not available. Capacity of drainage structure governs.

PROJECT NO. 1985-06-2

SCA CONSULTING ENGINEERS

Greiner's HEC-1 model routed the 'split' hydrograph from U.S. 395 to the two culverts under the runways. Upstream of the two culverts a 'reservoir' situation was modeled. As the culvert to the south will be abandoned, the flow was routed through the recommended culvert on the north side. The drainage areas in the SEA, Inc. report were investigated with the aid of the topo maps and accepted.

3.4.2.2 Infield Southside Drain East Branch Drainage System

The off-site flow from the Southside Drain East Branch box culvert (under U.S. 395) is conveyed east in an open channel to a 10'x5'x1100' box culvert under Terminal Way and Sky Way. An open channel (between Concentration Points SEB-1 and SEB-2) carries the flow to the next culvert under the runways. A short stretch of open channel leads the flow into another culvert (between Concentration Points SEB-4 and SEB-5) under the existing taxiway. This culvert has a couple of square openings along its north side, enabling it to discharge a portion of the flow to the north in order to serve the flow-equalizing channel between the University and Southside East Branch Drainage Systems. Between Concentration Points SEB-5 and SEB-6, an open channel with a few short culverts conveys the flow through the Brookside Municipal Golf Course to the Boynton Slough.

Again, the infield system, as analyzed in the Master Plan Drainage Study by SEA, Inc. (October 1992), was incorporated into Greiner's HEC-1 model after adding the 'split' hydrograph from U.S. 395.

3.4.2.3 Overflow of Reno Watershed R-1.2 into the Apron Watershed

A portion of the flow from Watershed R-1.2 after traveling along Terminal Way is diverted east along Pilot Way to the Apron Drainage System.

As a conservative measure, this diversion is not considered when modeling the Infield Southside Drain East Branch Drainage System. However, the diverted flow is incorporated into the SEA, Inc. model for the Apron Drainage System.

3.4.2.4 Modification of the Jet West Watershed

The drainage area, JWA, was increased from 0.036 square mile (within SEA, Inc. model) to 0.050 square mile (in Greiner's model).

3.4.2.5 Tower Watershed

Hydrologic parameters of the subareas within the Tower Watershed were reviewed and considered acceptable. Consequently, the SEA, Inc. discharges can be used in the hydraulic design.

3.5 Comparison of Greiner, Inc. and SEA, Inc. Discharges – Points of Significant Departure Noted

The flows computed by Greiner, Inc. are compared with the flows stated within the Master Plan Drainage Study by SEA, Inc. (October 1992). Points of significant departure from the SEA, Inc. hydrology, along with a brief explanation, are listed below:

- The off-site inflow to the infield Southside East and South Branch Drainage Systems increases by approximately 50 cfs for the 25-year frequency storms (see Table 3.4). The Greiner hydrologic model took into account the storage upstream of U.S. 395, as well as overtopping of Terminal Way. The SEA, Inc. study considered full flow (up to the soffit level) in the box culverts at and downstream of U.S. 395, thereby coming up with a lesser flow.

- The 60-inch pipe at the south end of the airport between Concentration Points SSB-6 and SSB-7 has been discarded in Greiner's model, as its downstream invert is five feet lower than the invert of the proposed box culvert for the Boynton Slough. Consequently, the flows from the south end of the airport have been directed to the proposed twin 10' x 6' box culvert between Concentration Points SSB-4 and SSB-5. Also, storage was considered upstream of this proposed culvert; however, this storage should not be considered in the hydraulic design. These changes, as well as the higher off-site flows coming from U.S. 395, result in the higher discharges generated by the Greiner model (see Table 3.4).

- The variation in SEA, Inc. and Greiner, Inc. discharges at the Apron and University Drainage Systems – Greiner's 25-year peak flows being approximately 25 cfs higher – is due to overflow from Terminal Way into the Apron Drainage System.

- An additional flow (due to off-site Drainage Area R-1.3) was computed at the downstream end of the University Drainage System.

TABLE 3.4: COMPARISON OF PEAK FLOWS FOR INFIELD DRAINAGE AREAS

CONCENTRATION POINT	GREINER 25-YR PEAK FLOW (CFS)	SEA 25-YR PEAK FLOW (CFS)	GREINER 100-YR PEAK FLOW (CFS)	SEA 100-YR PEAK FLOW (CFS)
SOUTHSIDE DRAIN SOUTH BRANCH DRAINAGE SYSTEM				
SSB-1	674	526	838	624
SSB-2	680	602	846	737
SSB-3	751	671	951	844
SSB-4 [1]	721 (762)	671	[1] 867 (965)	843[1]
SSB-5	–	698	–	886
SSB-6	–	93	–	138
SSB-7	–	120	–	183
SOUTHSIDE DRAIN EAST BRANCH DRAINAGE SYSTEM				
SEB-1	599	436	701	461
SEB-2	610	527	712	587
SEB-3	619	557	728	636
SEB-4	621	572	731	659
SEB-5	624	593	735	690
SEB-6	647	698	787	833
APRON DRAINAGE SYSTEM				
A-1	112	91	168	126
A-2	157	146	230	202
A-3	163	153	239	213
A-4	171	163	254	203
UNIVERSITY DRAINAGE SYSTEM				
U-1	322	323	473	478
U-2	548	518	813	758
U-3	562	529	837	783
U-4	604	576	900	851
U-5	631	588	938	872
U-6	506	–	976	–

TABLE 3.4: COMPARISON OF PEAK FLOWS FOR INFIELD DRAINAGE AREAS

CONCENTRATION POINT	GREINER 25-YR PEAK FLOW (CFS)	SEA 25-YR PEAK FLOW (CFS)	GREINER 100-YR PEAK FLOW (CFS)	SEA 100-YR PEAK FLOW (CFS)
JET WEST DRAINAGE SYSTEM				
JW1	29	23	46	31
JW2	39	36	56	51
JW3	113	112	169	167
JW4	153	154	230	231
JW5	151	152	230	231
TOWER DRAINAGE SYSTEM [2]				
T-1	–	70	–	101
T-2	–	76	–	111
T-3	–	116	–	176
T-4	–	133	–	210

NOTES:

1. Removal of the 60-inch culvert at the south end of the airport also eliminates Concentration Points SSB-5, SSB-6 and SSB-7. The number within parentheses is the peak flow prior to storage routing and is recommended for use in hydraulic design.

2. The Tower Drainage System peak flows from the SEA, Inc. Master Plan Drainage Study are considered acceptable.

3.5.1 Limitations/Shortcomings of the Hydrologic Study

It must again be emphasized that this is not a detailed and comprehensive study. Consequently, the limitations/shortcomings are inherent. Lack of detailed contour maps for off-site conditions and unavailability of reservoir data are additional contributing factors.

- Reservoir storage data, especially along the west side of U.S. 395, are based on USGS maps which have 20' contour intervals.
- Storage between Terminal Way and U.S. 395 has been disregarded.
- Localized depressions within the area along Terminal Way has been disregarded.
- Flow diversion from Terminal Way to the apron along Pilot Way is based on very limited data.
- Difference in datum elevations used for U.S. 395 by Nevada DOT and base topo maps by SEA, Inc. may result in inaccuracies for the discharge rating data developed for the culverts under U.S. 395.
- Virginia Lake routing is also approximate in the absence of detailed contour maps and plans for the principal spillway (morning glory).
- The various ditches/channels/aqueducts (Steamboat Ditch, Last Chance Ditch and Cochran Ditch) crossing the watershed have been disregarded with regards to their diversion potential.
- The hydrograph generation based on SCS procedures for the urbanized 'city blocks' Reno Watersheds R-1.1 and R-1.2 is approximate.

- In the absence of final grading plans which will be developed during later submittals, the infield hydrology is not finalized at this stage.

3.6 Hydraulic Analysis and Design

Hydraulic analysis and design involved the following sub-tasks:

- Tailwater and target upstream headwater determination based on existing conditions
- Evaluation of the hydraulic design recommended in the Master Plan Drainage Study performed by SEA, Inc (refer to Exhibits 3.4 through 3.6).
- Analysis and design of alternative drainage systems
- Recommended hydraulic design

The tailwater elevations for the Southside South Branch, Jet West and Tower Drainage Systems were taken from the HEC-2 run made by Nimbus Engineers on the Boynton Slough performed for FEMA after input of the 25-year precipitation data.

3.6.1 Hydraulic Design Guidelines, Constraints and Criteria

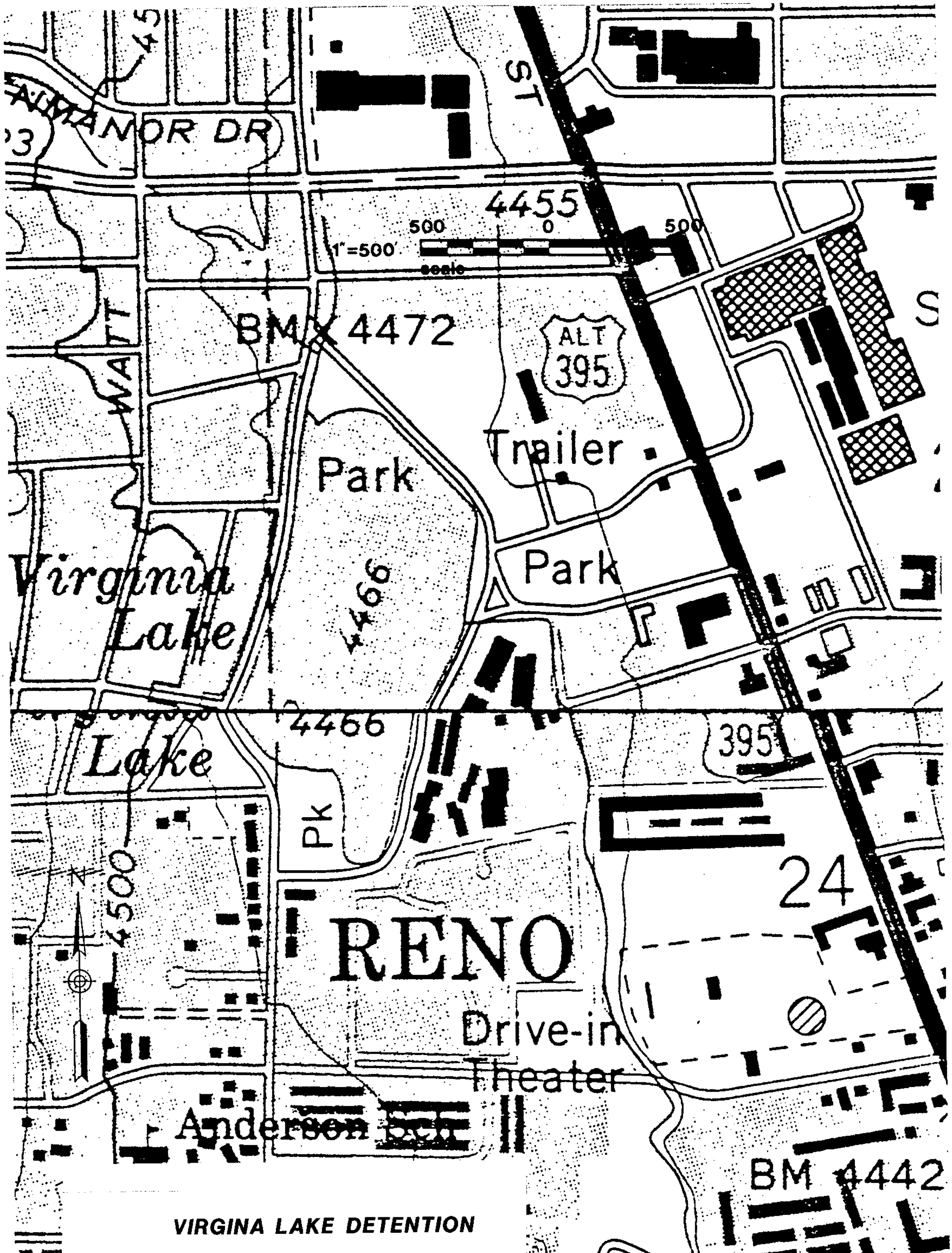
Hydraulic design was conducted in accordance with the FAA Drainage Manual as well as the following considerations:

- Avoidance of runway safety areas for location of inlets and junction structures, as well as the conveyance structures, as far as practically possible.

BACKUP COMPUTATIONS

BACKUP COMPUTATIONS

VIRGINIA LAKE DETENTION



VIRGINA LAKE DETENTION

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Job E024112 Computed By RHF Date 11-7-92

Description Virginia Lake Checked By Date

Stage - Discharge - Storage Sheet 1 of 1

STAGE (FT)	Morning Glory spillway (cfs)	Emergency spillway (cfs)	Virginia Lake Discharge (cfs)	Virginia Lake storage (Ac.-Ft.)
4466.07	0	0	0	0
4466.15	8	0	8	1.4
4466.25	25	0	25	3.7
4466.50	93	0	93	9.6
4466.75	183	19	202	15.4
4467.00	292	38	330	21.3
4467.25	413	77	490	27.1
4467.50	551	117	668	33.0
4467.60	609	132	741	35.3
4467.75	701	156	857	38.8
4468.00	853	195	1048	44.7
4468.10	920	217	1137	47.0
4468.25	1024	251	1275	50.5
4468.50	1190	306	1496	56.4
4468.75	1378	362	1740	62.2
4469.00	1556	418	1974	68.0
4469.25	1759	484	2243	73.9
4469.50	1946	551	2497	79.8
4469.69	2099	601	2700	84.2
4470.00*	2356	690	3046	91.5

* Note: 1) The bank elev. is 4469.69. The storage at 4470.0 assumes a vertical wall at 4469.69.

2.) Detailed topographic information was not available for the Lake. Therefore, the storage assumes a vertical bank.

Job No. E02411/2 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 1 of 2

Subject VIRGINIA LAKE VOLUME CALCULATIONS FOR HEC-1 INPUT

By RHF (REWRITTEN BY PRG) Date 11-4-92 Checked By Date

ELEV. (FT)	SURF. AREA (AC)	AVG. SURF AREA (AC)	Δ DEPTH (FT)	Δ STORAGE (ACRE-FT)	STORAGE (ACRE·FT)
4466.09	23.4				0
		23.4	.91	21.29	
4467	23.4				21.29
		23.4	1.0	23.4	
4468	23.4				44.69
		23.4	1.0	23.4	
4469	23.4				68.09
		23.4	.69	16.14	
4469.69	23.4				84.24

NOTES:
1. REFER TO USGS QUAD MAP MT. ROSE AND RENO FOR SURFACE AREA.
2. VERTICAL BANKS ASSUMED
3. DATUM EL. 4466.09' IS BASED ON FIELD OBSERVATIONS BY PAUL FROST OF NIMBUS ENGINEERS AND SOUTHSIDE DRAIN PLANS.

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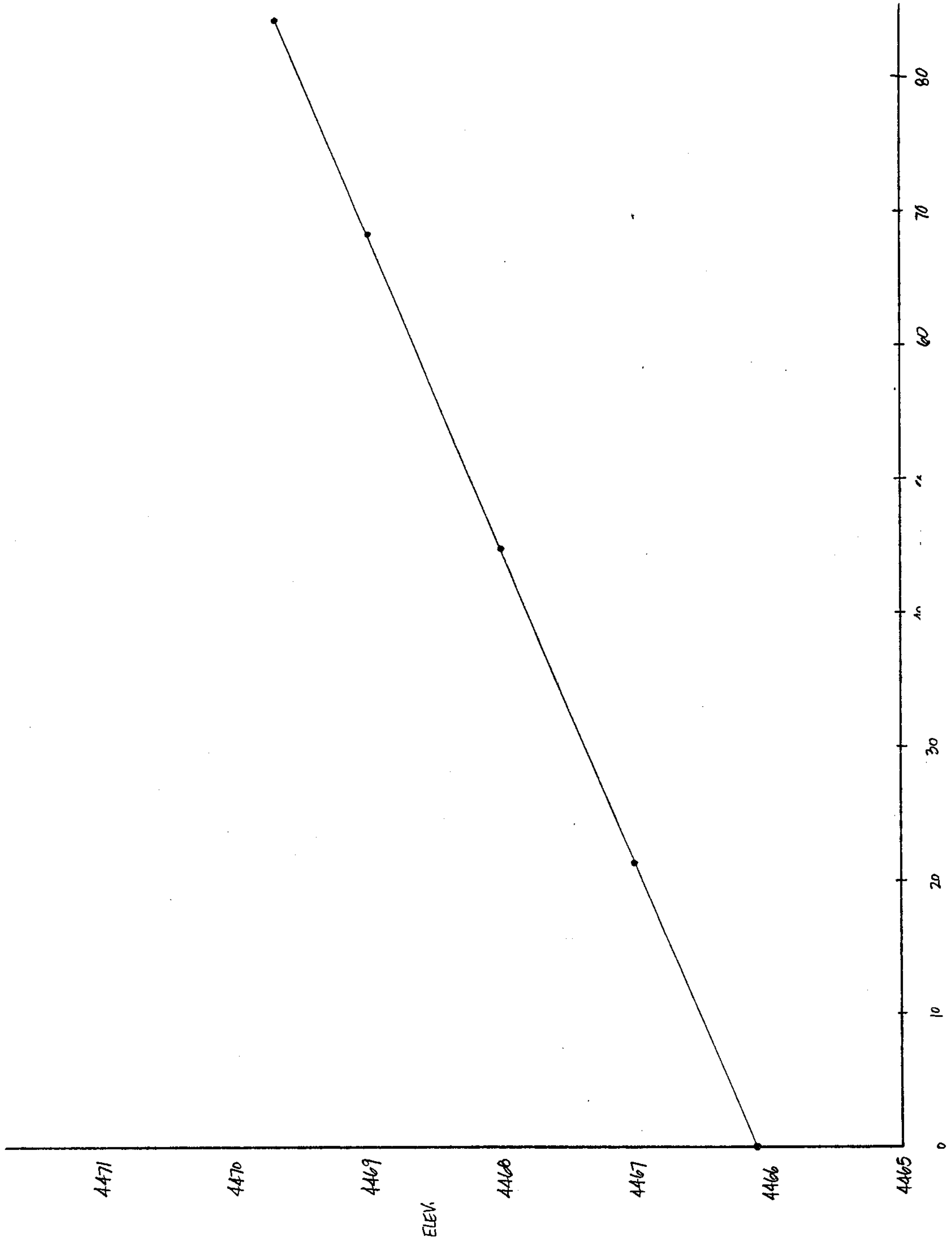
Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 2 of 2

Subject ELEVATION - STORAGE RELATIONSHIP FOR VIRGINIA LAKE

By DRG Date 11-6-92 Checked By _____ Date _____



Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 1 of 4

Subject VIRGINIA LAKE - MORNING GLORY STAGE-DISCHARGE RELATIONSHIP

By DRG Date 11-6-92 Checked By ______ Date ______

Assumptions:

$R_S = 12.5$

$P = 4.0'$*

$$Q = C_0 (2\pi R_s) H_0^{3/2}$$

From Design of Small Dams:

C_0 = Circular crest coefficient

R_s = Radius of circular crest

H_0 = depth above crest

(SEE ATTACHED)

$\frac{P}{R_s} = \frac{4.0}{12.5} = .32 \quad \therefore \text{ use } \frac{P}{R_s} = 0.3$

ELEV. (FT)	H_0	$\frac{H_0}{R_s}$	C_0	Q (CFS)
4466.07	0	0	—	0
4466.15	.08	.0064	≈ 4.2	7.4640
4466.25	.18	.014	≈ 4.2	25.19
4466.50	.43	.034	≈ 4.2	93.01
4466.75	.68	.054	4.15	182.77
4467.00	.93	.074	4.15	292.32
4467.25	1.18	.094	4.1	412.76
4467.50	1.43	.114	4.1	550.65
4467.60	1.53	.12	4.1	609.41
4467.75	1.68	.134	4.1	701.19
4468.00	1.93	.154	4.05	852.87
4468.10	2.03	.162	4.05	920.00
4468.25	2.18	.174	4.05	1023.83
4468.50	2.43	.194	4.0	1190.03
4468.75	2.68	.214	4.0	1378.33
4469.00	2.93	.234	3.95	1555.92
4469.25	3.18	.254	3.95	1759.25
4469.50	3.43	.274	3.9	1945.79
4469.69	3.62	.290	3.88	2098.86
4470.00	3.93	.314	3.85	2355.81

* Assumed based on comment from Nimbus Engineers.

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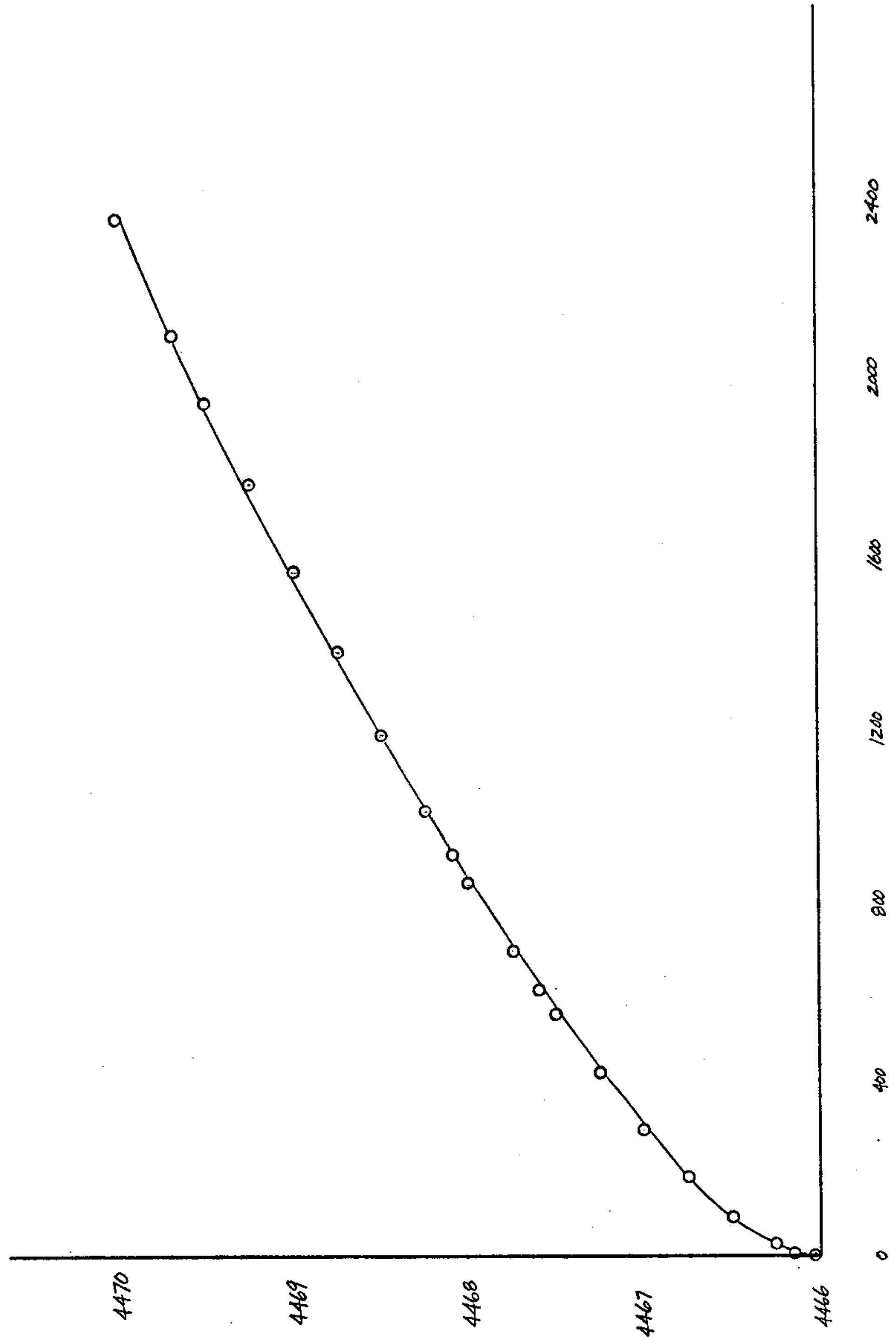
Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 2 of 4

Subject VIRGINIA LAKE - MORNING GLORY STAGE - DISCHARGE RELATIONSHIP

By DRG Date 11-6-92 Checked By ______ Date ______



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Job E024112 - RCIA Computed By RHF Date 11-6-92
Description Virginia Lake Checked By Date
Emergency Spillway outflow Calculation Sheet 1 of 3

$$Q = cLh^{3/2}$$

The spillway is a sharp crested weir ∴ C = 3.5

L = 30' - 5 sided structure, each side = 6'
(REFER TO INCLUDED DRAWING)

Weir crest elevation = 4466.49

WSEL. (FT)	Height of water over crest (FT.)	Discharge (cfs)
4466.49	0	0
4467.00	0.51	38.24
4468.00	1.51	194.83
4469.00	2.51	417.54
4469.69	3.20	601.06
4470.00	3.51	690.48

Top of Bank El. = 4469.69.

2 OF 3

```
**********************************************************************
E024112 RCIA: CULVERT RATING FOR THE PIPE TAKING FLOW FROM THE EMERGENCY
WEIR AT VIRGINIA LAKE. 1-66"x611' RCP @ 1.09%
**********************************************************************


                      CULVERT RATING SUMMARY TABLE


                      ELEVATION - DISCHARGE CURVE

        DISCHARGE   EG/YN              DISCHARGE   EG/YN

            0.00   4451.38                150.00   4456.97
          190.00   4457.88                230.00   4458.82
          270.00   4459.76                310.00   4460.79
          350.00   4462.71                390.00   4465.85
          430.00   4469.32                470.00   4473.19
          510.00   4477.26                550.00   4481.67
          590.00   4486.41                630.00   4491.48
          670.00   4496.89                710.00   4502.63
          750.00   4508.70                790.00   4515.10
          830.00   4521.84                870.00   4528.91


     ONCE THE HEC-1 MODEL HAS BEEN RAN, THE RESERVOUR ROUTED FLOW
     SHOULD BE CHECKED AGAINST THE STAGE - STORAGE - DISCHARGE CURVE
     FOR VIRGINIA LAKE TO DETERMINE THE FLOW CONVEYED BY THE WEIR
     AND THEN COMPARIED WITH THIS TABLE TO BE SURE THE WEIR IS NOT
     DROWN OUT BY ITS DOWNSTREAM CULVET, 1-66" RCP.
```

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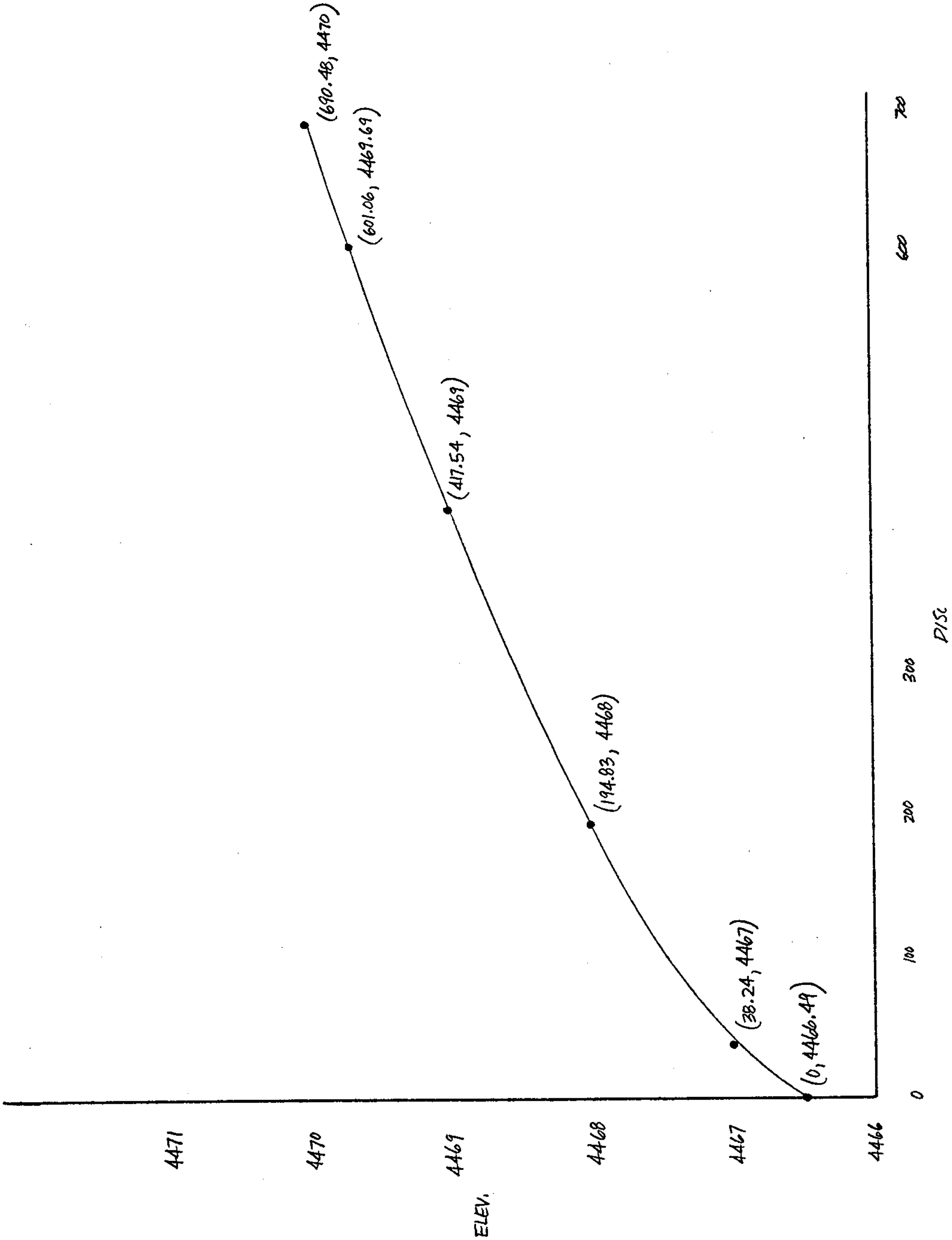
Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 3 of 3

Subject VIRGINIA LAKE ELEVATION - DISCHARGE RELATIONSHIP FOR EMERGENCY SPILLWAY

By DRG Date 11-6-92 Checked By ______ Date ______



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Job E002412 Computed By RHF Date 11-6-92

Description Virginia Lake Checked By Date

Existing outfall data Sheet 1 of 1

Emergency Spillway El. = 4466.49

Emergency Spillway Weir Length = 30'

Emergency Spillway Weir Coefficient = 3.5

Morning Glory lip El. = 4466.07

Morning Glory Weir Length = 60'

Lake Water Surface El = 4466.09

Top of Bank el. = 4469.69

Note: For

3 OF 4

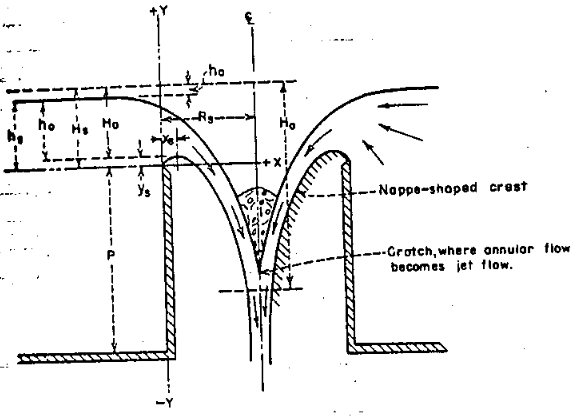

Figure 9-56.—Elements of nappe-shaped profile for circular weir. 288-D-2440.

sharp-crested circular weir at H_o head and if aeration is provided so that subatmospheric pressures do not exist along the lower nappe surface contact.

When the crest outline and transition shape conform to the profile of the nappe shape for an H_o head over the crest, free flow prevails for H_o/R_s up to approximately 0.45, and weir control governs. As H_o/R_s increases above 0.45, the weir partly submerges, and flow showing characteristics of a submerged weir is the controlling condition. When the H_o/R_s ratio approaches 1.0, the water surface above the weir is completely submerged. For this and higher stages of H_o/R_s, the flow phenomenon is that of orifice flow. The weir formula, $Q = CLH^{3/2}$, is used as the measure of flow through the drop inlet entrance regardless of the submergence, by using a coefficient that reflects the flow conditions through the various H_o/R_s ranges. Thus, from figure 9-57 it can be seen that the weir coefficient only changes slightly from that normally indicated for $H_o/R_s \nless$ 0.45, but reduces rapidly for the higher H_o/R_s values.

It should be noted that for most conditions of flow over a circular weir, the discharge coefficient increases with a reduction in the approach depth; whereas, the opposite is true for a straight weir. For both weirs, a shallower approach lessens the upward vertical velocity component and, consequently, suppresses the contraction of the nappe. However, for the circular weir, the submergence effect is reduced because of a depressed upper nappe surface, giving the jet a quicker downward impetus, which lowers the position of the crotch and increases the discharge.

Discharge coefficients for partial heads of H_e on the crest can be determined from figure 9-58 to prepare a discharge-head relationship. The designer must be cautious in applying the above criteria because subatmospheric pressure or submergence effects may alter the flow conditions differently for various profile shapes. This criteria, therefore, should not be applied for flow conditions where $H_e/R_s > 0.4$.

(c) *Crest Profiles.*—Values of coordinates that define the shape of the lower surface of a nappe flowing over an aerated sharp-crested circular weir for various conditions of P/R_s and H_s/R_s are shown in tables 9-5, 9-6, and 9-7. These data are based on experimental tests [24] conducted by the Bureau of Reclamation. The relationships of H_s to H_o are shown on figure 9-59. Typical upper and lower nappe profiles for various values of H_s/R_s are plotted on figure 9-60 in terms of X/H_s and Y/H_s for the condition of $P/R_s = 2.0$.

Figure 9-61 shows typical lower nappe profiles, plotted for various values of H_s for a given value of R_s. In contrast to the straight weir where the nappe springs farther from the crest as the head increases, it can be seen from figure 9-61 that the lower nappe profile for the circular crest springs farther only in the region of the high point of the trace, and then only for H_s/R_s values up to about 0.5.

The profiles become increasingly suppressed for larger H_s/R_s values. Below the high point of the profile, the traces cross and the shapes for the higher heads fall inside those for the lower heads. Thus, if the crest profile is designed for heads where H_s/R_s exceeds about 0.25 to 0.3, it appears that subatmospheric pressure will occur along some portion for the profile when heads are less than the designed maximum. If subatmospheric pressures are to be avoided along the crest profile, the crest shape selected should give support to the overflow nappe for the smaller H_s/R_s ratios. Figure 9-62 shows the approximate increase in radius required to minimize subatmospheric pressures on the crest. The crest shape for the enlarged crest radius is then based on $H'_s/R'_s = 0.3$.

(d) *Transition Design.*—The diameter of a jet issuing from a horizontal orifice can be determined for any point below the water surface if it is assumed that the continuity equation, $Q = av$, is valid and if friction and other losses are neglected.

For a circular jet the area is equal to πR^2. The discharge is equal to $av = \pi R^2 \sqrt{2gH_a}$. Solving for R,

4 OF 4

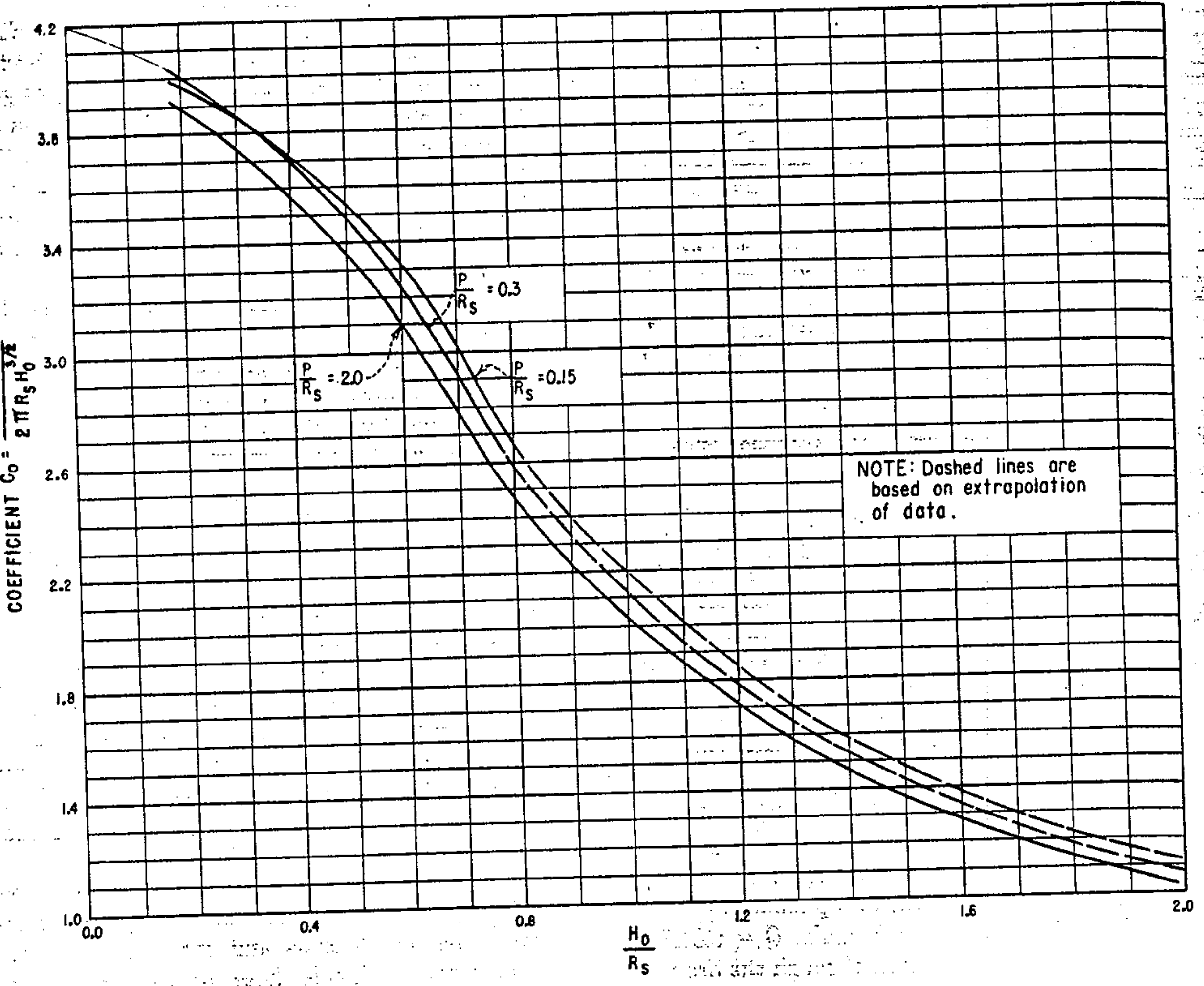

Figure 9-57.—Relationship of circular crest coefficient C_o to H_o/R_s for different approach depths (aerated nappe). 288–D–2441.

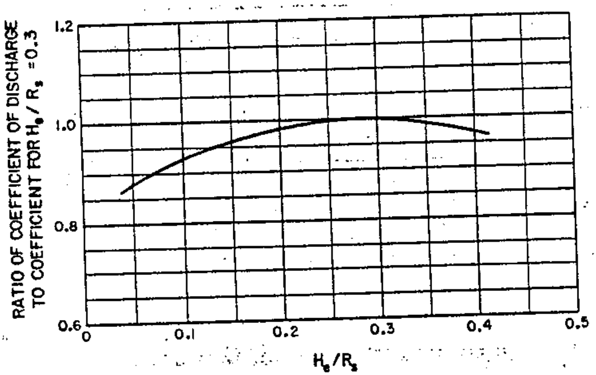

Figure 9-58.—Circular crest discharge coefficient for other than design head. 288–D–2442.

$R = Q_a^{1/2}/5H_a^{1/4}$; where H_a is equal to the distance between the water surface and the elevation under consideration. The diameter of the jet thus decreases with the distance of the free vertical fall for normal design applications.

If an assumed total loss (including jet contraction losses, friction losses, velocity losses from direction changes, etc.) is taken as 0.1 H_a, the equation for determining the approximate required shaft radius may be written:

$$R = 0.204 \frac{Q_a^{1/2}}{H_a^{1/4}} \tag{29}$$

Because this equation is for the shape of the jet,

I RS

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FAX TRANSMITTAL SHEET

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COMPANY: GREINER

FAX NUMBER: 602-943-1891

FROM: P. FROST

JOB NUMBER: 9219

COMMENTS: - CALL IF YOU HAVE ANY QUESTIONS - I'LL ~~SEND~~ FAX THE FLOW PATH ALIGNMENT FOR R1, R2 TODAY AS WELL. Paul

THERE ARE A TOTAL OF 4 PAGES, INCLUDING THIS COVER PAGE. IF ALL PAGES ARE NOT RECEIVED PROPERLY, PLEASE NOTIFY US IMMEDIATELY.

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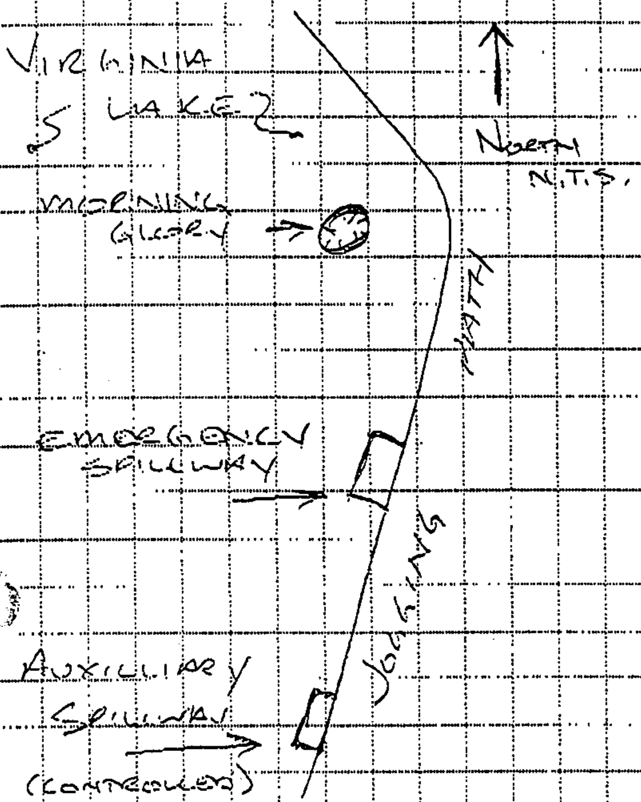
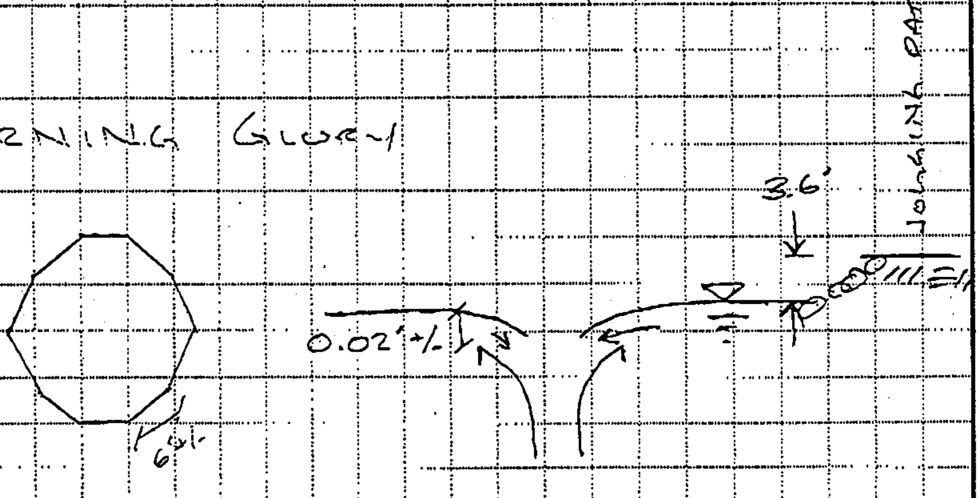
VIRGINIA LAKE SPILLWAYS - FIELD NOTES



MORNING GLORY



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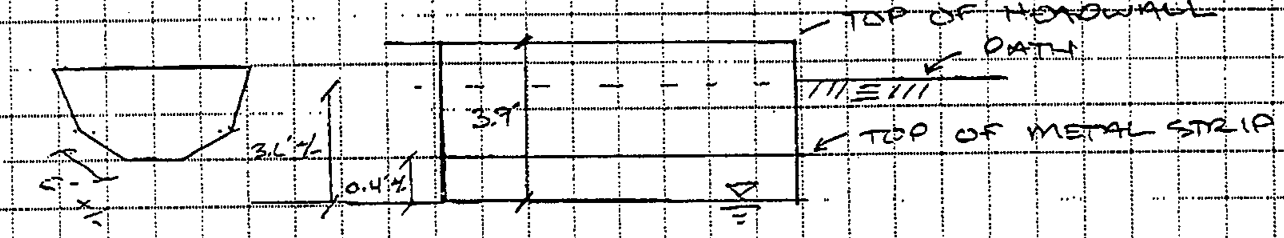
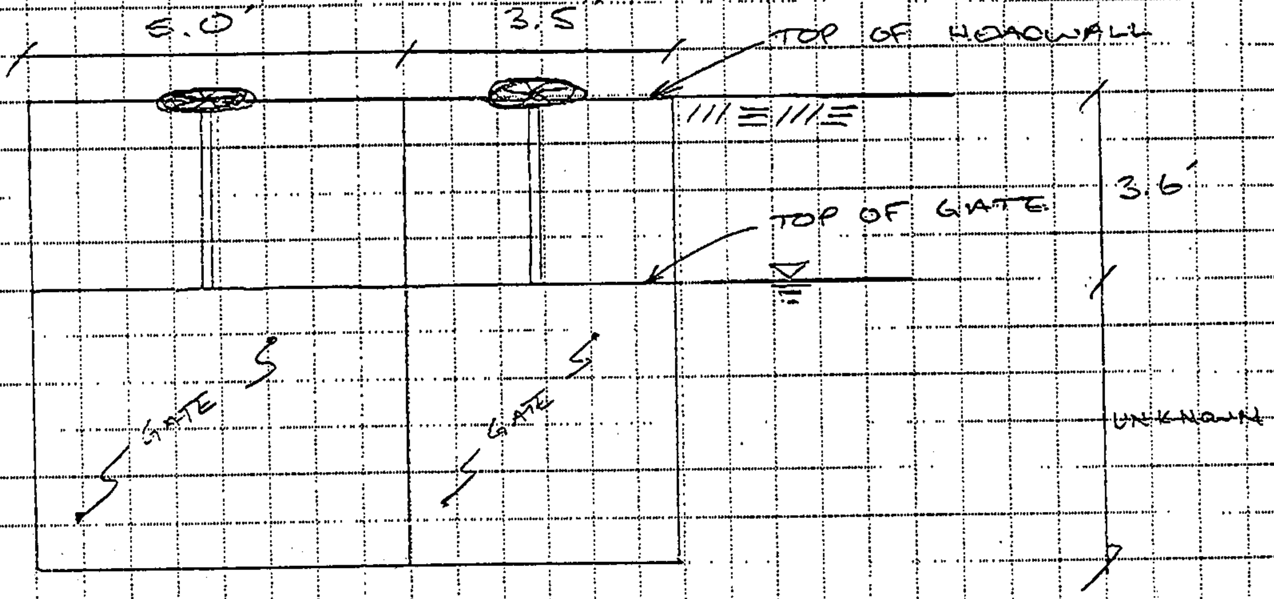
EMERGENCY SPILLWAY



AUXILLARY SPILLWAY



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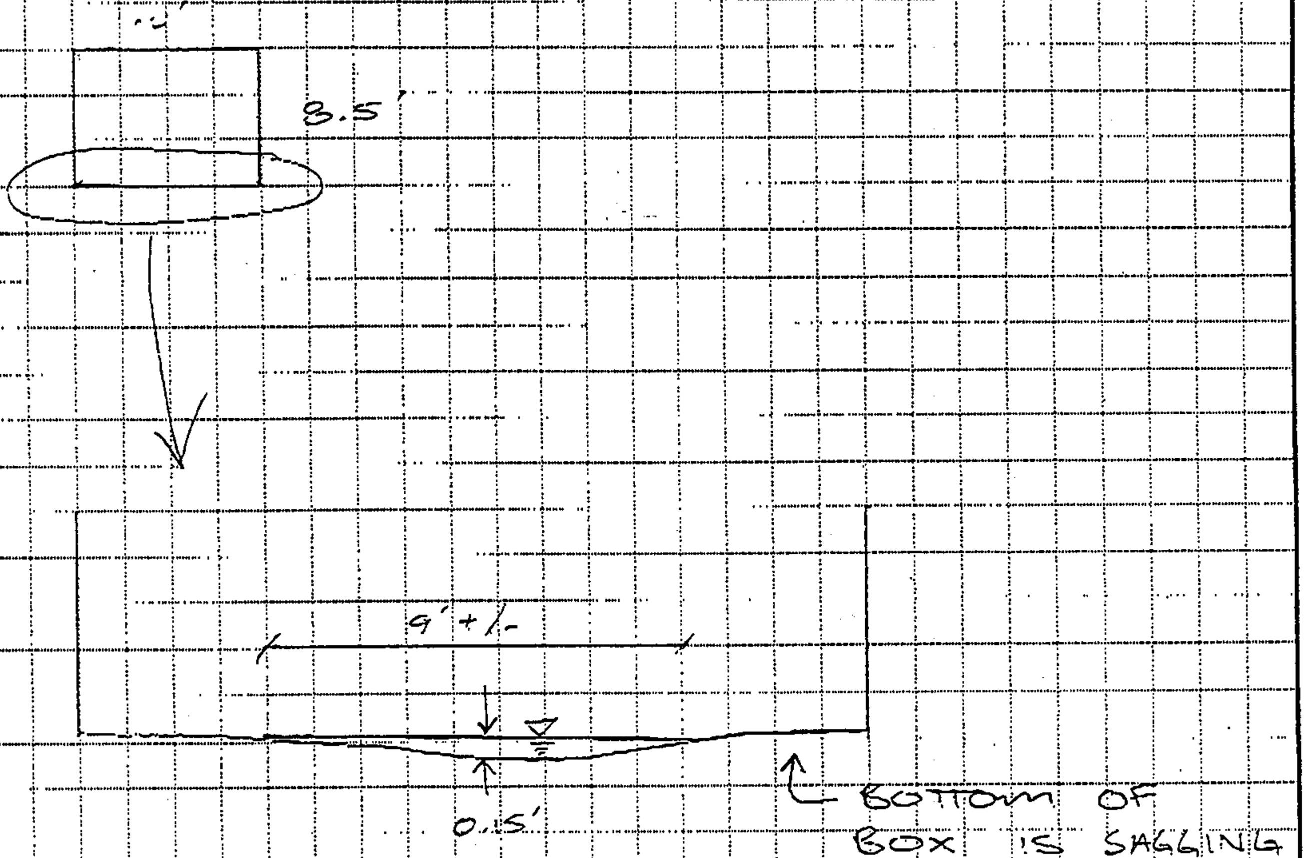
RCB UNDER HARVARD WAY

OUTLET



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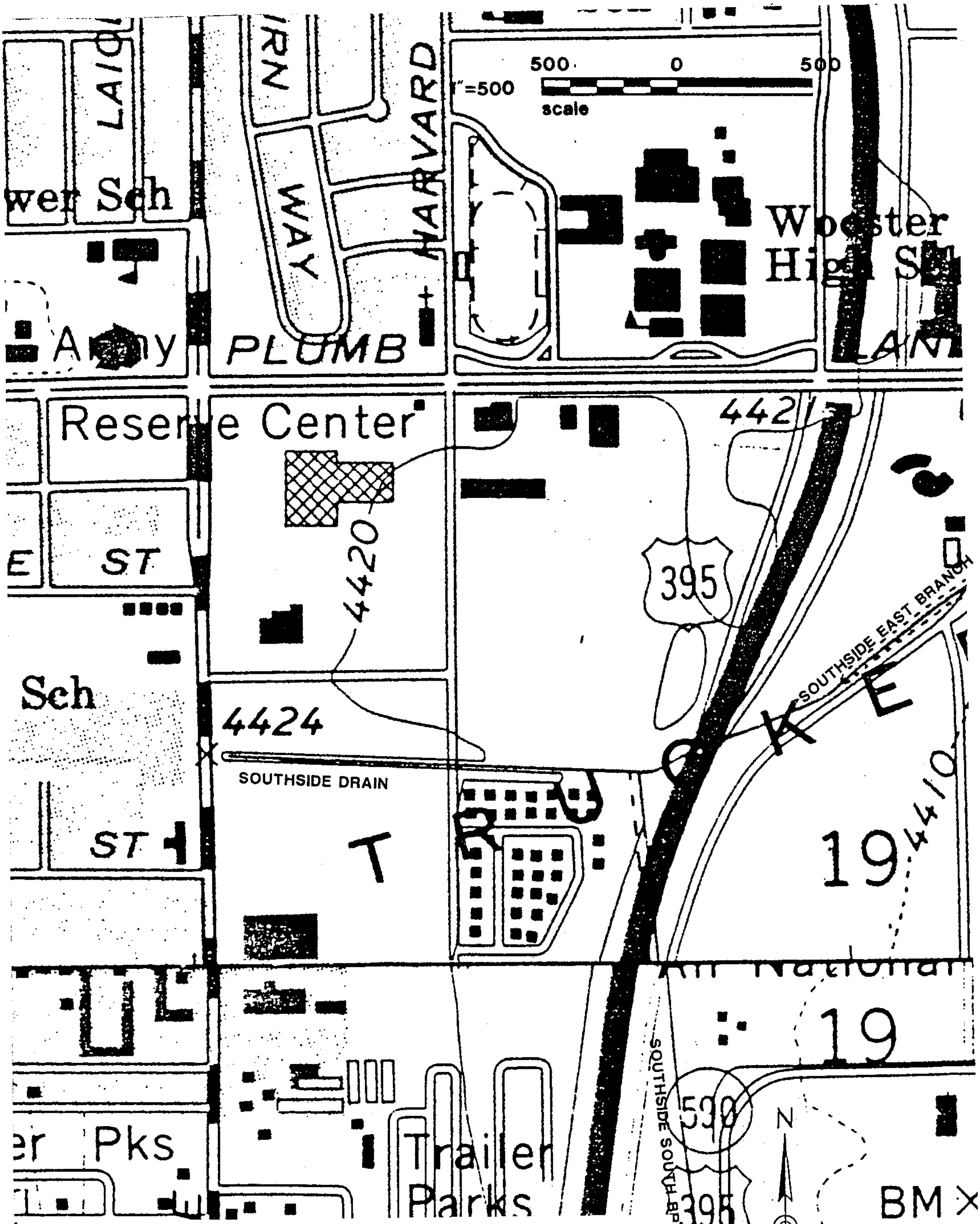
Job E0024 SF Date 11-3-92
Description Review Checked By ______ Date ______
Storm Drain - Preliminary Design Rpt. Sheet 1 of ___

1) Virginia Lake outflow is designed for the 50-YR flood.

2) Report makes reference to 40' weir but does not say if this is the morning glory, the emergency overflow weir, or a combination of both.

PONDING ALONG E. SIDE OF U.S. 395
AT SOUTHSIDE DRAIN BOX CULVERTS



PONDING ALONG E. SIDE OF U.S. 395
AT SOUTHSIDE DRAIN BOX CULVERTS

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Job E024112 RCIA Computed By RHF Date 11-7-92

Description Stage vs Discharge Checked By ______ Date ______

For Flow under US 395 Sheet 1 of 1

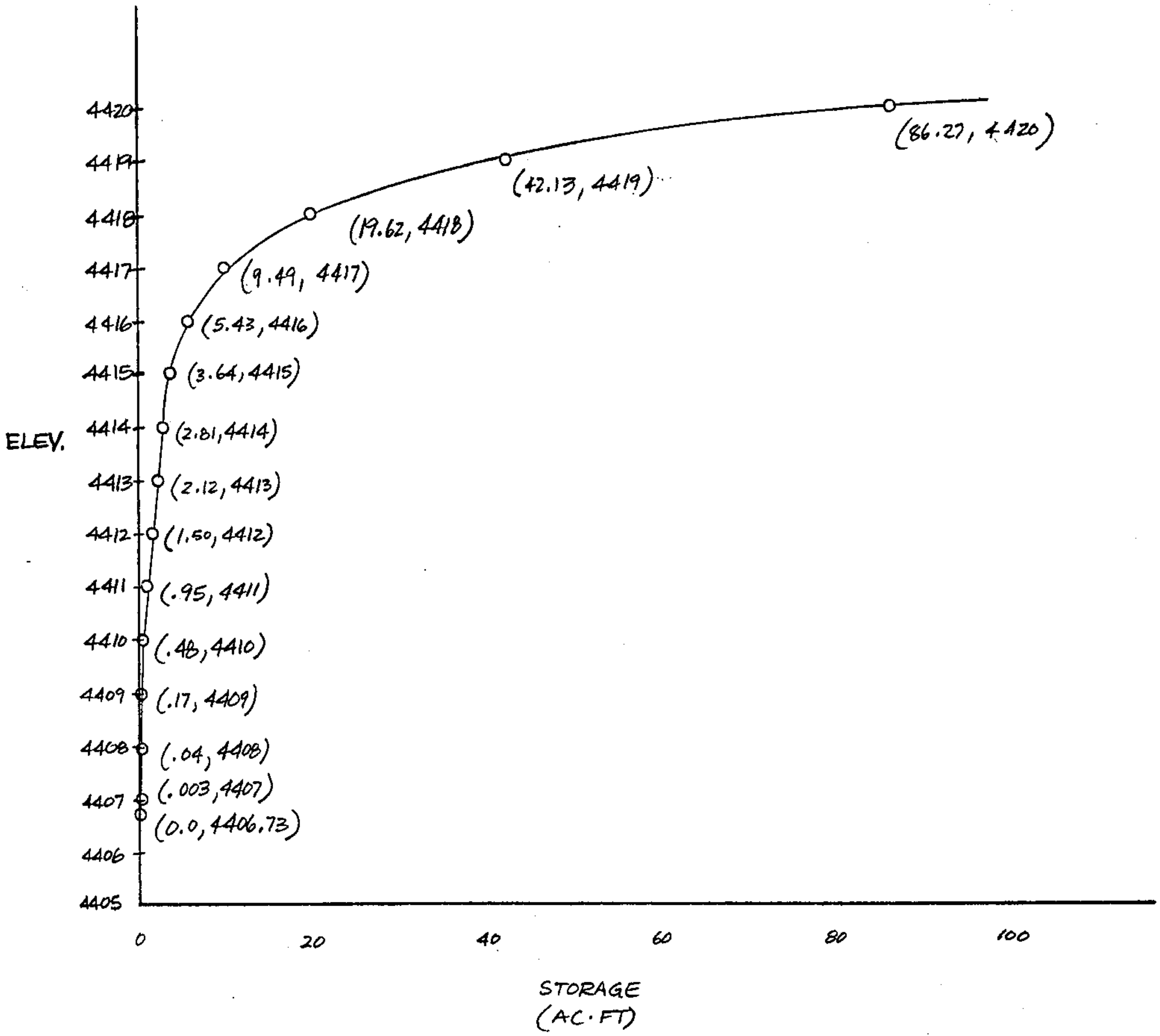
STAGE (FT)	1-10x5 SSS (cfs)	1-12x4 SSE (cfs)	Total outflow (cfs)	Total Storage (Ac-Ft.)	Updated 11-9-92 Area occupied by building in Reservoir removed. use these numbers ↓
4406.71	0	0	0	0	
4413.13	244	419	663	2.2	
4413.5	274	423	697	2.5	
4414.0	316	429	745	2.8	
4414.5	361	434	795	3.2	
4415.0	396	440	836	3.6	
4415.50	424	446	870	4.5	
4416.00	446	451	897	5.4	
4416.50	468	460	928	~~7.9~~	7.5
4417.00	488	470	958	~~10.4~~	9.5
4417.50	508	481	989	~~16.7~~	14.6
4418.00	527	492	1019	~~23.0~~	19.6
4418.50	546	502	1048	~~35.9~~	30.9
4419.00	564	512	1076	~~48.9~~	42.1
4419.50	582	522	1104	~~72.7~~	64.2
4420.00	598	532	1130	~~96.6~~	86.3
4420.50	614	542	1156	~~120.5*~~	115.1*
4421.00	631	551	1182	~~144.4*~~	144.0*
4421.50	649	560	1209	~~168.3*~~	172.9*
4422.00	666	569	1235	~~192.2*~~	201.7*

* Assumed storaged based on an assumed vertical wall at stage 4420.00

Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 2 of 9

Subject ELEVATION- STAGE RELATIONSHIP FOR AREA WEST

By DRG Date 11-6-92 Checked By Date



Job No. E024112 Project RENO CANNON INTL AIRPORT Sheet 4 of 9

Subject ELEVATION – STORAGE RELATIONSHIP / AREA CALCULATIONS @ VARIOUS ELEVATIONS

By DRG Date 11-5-92 Checked By ____ Date ____

ELEVATION	AREA (AC)
4420	20.8920 + 3.9104 + 21.5653 + 1.1088 + 13.8998 = 61.3763 AC – 3.66 AC 57.72 AC
4419	10.6730 + 1.4864 + 15.7902 + 1.0613 + 5.1364 = 34.1473 AC – 3.60 AC 30.56 AC
4418	4.0694 + .2834 + 11.2232 + 1.0138 + 1.0523 = 17.6421 AC – 3.17 AC 14.47 AC
4417	.2296 + 5.7636 + 1.3939 = 7.3871 AC – 1.61 AC 5.78 AC
4416	1.7506 + .8788 = 2.6294 AC – 0.29 AC 2.34 AC
4415	.1411 + .8003 = .9414 AC
4414	.7208 AC
4413	.6499 AC
4412	.5785 AC
4411	.5152 AC
4410	.4201 AC
4409	.1915 AC
4408	.0552 AC
4407	.0114 AC
4406.73	0 AC

* REFER TO EXHIBIT A.

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Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 1 of 2

Subject ELEVATION - STORAGE RELATIONSHIP FOR SOUTHSIDE SOUTH DRAIN CHANNEL

By DRG Date 11-8-92 Checked By Date

ELEVATION	AREA (FT^2)	AREA (AC)	AVG. AREA (AC)	Δ ELEV. (FT)	Δ STORAGE (AC·FT)	STORAGE (AC·FT)
4395.85	0	0				0
			.0037	0.15	.0005	.0005
4396	316.38	.0073				
			.1865	1.0	.1865	.1870
4397	15928.73	.3657				
			.6549	1.0	.6549	.8419
4398	41126.00	.9441				
			1.3155	1.0	1.3155	2.1574
4399	73481.66	1.687				
4400	112587.50	2.585	2.136	1.0	2.136	4.293
4401	140699.00	3.23	2.908	1.0	2.908	7.200
			5.235	1.0	5.235	12.436
4402	315421.20	7.24				
			10.172	1.0	10.172	22.608
4403	570833.09	13.105				
4404						44.70*

* Assumed graph extension.

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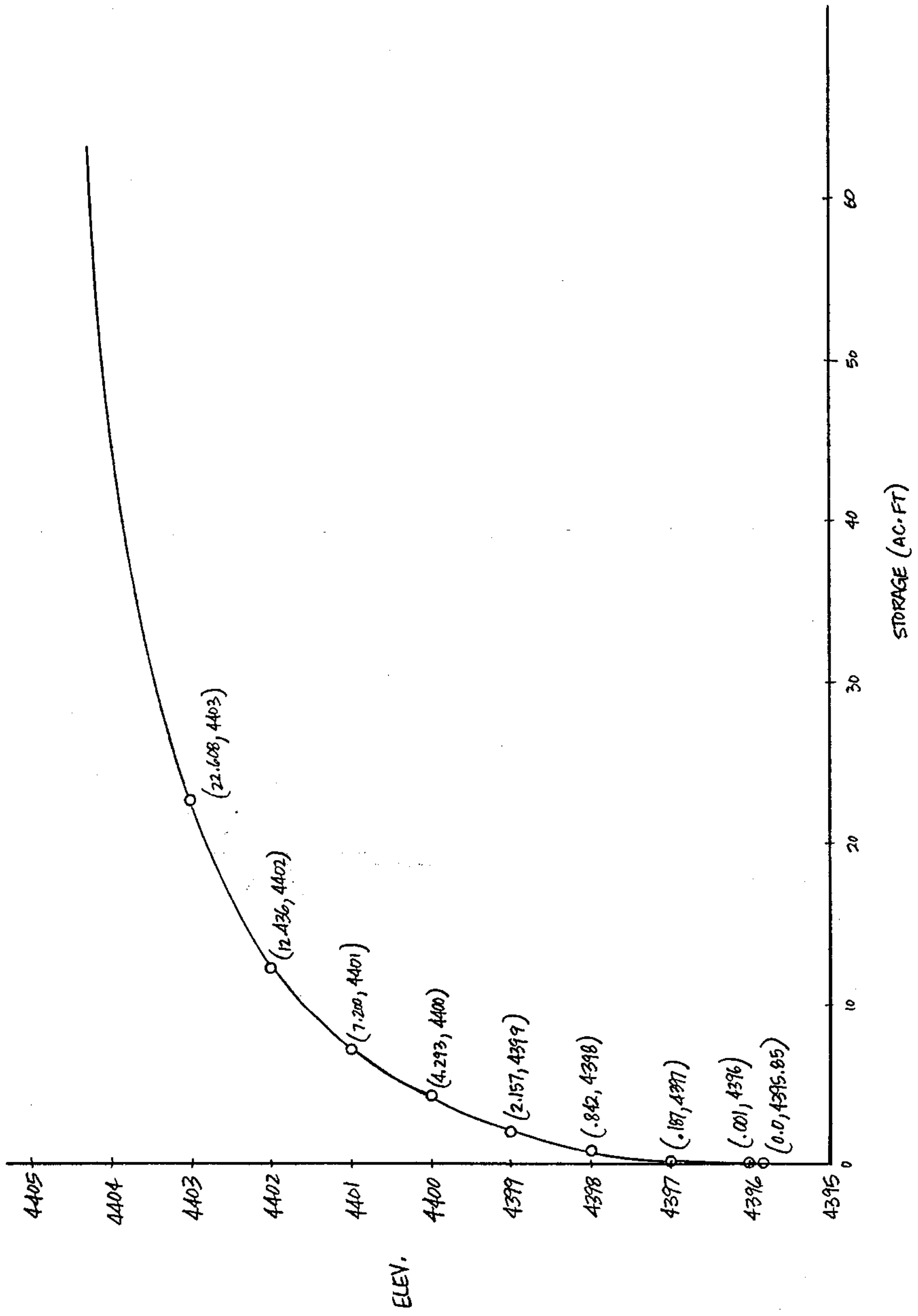
Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 2 of 2

Subject ELEVATION-STORAGE RELATIONSHIP FOR SSS CHANNEL & INCL. CHANNEL BETWEEN AIRPORT & PAMELA LANE

By DRG Date 11-8-92 Checked By ______ Date ______



1 OF 3

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************************************************************************
E024112 RCIA: CULVERT RATING FOR THE CULVERT UNDER US 395 SSE
-12x4x427' RCBC @ 1.22%
************************************************************************


                             CULVERT RATING SUMMARY TABLE

                             ELEVATION - DISCHARGE CURVE

             DISCHARGE   EG/YN                          DISCHARGE   EG/YN

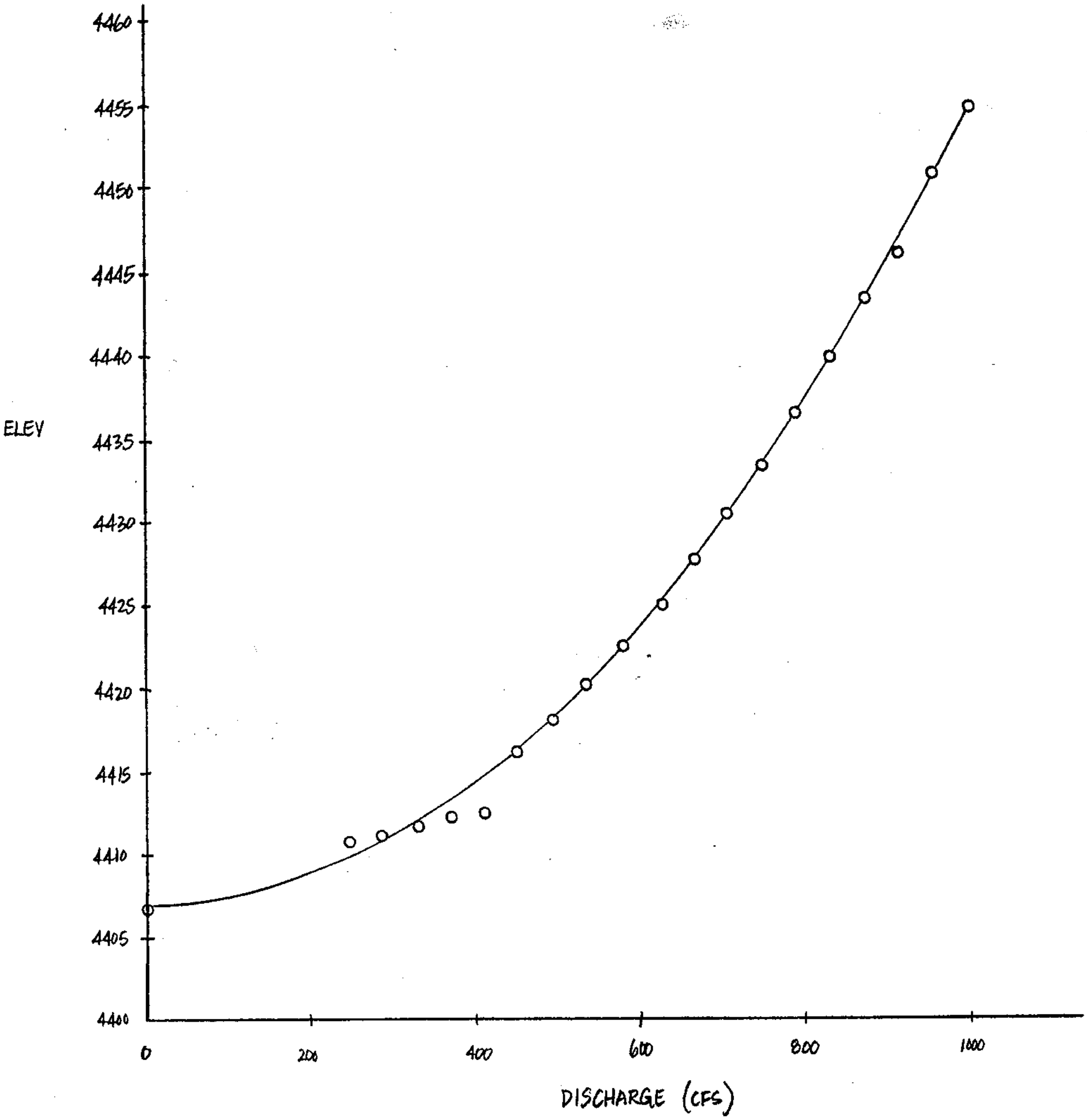
                  0.00   4406.71                           244.00   4410.80
                286.00   4411.26                           328.00   4411.69
                370.00   4412.13                           412.00   4412.52
                454.00   4416.24                           496.00   4418.18
                538.00   4420.29                           580.00   4422.59
                622.00   4425.04                           664.00   4427.67
                706.00   4430.47                           748.00   4433.45
                790.00   4436.59                           832.00   4439.92
                874.00   4443.40                           916.00   4447.06
                958.00   4450.90                          1000.00   4454.91
```

Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 2 of 3

Subject CULVERT RATING FOR THE CULVERT IN SSE UNDER US395 (12'x 4' RCB)

By RHF / DRG Date 11-6-92 Checked By ______ Date ______

ELEVATION-DISCHARGE CURVE:



Job E002412 RCIA Computed By RHF Date 11-5-92

Description Southside Drain East Branch Checked By ____ Date ____

Culvert under US 395 Sta 662+18 Sheet 3 of 3

Upstream Invert elev. = 4406.73

Downstream Invert elev. = 4401.50

Culvert Length = 427'

sholder elev. = 4417.00

slope = 1.22 %

OUTPUT FILE - SSE - US395.TBL

```
************************************************************************
024112 RCIA: CULVERT RATING FOR THE CULVERT DS OF US 395 DA SSE
1-10'x5'x1100' RCBC @ 0.209%

************************************************************************




                           CULVERT RATING SUMMARY TABLE


                          ELEVATION - DISCHARGE CURVE

            DISCHARGE   EG/YN                          DISCHARGE   EG/YN

                 0.00   4403.21                           244.00   4407.83
               286.00   4408.35                           328.00   4409.12
               370.00   4410.08                           412.00   4411.03
               454.00   4412.19                           496.00   4413.34
               538.00   4414.60                           580.00   4415.97
               622.00   4417.43                           664.00   4419.00
               706.00   4420.67                           748.00   4422.45
               790.00   4424.32                           832.00   4426.30
               874.00   4428.38                           916.00   4430.56
               958.00   4432.85                          1000.00   4435.24
```

1 OF 3

```
************************************************************************
S024112 RCIA: CULVERT RATING FOR THE BOX UNDER US395 FOR THE SSS
1-10'x5'x732' RCBC @ 0.199%
  **********************************************************************


                         CULVERT RATING SUMMARY TABLE


                         ELEVATION - DISCHARGE CURVE

           DISCHARGE   EG/YN                 DISCHARGE   EG/YN

                0.00   4408.51                  244.00   4413.13
              286.00   4413.65                  328.00   4414.14
              370.00   4414.60                  412.00   4415.24
              454.00   4416.17                  496.00   4417.19
              538.00   4418.28                  580.00   4419.45
              622.00   4420.73                  664.00   4421.94
              706.00   4423.23                  748.00   4424.60
              790.00   4426.05                  832.00   4427.58
              874.00   4429.19                  916.00   4430.88
              958.00   4432.64                 1000.00   4434.49
```

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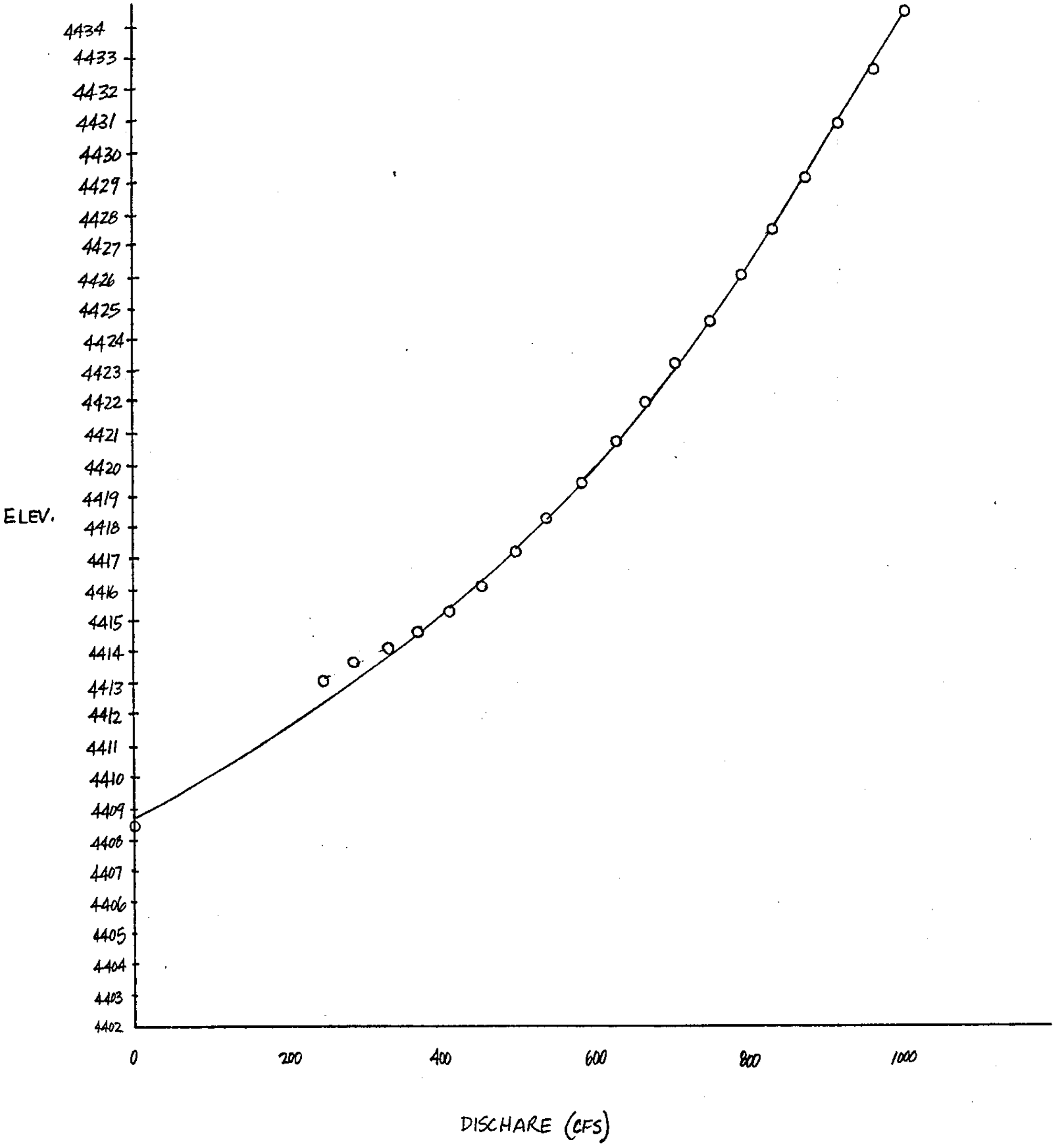
Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 2 of 3

Subject CULVERT RATING FOR THE SSS DS OF US 395 (1-10'x5' RCB)

By RHF / DRG Date 11-6-92 Checked By Date

ELEVATION - DISCHARGE CURVE:



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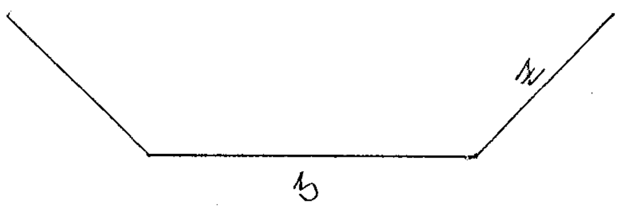
Job E002412 RCIA Computed By RHF Date 11-5-92
Description Southside Drain Checked By Date
East Branch Sheet 3 of 3

Downstream culvert for US-395 1-10'x5' RCBC

Upstream invert el. = 4408.51
Downstream invert el. = 4407.05
Culvert length = 732.0'
Shoulder El. = 4413.8
slope = 0.0020 FT/FT

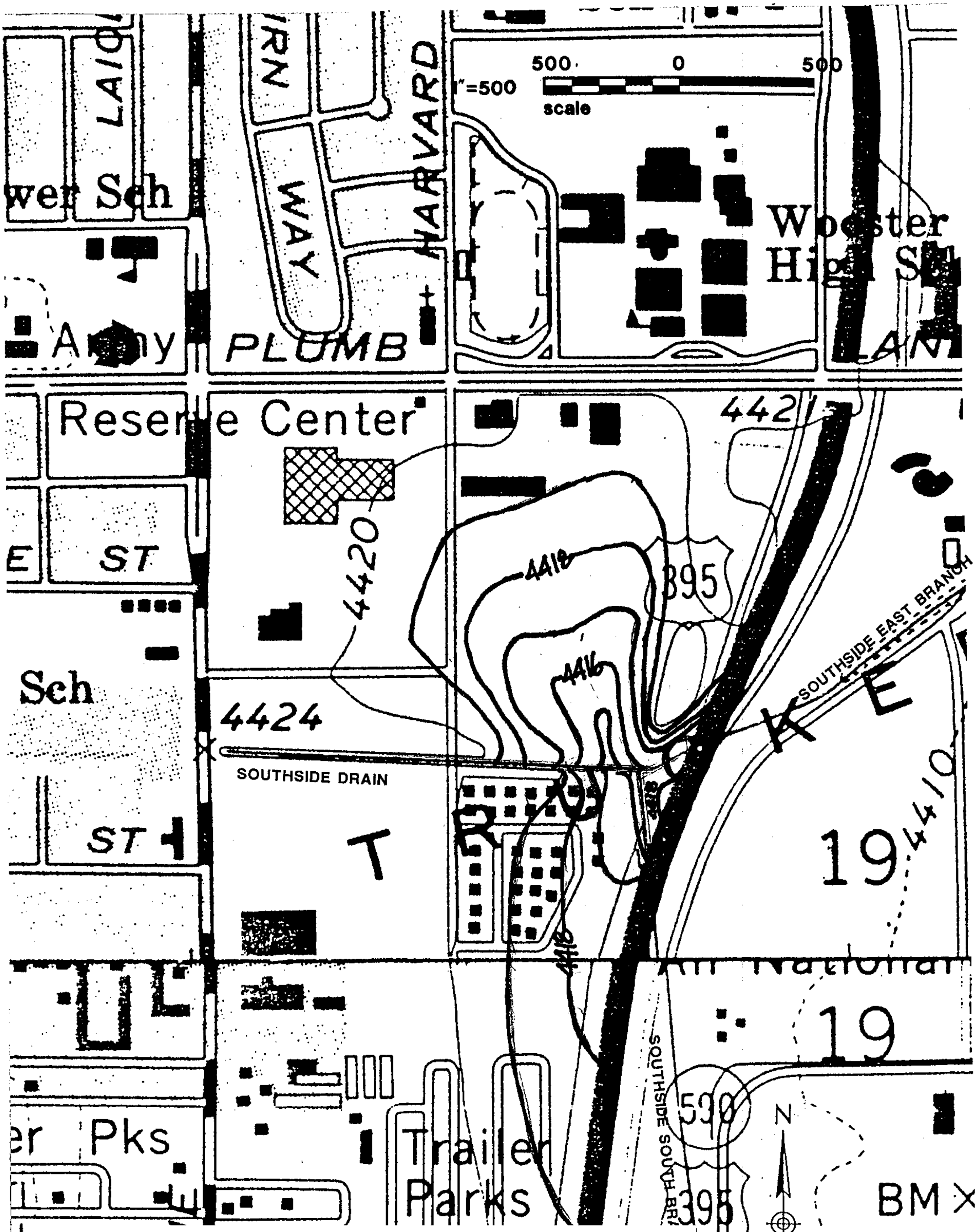
Downstream channel



n = 0.05
(FROM FIELD OBSERVATION)

b = 10'
Z = 1.2:1
n = 0.05
S = 0.23%

SOUTHSIDE SOUTH BRANCH DETENTION



SOUTHSIDE SOUTH BRANCH DETENTION

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Job E024112 RC1A Computed By RHF Date 11-8-92

Description Stage - STORAGE - Discharge Checked By ______ Date ______

For Flow through the SSSB at SSB4 and SSB6 Sheet 1 of 1

1 STAGE (FT.)	2 2-8.1'x5.8' ARCHES SSB4 (cfs)	3 10'x6' RCBC SSB4 (cfs)	4 Total SSB4 (2+3) (cfs)	5 1-60" cmp SSB6 (cfs)	6 Total SSB4+SSB6 (4+5) (cfs)	7 Volume (Ac-FT.)
4400.47	190.00	243.3	433.3	47.8	481.1	5.66
4400.60	198.4	254.2	452.6	49.4	502.0	6.04
4400.80	211.2	270.8	482.0	53.7	535.7	6.62
4401.00	224.1	287.5	511.6	58.0	569.6	7.20
4401.20	236.6	304.2	540.8	61.9	602.7	8.24
4401.40	247.2	320.8	568.0	65.8	633.8	9.29
4401.60	257.8	338.2	596.0	70.2	666.2	10.34
4401.80	268.4	355.9	624.3	74.7	699.0	11.39
4402.00	278.9	373.8	652.7	76.5	729.2	12.44
4402.20	285.0	392.5	677.5	78.0	755.5	14.47
4402.40	290.6	411.3	701.9	79.5	781.4	16.50
4402.60	296.2	431.0	727.2	81.0	808.2	18.54
4402.80	301.8	451.0	752.8	82.5	835.3	20.57
4403.00	307.4	470.5	777.9	83.9	861.8	22.61
4403.20	313.0	489.7	802.7	85.3	888.0	27.03
4403.40	318.6	506.2	824.8	86.7	911.5	31.44
4403.60	324.2	512.4	836.6	88.0	924.6	35.86
4403.80	327.8	518.6	846.4	89.4	935.8	40.28
4403.90	329.4	521.6	851.0	90.1	941.1	42.49
4404.0	331.0	524.7	855.7	90.8	946.5	44.70

This was modeled into the HEC-1 Run of 11-12-92

```
ILE NAME: SSB4-10BOX-2184.TBL

 ************************************************************************
 024112 RCIA: CULVERT RATING FOR THE ADDITIONAL PROPOSED BOX AT SSB-4
 HIS RATING IS FOR THE HYDROLOGIC MODEL USING THE TOTAL OVERALL SYSTEM
 ENGTH OF 2184.0'.  1-10'x6' RCBC @ 0.29%, n = 0.29%
 ************************************************************************


                           CULVERT RATING SUMMARY TABLE


                           ELEVATION - DISCHARGE CURVE

            DISCHARGE   EG/YN                 DISCHARGE   EG/YN

                0.00   4395.85                   190.00   4399.77
              235.00   4400.37                   280.00   4400.91
              325.00   4401.45                   370.00   4401.96
              415.00   4402.44                   460.00   4402.89
              505.00   4403.36                   550.00   4404.82
              595.00   4406.65                   640.00   4408.60
              685.00   4410.70                   730.00   4412.92
              775.00   4415.28                   820.00   4417.81
              865.00   4420.32                   910.00   4422.97
              955.00   4425.75                  1000.00   4428.67



              301.70   4401.17
              375.81   4402.02
              513.37   4403.63
              589.68   4406.43
              659.69   4409.52
              730.70   4412.96
              800.96   4416.74
              874.15   4420.86
              948.03   4425.32
```

Job E024112 RC1A Computed By RHF Date 11-8-92
Description Proposed 1-8'x6' RCBC Checked By ______ Date ______
The same information was used for the Sheet 2 of 2
10x6 & 12x6

Inlet Inv. El. = 4395.85
Outlet Inv. El. = 4389.52 *
Pipe Length = 2184.00' *
Ponding Limit El. = 4403.00
Pipe Slope = 0.2928% USE 0.29%
Manning's 'n' = 0.015
1 - 8'x6' RCBC
Ke = 0.5
Ponding Limit El. = 4403.00 (arbitrarily set)
SSB4 - BOX. OUT
SSB4 - BOX - 2184. OUT

Begin 190 45
El. =

4392.52

*The actual box Length is ~~1144.00~~ 1150.00 and the outlet invert is ~~4392.50~~. For hydrologic modeling purposes, The system was analyzed as the total SSB Length of 2184.0'. The projected outlet invert using the actual box slope is 4389.52

1 of 2

```
ILE NAME: SSB4-ARCH-2484.TBL

                                                    USER : SHI-EN SHIAU
 ************************************************************************
024112 RCIA: CULVERT RATING FOR THE 2-ARCH PIPES FOR THE SSSB ANALYZED FOR
THE HYDROLOGIC MODEL USING TOTAL OVERALL LENGTH OF 2184.0.
HESE ARCH PIPES WERE MODELED AS 2-84" CMP.
-8.1'x5.8'x 2184' STRUCTURAL PIPE ARCH PIPE @ 0.29%, n = 0.032
************************************************************************


                          CULVERT RATING SUMMARY TABLE


                          ELEVATION - DISCHARGE CURVE

            DISCHARGE    EG/YN                 DISCHARGE    EG/YN

                 0.00   4395.85                  190.00   4400.47
               235.00   4401.17                  280.00   4402.02
               325.00   4403.63                  370.00   4406.41
               415.00   4409.52                  460.00   4412.96
               505.00   4416.74                  550.00   4420.86
               595.00   4425.32                  640.00   4430.13
               685.00   4435.27                  730.00   4440.74
               775.00   4446.56                  820.00   4452.74
               865.00   4459.20                  910.00   4466.06
               955.00   4473.24                 1000.00   4480.77
```

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Job E024112 RCIA Computed By RHF Date 11-8-92
Description Existing 2-(8'-2"x5'-9") Checked By ______ Date ______
Structural Plate Arch Pipes Sheet 2 of 2

Inlet Inv. = 4395.85
Outlet Inv. = 4389.52 *
Pipe Length = 2184.0' Actual Length = ~~1144~~' 1150'
Ponding Limit El.: 4403.00
Pipe Slope = 0.2928% USE 0.29%
$n = 0.032$
$Ke = 0.5$
USE 84" as the equivalent pipe diameter.

Concentration pt. SSB-4

Inlet Loss = 0.5
Intermediate Loss = 0.4
SSB4-ARCH.OUT - actual length
SSB4-ARCH-2184.OUT length used for hydrologic modeling.
190 & 45

Note: the total overall length of the SSB structure for hydrologic modeling is 2184.0'

*Outlet Inv. at actual length of 1144' = 2392.50
*Outlet Inv. at total overall length of 2184.0' = 4389.52

1 of 2

```
ILE NAME: SSB6-PIPE.TBL

*******************************************************************************
 24112 RCIA: CULVERT RATING FOR THE PIPE WHICH CONVEYS THE SSB OVERFLOW
ONCENTRATION POINT SSB-6.  INLET CONFIGURATION IS UNKNOWN.  USE Ke = 0.7
```

1-60" x 1443' CMP @ 0.24 %

```
*******************************************************************************


                      CULVERT RATING SUMMARY TABLE

                      ELEVATION - DISCHARGE CURVE

      DISCHARGE    EG/YN                    DISCHARGE    EG/YN

          0.00   4397.07                       50.00   4400.63
         58.40   4401.02                       66.80   4401.45
         75.20   4401.82                       83.60   4402.95
         92.00   4404.18                      100.40   4405.52
        108.80   4406.97                      117.20   4408.54
        125.60   4410.21                      134.00   4412.00
        142.40   4413.89                      150.80   4415.88
        159.20   4417.99                      167.60   4420.21
        176.00   4422.55                      184.40   4424.97
        192.80   4427.53                      201.20   4430.20



         58.84   4401.04
         72.43   4401.70
         78.90   4402.32
         83.09   4402.88
         88.52   4403.67
         98.32   4405.19
        108.02   4406.84
        117.68   4408.63
        127.26   4410.56
        137.21   4412.72
        146.20   4414.79
        155.25   4417.00
        164.34   4419.35
        182.66   4424.47
        173.45   4421.84
        191.87   4427.25
        201.09   4430.16
```

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Job E024112 RC1A
Computed By RHF
Date 11-9-92
Description 1-60" CMP
Checked By
Date
Proposed total pipe at C.P. SSB-6
Sheet 2 of 2

Inlet Inv. El. = 4397.07
Outlet Inv. El. = 4393.61 ** 4405
Pipe Length = 1443' *
Ponding Limit El = 4404.00
Pipe slope = 0.2396% Use 0.24%
Manning's 'n' = 0.024
Ke = 0.7 assumed Mitered to bank slope.
no data available

SSB6-Pipe.out

Begin Q = 50 cfs increm. = 8.4

*Pipe Length = 1344' Existing, 99' Proposed.

** Outlet Inv. El. based on existing slope and existing inverts.

```
LE NAME: SSB4-12BOX-2184.TBL

*********************************************************************************
024112 RCIA: CULVERT ANALYSIS FOR THE ADDITINAL PROPOSED BOX AT SSB-4
HIS RATING IS FOR THE HYDROLOGIC MODEL USING THE TOTAL OVERALL SYSTEM
ENGTH OF 2184.0'.  1-12'x 6' RCBC @ 0.29%, n = 0.015
*********************************************************************************


                         CULVERT RATING SUMMARY TABLE


                         ELEVATION - DISCHARGE CURVE

         DISCHARGE    EG/YN                    DISCHARGE    EG/YN

              0.00    4395.62                     190.00    4399.09
            235.00    4399.62                     280.00    4400.11
            325.00    4400.57                     370.00    4401.02
            415.00    4401.45                     460.00    4401.87
            505.00    4402.27                     550.00    4402.64
            595.00    4403.03                     640.00    4403.41
            685.00    4404.62                     730.00    4406.07
            775.00    4407.58                     820.00    4409.17
            865.00    4410.85                     910.00    4412.61
            955.00    4414.55                    1000.00    4416.39



            315.43    4400.47
            328.30    4400.60
            348.13    4400.80
            368.01    4401.00
            388.68    4401.20
            409.38    4401.40
            430.74    4401.60
            452.26    4401.80
            474.33    4402.00
            496.66    4402.20
            520.30    4402.40
            544.80    4402.60
            568.16    4402.80
            591.28    4403.00
            614.97    4403.20
            638.72    4403.40
            647.07    4403.60
            654.53    4403.80
            658.26    4403.90
            662.00    4404.00
```

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Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 1 of 9

Subject ELEVATION-STORAGE CALCULATIONS FOR STORAGE AREA WEST OF U.S. 395 AT SOUTHSIDE DRAIN.

By DRG Date 11-5-92 Checked By ______ Date ______

ELEV. (FT)	SURFACE AREA (ACRES)	AVG. SURF. AREA (ACRES)	Δ DEPTH (FT)	Δ STORAGE (ACRE-FT)	STORAGE (ACRE-FT)
4406.73	0				0
		.01	0.27	.003	
4407	.01				.003
		.04	1.0	.04	
4408	.06				.04
		.13	1.0	.13	
4409	.19				.17
		.31	1.0	.31	
4410	.42				.48
		.47	1.0	.47	
4411	.52				.95
		.55	1.0	.55	
4412	.58				1.50
		.62	1.0	.62	
4413	.65				2.12
		.69	1.0	.69	
4414	.72				2.81
		.83	1.0	.83	
4415	.94				3.64
		1.79	1.0	1.79	
4416	2.34				5.43
		4.06	1.0	4.06	
4417	5.78				9.49
		10.13	1.0	10.13	
4418	14.47				19.62
		22.51	1.0	22.51	
4419	30.55				42.13
		44.14	1.0	44.14	
4420	57.72				86.27
		57.72	1.0	57.72	
4421	57.72				143.99
		57.72	1.0	57.72	
4422	57.72				201.71

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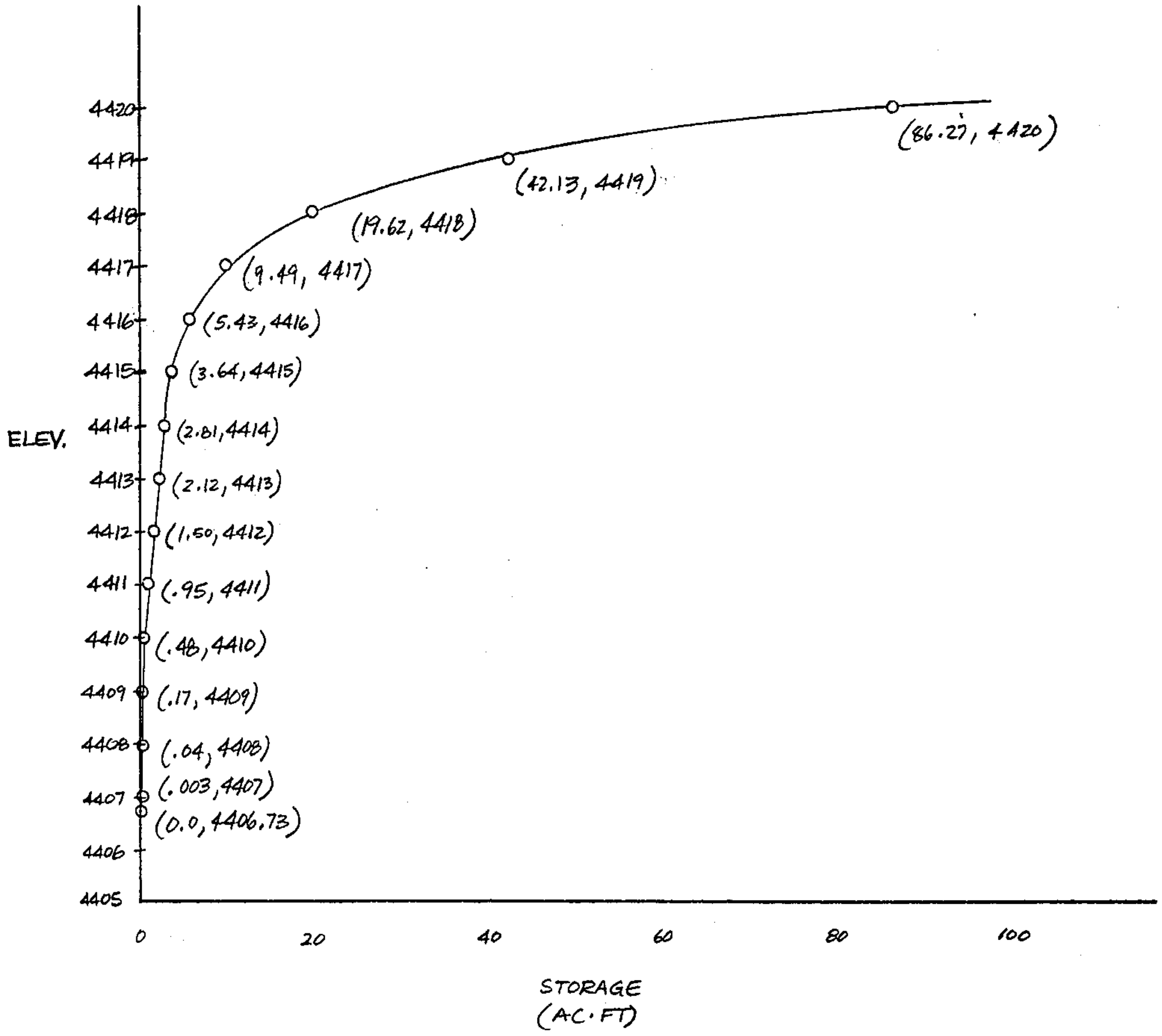
Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 2 of 9

Subject ELEVATION- STAGE RELATIONSHIP FOR AREA WEST

By DRG Date 11-6-92 Checked By Date



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Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 3 of 9

Subject RESERVOIR RATING INFO. FOR AREA WEST OF US 395 AT SOUTHSIDE DRAIN

By DRG Date 11-5-92 Checked By Date

RESERVOIR RATING TABLE

ELEV. (FT)	DISCHARGE (CFS)	STORAGE (AC-FT)
4406.73	0	0
4407	—	.003
4408	—	.04
4409	—	.17
4410	—	.48
4411	—	.95
4412	—	1.50
4413	—	2.12
4414	745	2.81
4415	836	3.64
4416	897	5.43
4417	958	9.49
4418	1019	19.62
4419	1076	42.13
4420	1130	86.27
4421	1182	143.99
4422	1235	201.71

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Job No. E024112 Project RENO CANNON INTL AIRPORT Sheet 4 of 9

Subject ELEVATION – STORAGE RELATIONSHIP / AREA CALCULATIONS @ VARIOUS ELEVATIONS

By DRG Date 11-5-92 Checked By Date

ELEVATION	AREA (AC)
4420	20.8920 + 3.9104 + 21.5653 + 1.1088 + 13.8998 = 61.3763 AC − 3.66 AC 57.72 AC
4419	10.6730 + 1.4864 + 15.7902 + 1.0613 + 5.1364 = 34.1473 AC − 3.60 AC 30.55 AC
4418	4.0694 + .2834 + 11.2232 + 1.0138 + 1.0523 = 17.6421 AC − 3.17 AC 14.47 AC
4417	.2296 + 5.7636 + 1.3939 = 7.3871 AC − 1.61 AC 5.78 AC
4416	1.7506 + .8788 = 2.6294 AC − 0.29 AC 2.34 AC
4415	.1411 + .8003 = .9414 AC
4414	.7208 AC
4413	.6499 AC
4412	.5785 AC
4411	.5152 AC
4410	.4201 AC
4409	.1915 AC
4408	.0552 AC
4407	.0114 AC
4406.73	0 AC

* REFER TO EXHIBIT A.

DIVERSION AT TERMINAL WAY/ PILOT WAY INTERSECTION

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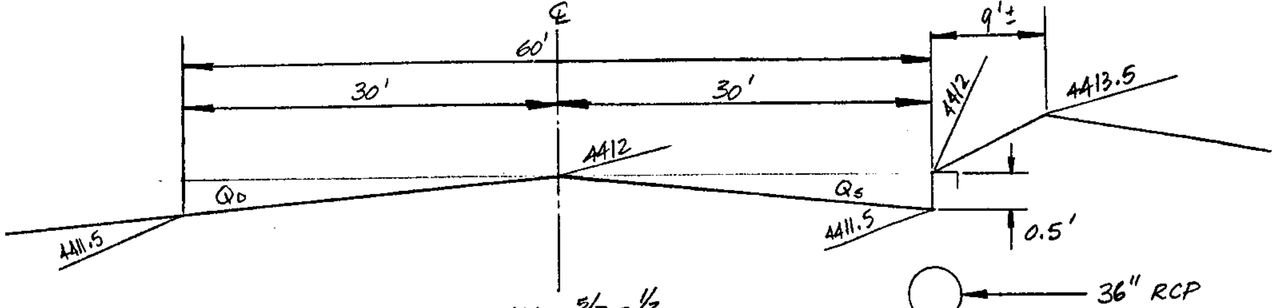
Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 1 of 5

Subject Q_D & Q_T RATING CURVE FOR TERMINAL WAY @ PILOT WAY

By DRG Date 11-8-92 Checked By Date



$$Q = \frac{1.486\, a^{5/3} s^{1/2}}{n p^{2/3}}$$

$s = 0.01$

ELEV.	Q_P (CFS)	Q_S (CFS)	Q_D (CFS)	Q_T (CFS)
4411.50	23.185	0	0	23.185
4411.75	23.185	3.442	0	26.627
4412.00	23.185	22.125	0	45.310
4412.25	23.185	69.334	69.799	162.318
4412.50	23.185	136.638	136.602	296.425
4412.75	23.185	222.415	219.240	464.840
4413.00	23.185	324.985	316.318	664.488
4413.25	23.185	444.558	426.375	894.118
4413.50	23.185	580.592	548.384	1152.161

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Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 2 of 5

Subject Q_T & Q_D RATING CURVES FOR TERMINAL WAY @ PILOT WAY

By DRG Date 11-8-92 Checked By Date

ELEV	a_s (FT^2)	P_s (FT)	a_D (FT^2)	P_D (FT)
4411.50	0	0	0	0
4411.75	1.875	15.252	0	0
4412.00	7.500	30.004	0	0
4412.25	15.188	31.525	15.00	30.254
4412.50	23.250	33.045	22.50	30.504
4412.75	31.688	34.566	30.00	30.754
4413.00	40.500	36.087	37.50	31.004
4413.25	49.688	37.608	45.00	31.254
4413.50	59.250	39.128	52.50	31.504

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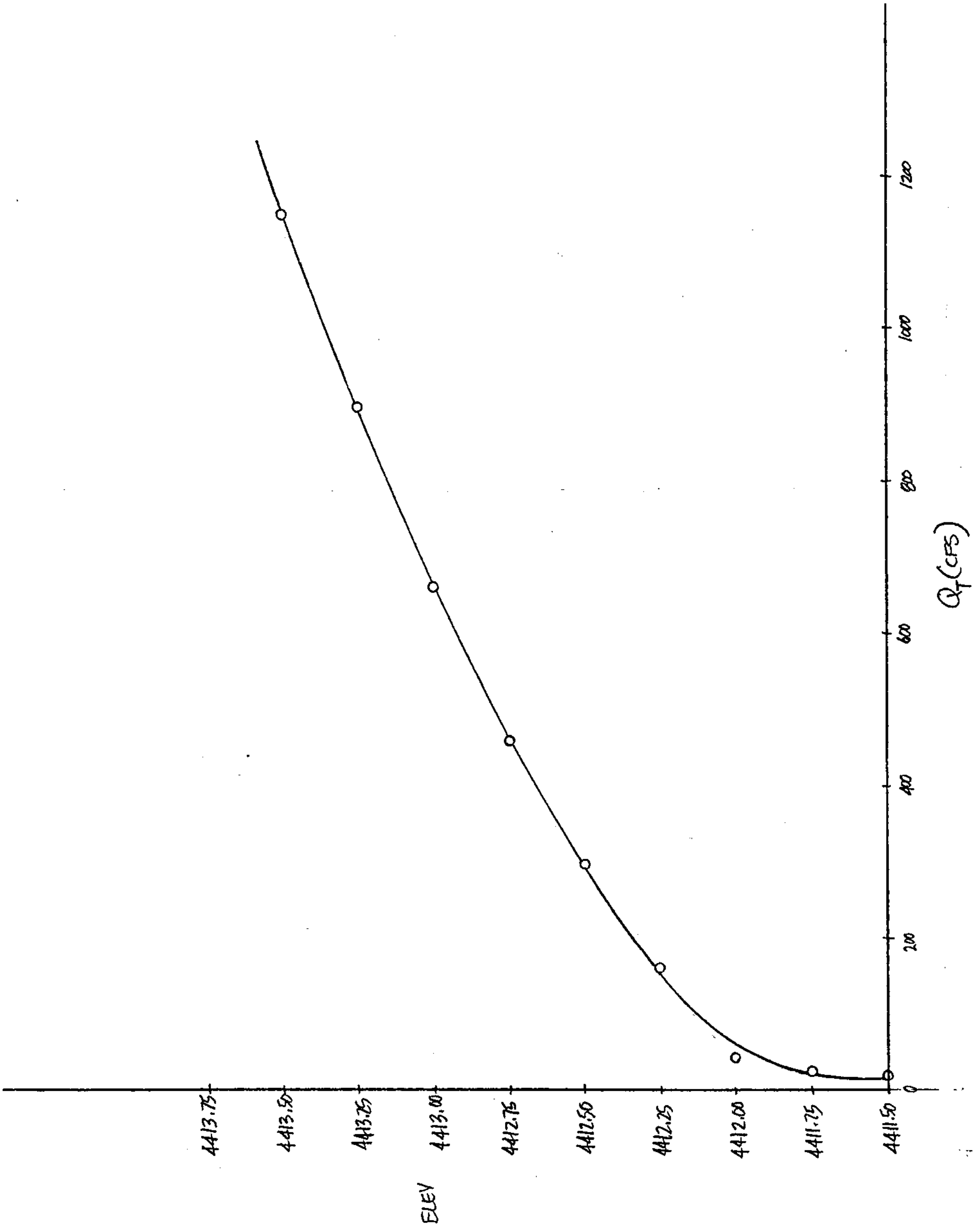
Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 3 of 5

Subject ELEVATION VS. Q_T RATING CURVE FOR TERMINAL WAY AT PILOT WAY

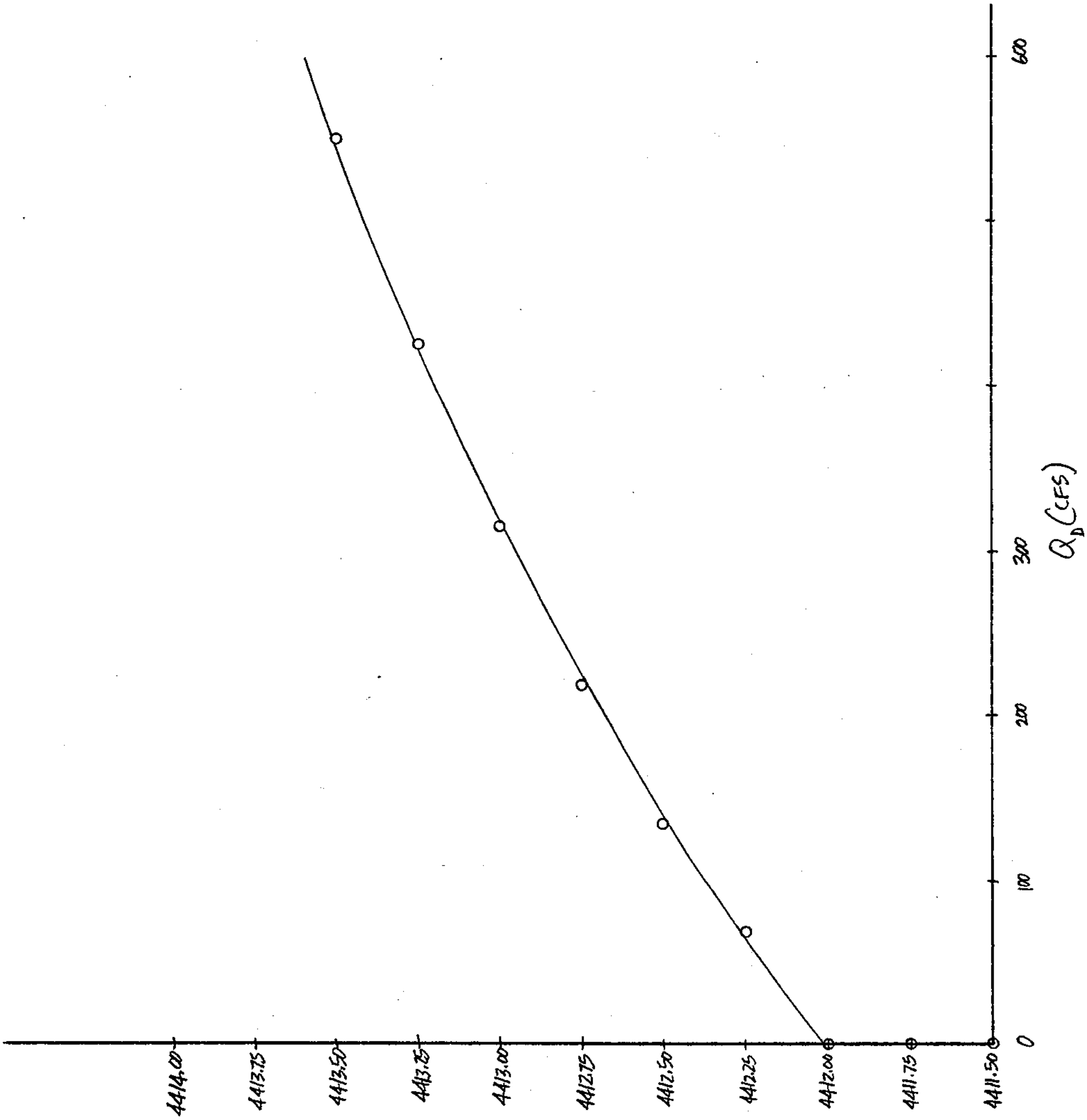
By DRG Date 11-8-92 Checked By ______ Date ______



Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 4 of 5

Subject ELEVATION VS. Q_D RATING CURVE FOR TERMINAL WAY AT PILOT WAY

By DRG Date 11-8-92 Checked By ______ Date ______



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Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 5 of 5

Subject 36" RCP & STREET CAPACITY'S ALONG TERMINAL WAY

By DRG Date 11-8-92 Checked By ________ Date ________

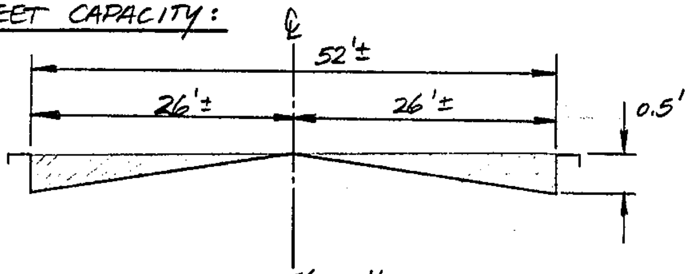
36" RCP CAPACITY:

$Q = VA$ WHERE $V = 3.28 \ \text{FT/S}$ (FROM T_C CALCS. FOR SUBAREA R-1.2)

$A = \pi R^2 = \pi (1.5)^2 = 7.0686 \ FT^2$

$$Q = (3.28 \ FT/s)(7.0686 \ FT^2)$$
$$= 23.185 \ CFS$$

STREET CAPACITY:



$$Q = \frac{1.486 \, a^{5/3} \, S^{1/2}}{n p^{2/3}}$$ WHERE $S = \frac{2}{200} = .01$

$n = .02$ (PER NASIR RAZA 11-8-92)

$$Q_{\frac{1}{2}} = \frac{1.486 (6.5)^{5/3} (.01)^{1/2}}{(.02)(26.505)^{2/3}} = \frac{3.3662}{.1778}$$
$$= 18.933 \ CFS$$

$a_{\frac{1}{2}} = \frac{1}{2}(26')(0.5') = 6.5 \ FT^2$

$a_T = 2(6.5) = 13 \ FT^2$

$P_{1/2} = 0.5 + \sqrt{(0.5)^2 + (26)^2} = 0.5 + 26.005$
$= 26.505 \ FT$

$Q_T = 2(18.933 \ CFS) = 37.866 \ CFS$

$P_T = 2(26.505) = 53.01 \ FT$

$Q_{PIPE} + Q_{ROAD} = 23.185 \ CFS + 37.866 \ CFS = 61.051 \ CFS$

COMPARISIONS OF SEA & GREINER INFIELD (AIRPORT) AREAS

Greiner

Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 1 of 1

Subject AREA CALCULATIONS FOR JET WEST, TOWER, AND APRON

By DRG Date 11-10-92 Checked By Date

	DRAINAGE AREA	GREINER AREA (FT^2)	GREINER AREA (MI^2)	SEA, INC AREA (MI^2)
TOWER:	TA	2564812.80	.092	.096
	TB	529689.60	.019	.022
	TC	1895731.20	.068	.070
	TD	1672704.00	.060	.060
JET WEST:	JWA	1393920.00	.050	.036
	JWB	1170892.80	.042	.042
	JWC	1700582.40	.061	.061
	JWD	1366041.60	.049	.049
	JWE	139392.00	.005	.005
APRON:	AA	2930880.00	.105	.082
	AB	1170892.80	.042	.047
	AC	418176.00	.015	.015
	AD	864230.40	.031	.031

Greiner

Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 1 of 8

Subject HYDROLOGICAL SUBAREA CONFIRMATION

By DRG Date 11-7-92 Checked By Date

Comments:

Upon inspection of SEA, Incs. hydrological study drainage area map and topo. base sheets I have made the following conclusions.

Regarding the Southside Drain (East Branch)

- Drainage subarea SEBA seems to be slightly smaller than what I determined from the topo. base sheets.
- Drainage subarea SEBB should include a portion of area belonging to the Apron drainage area. This area also exchange equal portions of area with Tower to the south.
- subareas SEBB & SEBC also should include a small porti of Tower to the south.
- subareas SEBD & SEBE also evenly exchange a portion of a with tower.

■ In conclusion, it is my opinion that the subareas delinea by SEA, Inc. for the Southside Drain (East Branch) seem reasonable and the majority of the variations cancel each other out.

Regarding the Southside Drain (South Branch):

- Drainage subarea SSBA should be larger than that determined by SEA, Inc, however the difference is that it should include a portion of SSBB. Since SSBA & SSBB end up coming together this is not an important difference.
- Similarly it is my contention that a portion of SSBB that SEA, Inc. determined actually should be a part of Jet West. However it is such negligible amount when compared to the overall sizes of Southside Drain (South Branch) and Jet West so that we can ignore it.

■ I would conclude that SEA, Inc.'s subareas are reasonable and adequate.

Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 2 of 8

Subject DRAINAGE AREA COMPARISONS - SOUTHSIDE DRAIN

By DRG Date 11-7-92 Checked By Date

EAST BRANCH:

DRAINAGE AREA	AREA (FT²)	AREA (MI²)	SEA, INC. AREA (MI²)
SEBA	1717333.334	.062	.055
SEBB	2534666.667	.091	.082
SEBC	1373333.334	.049	.046
SEBD	539000.000	.019	.021
SEBE	648000.000	.023	.019
SEBF	3494666.667	.125	.125
TOTAL	—	.369	.348

SOUTH BRANCH:

DRAINAGE AREA	AREA (FT²)	AREA (MI²)	SEA, INC. AREA (MI²)
SSBA	560000.000	.020	.013
SSBB	2145333.334	.077 *	.094
SSBC	—	.000 **	.004
SSBD	151111.111	.005	.005
SSBE	975744.000	.035	.035
TOTAL	—	.137	.151

* ALSO HAD .006 MI² GO TO JET WEST PER MY DELINEATION AND CALCULATION

** .004 WENT TO JET WEST.

RUNOFF CURVE NUMBERS

Worksheet 2: Runoff curve number and runoff

Project RENO CANNON INTERNATIONAL AIRPORT By DRG Date 11-3-92

Location RENO, NEVADA Checked ____ Date ____

Circle one: Present [✓ Developed] DRAINAGE SUB-AREA SK-1

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/			Area ☐ acres ☐ mi^2 ☒ %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
B	Suburban Residential (SR) Residential 1/3 Acre 30% Imperv.	72			1.5	108
B	Low Density Residential (LR) Residential 1/4 Acre 38% Imperv.	75			1.5	112.5
C	Low Density Residential (LR) Residential 1/4 Acre 38% Imperv.	83			7	581
D	Special Planning Area (SPA) Residential 1/3 Acre 30% Imperv.	86			24	2064
D	Park / open Space (POS) Open space, good condition	80			7	560
D	Low Density Residential (LR) Residential 1/4 Acre 38% Imperv.	87			17	1479
D	Suburban Residential (SR) Residential 1/3 Acre 30% Imperv.	86			39	3354
D	Medium Density Residential (MR) Residential 1/8 Acre 65% Imperv.	92			3	276
				Totals =	100	8534.5

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{8534.5}{100} = 85.35$; Use CN = $\boxed{85}$

2. Runoff

	Storm #1	Storm #2	Storm #3
Frequency .... yr			
Rainfall, P (24-hour) .... in			
Runoff, Q .... in (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)			

NOTES: 1. LAND USE CATEGORIES HAVE BEEN DETERMINED WITH THE AID OF CITY OF RENO MASTER PLAN (1992), SEE LAND USE PLAN.

2. RUNOFF CURVE NO. FOR THIS AREA IN THE NIMBUS ENGINEERS HYDROLOGIC ANALYSIS IS 85. THIS REPORT HAS BEEN TENTATIVELY APPROVED BY BAKER ENGINEERING FOR FEMA (PERSONAL COMMUNICATION SEE TELEPHONE RECORD DATED). CONSEQUENTLY AN RCN OF 85 SHALL BE USED WITHIN THE

SHEET 2 OF 15

Worksheet 2: Runoff curve number and runoff

Project RENO CANNON INTERNATIONAL AIRPORT By DRQ Date 11-3-92

Location RENO, NEVADA Checked ______ Date ______

Circle one: Present [✓ Developed] DRAINAGE SUBAREA SK-2

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/			Area ☐ acres ☐ mi^2 ☒ %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
LAKE	Virginia Lake Surface 100% Imperv.	100			15	1500
B	Suburban Residential (SR) Residential 1/3 Acre 30% Imperv.	72			7	504
B	Neighborhood Commercial (NC) Urban commercial and business	92			4	368
C	High Density Residential (HR) Residential 1/8 Acre 65% Imperv.	90			4	360
C	Neighborhood Commercial (NC) Urban commercial and business	94			7	658
D	Suburban Residential (SR) Residential 1/3 Acre 30% Imperv.	86			22	1892
D	Low Density Residential (LR) Residential 1/4 Acre 38% Imperv.	87			34	2958
D	High Density Residential (HR) Residential 1/8 Acre 65% Imperv.	92			7	644
				Totals =	100	8884

1/ Use only one CN source per line.

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{8884}{100} = 88.84;$$ Use CN = 89

2. Runoff

	Storm #1	Storm #2	Storm #3
Frequency .... yr			
Rainfall, P (24-hour) .... in			
Runoff, Q .... in (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)			

NOTE: LAND USE CATEGORIES HAVE BEEN DETERMINED WITH THE AID OF CITY OF RENO MASTER PLAN (1992), SEE LAND USE PLAN.

SHEET 3 OF 15

Worksheet 2: Runoff curve number and runoff

Project RENO CANNON INTERNATIONAL AIRPORT By DRG Date 11-3-92

Location RENO, NEVADA Checked ____ Date ____

Circle one: Present [✓ Developed] DRAINAGE SUB-AREA DT-1

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/			Area	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4	☐ acres ☐ mi^2 ☒ %	
C	Special Planning Area (SPA) Residential 1/3 Acre 30% Imperv.	81			8.5	688.5
D	Special Planning Area (SPA) Residential 1/3 Acre 30% Imperv.	86			65.5	5633
D	Low Density Residential (LR) Residential 1/4 Acre 38% Imperv.	87			16	1392
D	Suburban Residential (SR) Residential 1/3 Acre 30% Imperv.	86			10	860
				Totals =	100	8573.5

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{8573.5}{100} = $ 85.74; Use CN = 86

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr			
Rainfall, P (24-hour)	in			
Runoff, Q .... (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in			

NOTES: 1. LAND USE CATEGORIES HAVE BEEN DETERMINED WITH THE AID OF CITY OF RENO MASTER PLAN (1992), SEE LAND USE PLAN.

2. RUNOFF CURVE NO. FOR THIS AREA IN THE NIMBUS ENGINEERS HYDROLOGIC ANALYSIS IS 85. THIS REPORT HAS BEEN TENTATIVELY APPROVED BY BAKER ENGINEERING FOR FEMA (PERSONAL COMMUNICATION, SEE TELEPHONE RECORD DATED). CONSEQUENTLY AN RCN OF 85 SHALL BE USED WITHIN THE HEC-1 MODEL.

Worksheet 2: Runoff curve number and runoff

Project RENO CANNON INTERNATIONAL AIRPORT By DRG Date 11-3-92

Location RENO, NEVADA Checked _____ Date _____

Circle one: Present [✓ Developed] DRAINAGE SUBAREA DT-2

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/			Area ☐ acres ☐ mi^2 ☒ %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
B	Suburban Residential (SR) Residential 1/3 Acre 30% Imperv.	72			1	72
C	Suburban Residential (SR) Residential 1/3 Acre 30% Imperv.	81			20	1620
C	Medium Density Residential (MR) Residential 1/8 Acre 65% Imperv.	90			2	180
C	High Density Residential (HR) Residential 1/8 Acre 65% Imperv.	90			12	1080
D	Park/Open Space (POS) Open Space, good condition	80			8	640
D	Suburban Residential (SR) Residential 1/3 Acre 30% Imperv.	86			49	4214
D	Low Density Residential (LR) Residential 1/4 Acre 38% Imperv.	87			.5	43.5
D	Medium Density Residential (MR) Residential 1/8 Acre 65% Imperv.	92			2	184
D	High Density Residential (HR) Residential 1/8 Acre 65% Imperv.	92			.5	46
D	General Commercial (GC) Urban commercial and business	95			5	475
				Totals =	100	8554.5

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{8554.5}{100} = $ 85.55; Use CN = $\boxed{86}$

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr			
Rainfall, P (24-hour)	in			
Runoff, Q .... (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in			

NOTES: 1. LAND USE CATEGORIES HAVE BEEN DETERMINED WITH THE AID OF CITY OF RENO MASTER PLAN (1992), SEE LAND USE PLAN.

2. RUNOFF CURVE NO. FOR THIS AREA IN THE NIMBUS ENGINEERS HYDROLOGIC ANALYSIS IS 85. THIS REPORT HAS BEEN TENTATIVELY APPROVED BY BAKER ENGINEERING FOR FEMA (PERSONAL COMMUNICATION, SEE TELEPHONE RECORD DATA) CONSEQUENTLY AN RCN OF 85 SHALL BE USED WITHIN THE HEC-1 MODEL.

SHEET 5 OF 15

Worksheet 2: Runoff curve number and runoff

Project RENO CANNON INTERNATIONAL AIRPORT By DRG Date 11-3-92

Location RENO, NEVADA Checked ____ Date ____

Circle one: Present [✓ Developed] DRAINAGE SUBAREA R-1.1

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/			Area ☐ acres ☐ mi² ☒ %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
B	Neighborhood Commercial (NC) Urban commercial and business	92			34	3128
B	General Commercial (GC) Urban commercial and business	92			4	368
B	Public Facility (PF) Urban commercial and business	92			2	184
B	Low Density Residential (LR) Residential 1/4 Acre 38 % Imperv.	75			20	1500
B	Medium Density Residential (MR) Residential 1/8 Acre 65% Imperv.	85			11	935
B	High Density Residential (HR) Residential 1/8 Acre 65% Imperv.	85			7	595
C	Employment (E) Urban commercial and business	94			2	188
C	Neighborhood Commercial (NC) Urban commercial and business	94			5	470
C	Medium Density Residential (MR) Residential 1/8 Acre 65% Imperv.	90			2	180
D	Neighborhood Commercial (NC) Urban commercial and business	95			9	855
D	Low density residential (LR) Residential 1/4 Acre 38 % Imperv.	87			4	348
				Totals =	100	8751

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{8751}{100}$ = 87.51; Use CN = $\boxed{88}$

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr			
Rainfall, P (24-hour)	in			
Runoff, Q .... (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in			

NOTE: LAND USE CATEGORIES HAVE BEEN DETERMINED WITH THE AID OF CITY OF RENO MASTER PLAN (1992), SEE LAND USE PLAN.

SHEET 6 OF 15

Worksheet 2: Runoff curve number and runoff

Project RENO CANNON INTERNATIONAL AIRPORT By DRG Date 11-4-92

Location RENO, NEVADA Checked ____ Date ____

Circle one: Present [✓ Developed] DRAINAGE SUBAREA R-1.2

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1/] Table 2-2	Fig. 2-3	Fig. 2-4	Area ☐ acres ☐ mi^2 ☒ %	Product of CN x area
B	Employment (E) Urban commercial and business	92			7	644
B	Tourist commercial (TC) Urban commercial and business	92			7	644
C	Employment (E) Urban commercial and business	94			36	3384
C	Tourist commercial (TC) Urban commercial and business	94			7	658
D	Tourist commercial (TC) Urban commercial and business	95			7	665
B	Public Facility (PF) Urban commercial and business	92			29	2668
B	High Density Residential (HR) Residential 1/8 Acre ; 65% Impervi.	85			7	595
				Totals =	100	9258

[1/] Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{9258}{100}$ = 92.58; Use CN = 93

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr			
Rainfall, P (24-hour)	in			
Runoff, Q .... (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	in			

NOTE: LAND USE CATEGORIES HAVE BEEN DETERMINED WITH THE AID OF CITY OF RENO MASTER PLAN (1992), SEE LAND USE PLAN.

Worksheet 2: Runoff curve number and runoff

Project E024112- RENO CANNON INTERNATIONAL AIRPORT By DRG Date 11-16-92

Location RENO, NEVADA Checked ______ Date ______

Circle one: Present [✓ Developed] ROCK BLVD DRAINAGE AREAS R-1.3

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/			Area ☐ acres ☒ mi^2 ☐ %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
B	Urban, Commercial and Business*	92			.059	5.428
C	Urban, Commercial and Business*	94			.199	18.706
				Totals =	.258	24.134

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{24.134}{.258} = $ 93.54; Use CN = $\boxed{94}$

2. Runoff

	Storm #1	Storm #2	Storm #3
Frequency .... yr			
Rainfall, P (24-hour) .... in			
Runoff, Q .... in (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)			

* Assumption made by use of City of Reno Land Use Map (10/12/92)

Greiner

Job No. E0241.12 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 7 of 15

Subject SOIL WATER FEATURES

By DRG Date 11-3-92 Checked By ________ Date ________

MAP SYMBOL #	SOIL NAME	HYDROLOGIC GROUP	DESCRIPTION
190, 191	MANOGUE	D	190 – COBBLY CLAY, 2 TO 8 PERCENT SLOPES 191 – COBBLY CLAY, 8 TO 15 PERCENT SLOPES
282	WEDEKIND	D	GRAVELY SANDY LOAM, 30 TO 50 PERCENT SLOPES
312	RISLEY	D	COBBLY LOAM, 15 TO 30 PERCENT SLOPES
350	MIZEL	D	VERY GRAVELLY COARSE SANDY LOAM, 15 TO 50 PERCENT SLOPES
390	DUCKHILL	D	STONY LOAM, 30 TO 50 PERCENT SLOPES
456	VOLTAIRE	D	CLAY LOAM, GRAVELLY SUBSTRATUM
550, 551	LEVIATHAN	B	550 – STONY SANDY LOAM, 0 TO 2 PERCENT SLOPES 551 – STONY SANDY LOAM, 2 TO 8 PERCENT SLOPES
585	BARNARD	D	BARNARD–TROSI ASSOCIATION (SEE ATTACHED)
600, 602	IDLEWILD	D	600 – CLAY LOAM, DRAINED 602 – GRAVELLY SANDY LOAM
613, 615	VERDICO	D	613 – EXTREMELY STONY SANDY LOAM, 8 TO 15 PERCENT SLOPES 615 – SANDY LOAM, 4 TO 8 PERCENT SLOPES
630, 631, 632	FLEISCHMANN	D	630 – GRAVELLY CLAY LOAM, 2 TO 4 PERCENT SLOPES 631 – GRAVELLY CLAY LOAM, 4 TO 8 PERCENT SLOPES 632 – LOAM, 8 TO 15 PERCENT SLOPES
650, 652	CHALCO	D	650 – VERY STONY CLAY LOAM, 15 TO 30 PERCENT SLOPES 652 – STONY LOAM, 4 TO 8 PERCENT SLOPES
661	OEST	B	BOULDERY SANDY LOAM, 2 TO 8 PERCENT SLOPES
681, 683	RENO	D	681 – VERY STONY FINE SANDY LOAM, 8 TO 15 PERCENT SLOPES 683 – STONY SANDY LOAM, 2 TO 8 PERCENT SLOPES
730, 731	STODICK	D	730 – VERY STONY LOAM, 15 TO 30 PERCENT SLOPES 731 – STONY LOAM, 30 TO 50 PERCENT SLOPES
780	BIEBER	D	STONY SANDY LOAM, 0 TO 4 PERCENT SLOPES
850	WASHOE	B	GRAVELLY SANDY LOAM, 0 TO 4 PERCENT SLOPES
861, 862, 863	REYWAT	D	861 – EXTREMELY STONY LOAM, 15 TO 30 PERCENT SLOPES 862 – VERY COBBLY SANDY LOAM, 8 TO 15 PERCENT SLOPES 863 – ROCK OUTCROP COMPLEX, 15 TO 50 PERCENT SLOPES

Greiner

Job No. E0241.12 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 8 of 15

Subject SOIL WATER FEATURES

By DRG Date 11-3-92 Checked By ______ Date ______

MAP SYMBOL #	SOIL NAME	HYDROLOGIC GROUP	DESCRIPTION
871, 872	XMAN	D	871 – VERY STONY LOAM, 15 TO 30 PERCENT SLOPES 872 – VERY STONY SANDY LOAM, 8 TO 15 PERCENT SLOPES
881, 882	ZEPHAN	C	881 – VERY GRAVELLY SANDY LOAM, 30 TO 50 PERCENT SLOPES 882 – STONY SANDY LOAM, 15 TO 30 PERCENT SLOPES
900	FLEX	D	VERY GRAVELLY SANDY LOAM, 15 TO 30 PERCENT SLOPES
911	VAMP	C	SILT LOAM, STRONGLY SALINE-ALKALI
930, 931, 932	OLD CAMP	D	930 – STONY SANDY LOAM, 15 TO 30 PERCENT SLOPES 931 – ROCK OUTCROP COMPLEX, 15 TO 50 PERCENT SLOPES 932 – STONY SANDY LOAM, 8 TO 15 PERCENT SLOPES
991	XERIC TORRIORTHENTS	C (ASSUMED)*	URBAN LAND COMPLEX (SEE ATTACHED)

* Soil type of 991 was assumed to be Hydrologic Group C after assessing the attached narrative for that soil and studying the adjacent soils.

585—Barnard-Trosi association. This map unit is on dissected alluvial fans and on terraces. Elevation is 4,600 to 5,200 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is 49 to 51 degrees F, and the average frost-free period is 80 to 100 days.

This unit is 50 percent Barnard stony sandy loam, 2 to 4 percent slopes, and 35 percent Trosi very stony sandy loam, 4 to 8 percent slopes. Barnard and Trosi soils are on similar landscape positions. The Barnard soil has a hardpan at a depth of 20 to 30 inches and supports big sagebrush. The Trosi soil has a hardpan at a depth of 12 to 20 inches and supports low sagebrush.

Included in this map unit are Bieber soil on lower terraces, Galeppi soils adjacent to drainageways on the side slopes, Indian Creek soils on nearly level alluvial fan tops, Oest soils on alluvial fan skirts, and wet areas near seeps. The unit is about 4 percent Bieber soils, 4 percent Galeppi soils, 3 percent Indian Creek soils, 2 percent Oest soils, and 2 percent wet areas.

The Barnard soil is moderately deep and well drained. It formed in alluvium and pedisediments from mixed rock sources. Typically, 1 to 3 percent of the surface is covered with stones. The surface layer is grayish brown stony sandy loam about 15 inches thick. The subsoil is light yellowish brown clay about 11 inches thick. The upper part of the substratum is an indurated, silica-cemented hardpan. The depth to the hardpan ranges from 20 to 30 inches. Below the hardpan is gravelly and cobbly alluvium.

Permeability of the Barnard soil is slow. Available water capacity is low. Effective rooting depth is 20 to 30 inches. Runoff is medium, and the hazard of water erosion is slight. The hazard of soil blowing is slight.

The Trosi soil is shallow and well drained. It formed in alluvium from mixed rock sources. Typically, 3 to 15 percent of the surface is covered with stones and some cobbles. The surface layer is light brown very stony sandy loam about 12 inches thick. The subsoil is brown very cobbly clay about 7 inches thick. The upper 15 inches of the substratum is an indurated hardpan. The depth to the hardpan ranges from 12 to 20 inches. Below the hardpan is very gravelly and very cobbly alluvium interbedded with layers of finer material.

Permeability of the Trosi soil is very slow. Available water capacity is very low. Effective rooting depth is 12 to 20 inches. Runoff is medium, and the hazard of water erosion is slight. The hazard of soil blowing is slight.

The unit is used for urban development and as rangeland.

If the unit is used for urban development, the main limitations to the use of the unit as sites for buildings are the high shrink-swell potential of the Barnard soil and stoniness and the hardpan. Structural damage can be prevented if foundations and footings are properly designed and the soil is kept dry by diverting water away from the buildings. Heavy equipment is needed to excavate the large stones and to cut through the hardpan. The main limitations to use of this unit as septic tank absorption fields are the hardpan and the very slowly permeable subsoil of the Trosi soil and the hardpan of the Barnard soil. In some areas, percolation can be improved by placing the leach line below the hardpan.

The main limitations to use of this unit as sites for roads are low strength of the soil and high clay content of the Barnard soil and the hardpan of the Trosi soil. Suitable base material and an adequate wearing surface are needed. Deep cuts should be avoided because of the underlying hardpan.

The present vegetation in most areas of the Barnard soil is mainly big sagebrush, antelope bitterbrush, and bottlebrush squirreltail. A small amount of juniper is dispersed throughout the area. The production of forage is limited by moderately low precipitation, low available water capacity, and the restricted depth of the root zone over the hardpan. The suitability of this soil for rangeland seeding is poor, mainly because of the moderately low precipitation.

The present vegetation on the Trosi soils in most areas is mainly low sagebrush, antelope bitterbrush, and bottlebrush squirreltail. The production of forage is limited by very low available water capacity and the restricted depth of the root zone over the hardpan. The suitability of this soil for rangeland seeding is very poor because of the very low available water capacity of the surface layer and the restricted depth of the root zone over the hardpan.

Grazing should be delayed until the soil is firm and the more desirable plants have achieved sufficient growth to withstand grazing pressure.

The Barnard soil is in capability subclass VIs, nonirrigated. The Trosi soil is in capability subclass VIIs, nonirrigated.

991—Xeric Torriorthents-Urban land complex. This complex is about 45 percent nearly level, well drained Xeric Torriorthents, 45 percent Urban land, and 10 percent included soils.

The Xeric Torriorthents portion of this unit consists of artificially filled areas of soil, trash, and rock. The soil characteristics are variable, but most of the material is more than 35 percent nonsoil fragments in a loamy matrix. In some areas, however, the matrix is clayey. Many of these areas are planted to lawns or to landscape plants.

The Urban land is covered by streets, parking lots, buildings, and other structures that so obscure or alter the soils that identification is not feasible.

Included in this unit are areas of unidentified soils and miscellaneous dumps. These areas make up about 10 percent of the unit.

This complex is used for residential, commercial, and other urban developments.

Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 11 of 15

Subject LAND USE ASSUMPTIONS

By DRG Date 11-5-92 Checked By Date

- Suburban Residential (SR) (1-3du./ac.) was assumed to be Residential (1/3 acre lot, 30% impervious) per Table 2.2a of TR-55.
- Special Planning Area (SPA) was assumed to be Residential (1/3 acre lot, 30% impervious) per Table 2.2a of TR-55.
- Low Density Residential (LR) (3-7 du./ac.) was assumed to be Residential (1/4 acre lot, 38% impervious) per Table 2.2a of TR-55.
- Medium Density Residential (MR) (7-21 du./ac.) was assumed to be Residential (1/8 acre lot, 65% impervious) per Table 2.2a of TR-55.
- High Density Residential (HR) (21 du./ac.) was assumed to be Residential (1/8 acre lot, 65% impervious) per Table 2.2a of TR-55.
- Park/Open Space (POS) was assumed to be Open space, good condition per Table 2.2a of TR-55.
- Public Facility (PF) was assumed to be Urban commercial and business per Table 2.2a of TR-55.
- Neighborhood Commercial (NC) was assumed to be Urban commercial and business per Table 2.2a of TR-55.
- Employment (E) was assumed to be Urban commercial and business per Table 2.2a of TR-55.
- General Commercial (GC) was assumed to be Urban commercial and business per Table 2.2a of TR-55.
- Tourist Commercial (TC) was assumed to be Urban commercial and business per Table 2.2a of TR-55.
- Downtown (D) was assumed to be Urban commercial and business per Table 2.2a of TR-55.

NOTES: 1. ABOVE LAND USE DESCRIPTIONS HAVE BEEN TAKEN FROM THE CITY OF RENO LAND MASTER PLAN AND RELATED TO CATEGORIES IN TABLE 2.2a, TR55. SEE LAND USE MAP.

RR	Rural Residential (1 -2.5 ac./du.)	GC	General Commercial
SR	Suburban Residential (1 -3 du./ac.)	TC	Tourist Commercial (resorts, outlet mal
LR	Low Density Residential (3 -7 du./ac.)	E	Employment
MR	Medium Density Residential (7 -21 du./ac.)	DW	Distribution and Warehousing
HR	High Density Residential (21 du./ac.)	POS	Park / Open Space
D	Downtown	PF	Public Facility
NC	Neighborhood Commercial	SPA	Special Planning Area
URBAN, SERVE	Regional Plan Designation	▲	Access Issue

~~2~~ OF ~~3~~
12 OF 15

3 OF 3
13 OF 15

Table 2-2a.—Runoff curve numbers for urban areas[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type and hydrologic condition	Average percent impervious area[2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)[4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)[5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

---

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4, based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Greiner

Job No. E0241.12 Project RENO CANNON INTL. AIRPORT Sheet 14 of 15

Subject RUNOFF COEFFICIENT NUMBER CALCULATIONS

By DRG Date 11-3-92 Checked By Nasir Raza Date 11-3-92

1/3 per 30

SPA - Special Planning Area	(Residential ~~1/4~~ acre)	
SR - Suburb. Residential	(Residential 1/3 acre)	30
LR - Low Density Residential	(Residential 1/4 acre)	38
PF - Public Facility	(Urban commercial)	and bus
POS - Park/Open Space	(Open Space - Good)	cond.
MR - Med. Density Residential	(Residential 1/8 acre)	65
HR - High Density Residential	(Residential 1/8 acre)	65
NC - Neighborhood Commercial	(Urban commercial)	and bus.
E - Employment	(Urban commercial)	and bus
GC - General Commercial	(Urban commercial)	and bus.
D - Downtown	(Urban commercial)	and bus.
TC - Tourist Commercial	(Urban commercial)	and bus.

Greiner

Job No. E0241.12 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 15 of 15

Subject RUNOFF COEFFICIENT CALCULATIONS

By DRG Date 11-3-92 Checked By ______ Date ______

DT-1

OF SQUARES IN SOIL MAP #2

C-SPA ⇒	65.3387 AC	2.5	8.5%
D-SPA ⇒	476.7959 AC	19	65.5%
D-LR ⇒	116.5501 AC	4.5	16%
D-SR ⇒	77.7001 AC	3	10%
	736.3848 AC	29	

LAND USE FROM CITY OF RENO MASTER PLAN (1978)

HYDROLOGIC SOIL GROUP FROM SOIL SURVEY FOR WASHOE COUNTY (10/21/92)

R-1.2

B-E ⇒	.5	7%
C-E ⇒	2.5	36%
C-TC ⇒	.5	7%
B-TC ⇒	.5	7%
D-TC ⇒	.5	7%
B-PF ⇒	2	29%
B-HR ⇒	.5	7%
	7	

DT-2

D-SR ⇒	301.0878 AC	12	49%
B-SR ⇒	2.3545 AC	.25 (1/4)	1%
D-POS ⇒	52.0944 AC	2	8%
C-SR ⇒	114.7842 AC	5	20%
D-LR ⇒	1.7659 AC	.10 (1/10)	.5%
D-HR ⇒	1.7659 AC	.125 (1/8)	.5%
C-HR ⇒	65.3387 AC	3	12%
C-MR ⇒	13.5386 AC	.5 (1/2)	2%
D-GC ⇒	32.3750 AC	1.25 (1 1/4)	5%
D-MR ⇒	8.8296 AC	.33 (1/3)	2%
	593.9346 AC	24.555	

SK-1

D-SPA ⇒	14	24%
D-POS ⇒	4	7%
D-LR ⇒	10	17%
D-MR ⇒	2	3%
D-SR ⇒	23	39%
C-LR ⇒	4	7%
B-SR ⇒	1	1.5%
B-LR ⇒	1	1.5%
	59	

R-1.1

✓B-NC ⇒	25	34%
✓B-MR ⇒	8.5	11%
✓B-LR ⇒	15	20%
✓B-HR ⇒	5.5	7%
✓C-E ⇒	1	2%
D-LR ⇒	3	4%
✓D-NC ⇒	6.5	9%
✓B-PF ⇒	1	2%
✓C-MR ⇒	1.5	2%
✓C-NC ⇒	4	5%
✓B-GC ⇒	3	4%
	74	

SK-2

D-SR ⇒	3	22%
B-SR ⇒	1	7%
LAKE ⇒	2	15%
D-HR ⇒	1	7%
D-LR ⇒	4.5	34%
C-NC ⇒	1	7%
D-NC ⇒	.5	4%
C-HR ⇒	.5	4%
	13.5	

NOTE: REFER TO SOILS MAP NO. 2 FOR THESE COMPUTATIONS.

TIME OF CONCENTRATION

SHEET 1 of 8

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project RENO CANNON INTERNATIONAL AIRPORT By DRG Date 11-3-92

Location RENO, NEVADA Checked ____ Date ____

Circle one: Present [✓ Developed]

Circle one: [✓ T_c] T_t through subarea SK-2 DRAINAGE SUBAREA

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

Segment ID		AB				
1. Surface description (table 3-1)		GRASS				
2. Manning's roughness coeff., n (table 3-1)		0.14*				
3. Flow length, L (total L $\leq$ 300 ft)	ft	300				
4. Two-yr 24-hr rainfall, P_2	in	1.6*				
5. Land slope, s $S = \frac{4632-4620}{300'} = \frac{12'}{300'} = .04 ft/ft$	ft/ft	.04				
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	.40	+		=	.40

Shallow concentrated flow

Segment ID		BC		CD		
7. Surface description (paved or unpaved)		Unpaved		Paved		
8. Flow length, L	ft	2300		1200		
9. Watercourse slope, s $S_{BC} = \frac{4620-4532}{2300'} = \frac{88'}{2300'}$	ft/ft	0.038		0.043		$S_{CD} = \frac{4532-4480}{1200'} = \frac{52'}{1200'}$
10. Average velocity, V (figure 3-1)	ft/s	3.1		4.1		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.21	+	0.08	=	0.29

Channel flow

Segment ID						
12. Cross sectional flow area, a	ft^2					
13. Wetted perimeter, P_w	ft					
14. Hydraulic radius, $r = \frac{a}{P_w}$ Compute r	ft					
15. Channel slope, s	ft/ft					
16. Manning's roughness coeff., n						
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s					
18. Flow length, L	ft					
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		+		=	

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr .69

* see attached

** T_t through the lake is assumed to be 0.0 hr. as per page 3-4 of TR-55 manual.

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project RENO CANNON INTERNATIONAL AIRPORT By DRG Date 11-3-92

Location RENO, NEVADA Checked ____ Date ____

Circle one: Present [✓ Developed]

Circle one: [✓ T_c] T_t through subarea R-1.1 (SHT. 1 OF 3)

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only) Segment ID		AB		
1. Surface description (table 3-1)		Grass		
2. Manning's roughness coeff., n (table 3-1) ..		0.06*		
3. Flow length, L (total L ≤ 300 ft)	ft	300		
4. Two-yr 24-hr rainfall, P_2	in	1.6*		
5. Land slope, s $s = \frac{4621-4609}{300'} = \frac{12'}{300'}$	ft/ft	0.04		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	.20	+	= .20
Shallow concentrated flow Segment ID		BC	CD	
7. Surface description (paved or unpaved)		Paved	Paved	
8. Flow length, L	ft	3900	1800	
9. Watercourse slope, s $S_{BC} = \frac{4609-4500}{3900'} = \frac{109'}{3900'}$	ft/ft	0.028	0.011	$S_{CD} = \frac{4500-4480}{1800'} = \frac{20'}{1800'}$
10. Average velocity, V (figure 3-1)	ft/s	3.4	2.1	
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	.32	+ .24	= .56
Channel flow Segment ID				
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s			
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		+	=
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr			**

* see attached

** see sheet 3 of 3

SHEET 3 OF 8

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project RENO CANNON INTERNATIONAL AIRPORT By DRG Date 11-3-92

Location RENO, NEVADA Checked ______ Date ______

Circle one: Present [✓ Developed] ____________

Circle one: [✓ T_c] T_t through subarea R-1.1 (SHT. 2 OF 3)

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

Segment ID						
1. Surface description (table 3-1)						
2. Manning's roughness coeff., n (table 3-1) ..						
3. Flow length, L (total L $\leq$ 300 ft)	ft					
4. Two-yr 24-hr rainfall, P_2	in					
5. Land slope, s	ft/ft					
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{\ 0.5}\ s^{0.4}}$ Compute T_t	hr		+		=	

Shallow concentrated flow

Segment ID		DE		EF		
7. Surface description (paved or unpaved)		Paved		Paved		
8. Flow length, L	ft	700		1600		
9. Watercourse slope, s $S_{DE} = \frac{4480-4460}{700'} = \frac{20'}{700'}$	ft/ft	0.029		0.003		$S_{EF} = \frac{4460-4455}{1600'} = \frac{5'}{1600'}$
10. Average velocity, V (figure 3-1)	ft/s	3.5		1.1		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.06	+	.40	=	.46

Channel flow

Segment ID						
12. Cross sectional flow area, a	ft^2					
13. Wetted perimeter, p_w	ft					
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft					
15. Channel slope, s	ft/ft					
16. Manning's roughness coeff., n						
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s					
18. Flow length, L	ft					
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		+		=	
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr					**

** see sheet 3 of 3

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project RENO CANNON INTERNATIONAL AIRPORT By DRG Date 11-3-92

Location RENO, NEVADA Checked ____ Date ____

Circle one: Present [✓ Developed]

Circle one: [✓ T_c] T_t through subarea R-1.1 (SHT. 3 OF 3)

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

Segment ID				
1. Surface description (table 3-1)				
2. Manning's roughness coeff., n (table 3-1) ..				
3. Flow length, L (total L $\le$ 300 ft)	ft			
4. Two-yr 24-hr rainfall, P_2	in			
5. Land slope, s	ft/ft			
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{\ 0.5}\ s^{0.4}}$ Compute T_t	hr		+	=

Shallow concentrated flow

Segment ID		FG	GH	
7. Surface description (paved or unpaved)		Paved	Paved	
8. Flow length, L	ft	5200	1600	
9. Watercourse slope, s $S_{FG} = \frac{4455-4420}{5200'} = \frac{35'}{5200'}$	ft/ft	.007	.002	$S_{GH} = \frac{4420-4417}{1600'} = \frac{3'}{1600'}$
10. Average velocity, V (figure 3-1)	ft/s	1.7	.9	
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	.85	+ .49	= 1.34

Channel flow

Segment ID				
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s			
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 2.56

SHEET 5 OF 8

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project RENO CANNON INTERNATIONAL AIRPORT By DRG Date 11-4-92

Location RENO, NEVADA Checked ______ Date ______

Circle one: Present [✓ Developed]

Circle one: [✓ T_c] T_t through subarea R-1.2 (SHT. 1 OF 2)

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only) Segment ID		AB				
1. Surface description (table 3-1)		Grass				
2. Manning's roughness coeff., n (table 3-1) ..		0.06*				
3. Flow length, L (total L $\leq$ 300 ft)	ft	300				
4. Two-yr 24-hr rainfall, P_2	in	1.6*				
5. Land slope, s .... $s = \frac{4433' - 4428'}{300'} = \frac{5'}{300'}$	ft/ft	0.017				
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{\ 0.5}\ s^{0.4}}$ Compute T_t	hr	.29	+		=	.29

Shallow concentrated flow Segment ID		BC		CD		
7. Surface description (paved or unpaved)		Paved		Paved		
8. Flow length, L	ft	1000		900		
9. Watercourse slope, s .... $S_{BC} = \frac{4428 - 4422}{1000'} = \frac{6'}{1000'}$	ft/ft	.006		.007		$S_{CD} = \frac{4422 - 4416}{900'} = \frac{6'}{900'}$
10. Average velocity, V (figure 3-1)	ft/s	1.6		1.7		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	.17	+	.15	=	.32

Channel flow Segment ID						
12. Cross sectional flow area, a	ft^2					
13. Wetted perimeter, p_w	ft					
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft					
15. Channel slope, s	ft/ft					
16. Manning's roughness coeff., n						
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s					
18. Flow length, L	ft					
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		+		=	
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr					**

* see attached
** see sheet 2 of 2

SHEET 6 OF 8

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project RENO CANNON INTERNATIONAL AIRPORT By DRG Date 11-4-92

Location RENO, NEVADA Checked ____ Date ____

Circle one: Present [✓ Developed]

Circle one: [✓ T_c] T_t through subarea R-1.2 (SHT 2 OF 2)

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)				
Segment ID				
1. Surface description (table 3-1)				
2. Manning's roughness coeff., n (table 3-1) ..				
3. Flow length, L (total L ≤ 300 ft)	ft			
4. Two-yr 24-hr rainfall, P_2	in			
5. Land slope, s	ft/ft			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr		+	=

Shallow concentrated flow				
Segment ID				
7. Surface description (paved or unpaved)				
8. Flow length, L	ft			
9. Watercourse slope, s	ft/ft			
10. Average velocity, V (figure 3-1)	ft/s			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr		+	=

~~Channel~~ Pipe flow (full flow assumed)				
Segment ID				
12. Cross sectional flow area, a $A = \pi r^2 = \pi(1.5)^2$	ft^2	7.07		
13. Wetted perimeter, p_w $P = \pi d = \pi(3)$	ft	9.42		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft	.75		
** 15. Channel slope, s $s = \frac{4401.57 - 4398.74}{2430'} = \frac{2.83'}{2430'}$	ft/ft	.0012		
16. Manning's roughness coeff., n		.013***		
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft/s	3.28		
18. Flow length, L	ft	4200		
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr	.36	+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 0.97

** assumed same slope as that of 36" RCP running adjacent to Terminal Way as found on Utility Maps by Murray-McCormick dated 1974.

*** assumed for RCP.

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project E024112 - RENO CANNON INTERNATIONAL AIRPORT By DRG Date 11-16-92

Location RENO, NEVADA Checked ____ Date ______

Circle one: Present [✓ Developed] ______

Circle one: [✓ T_c] T_t through subarea ROCK BLVD. DRAINAGE AREAS R-1.3

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

Segment ID		AB		
1. Surface description (table 3-1)		Grass		
2. Manning's roughness coeff., n (table 3-1) ..		0.14*		
3. Flow length, L (total L ≤ 300 ft)	ft	300'		
4. Two-yr 24-hr rainfall, P_2	in	1.6*		
5. Land slope, s .... $S = \frac{2'}{300'} = .007$ (AVERAGE SLOPE)	ft/ft	.007		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	.80	+	= .80

Shallow concentrated flow

Segment ID		BC		
7. Surface description (paved or unpaved)		Unpaved		
8. Flow length, L	ft	2600		
9. Watercourse slope, s $\frac{10'}{2600'} = .0038$	ft/ft	.004		
10. Average velocity, V (figure 3-1)	ft/s	1.02		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	.71	+	= .71

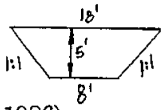
Channel flow

Segment ID		CD	DE	
12. Cross sectional flow area, a	ft^2	65**	168.75***	
13. Wetted perimeter, p_w	ft	22.14**	36.21***	
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft	2.94	4.66	
15. Channel slope, s $\frac{10'}{2600'} = .0038$	ft/ft	.004	.003****	
16. Manning's roughness coeff., n		.03	.03	
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s	6.45	7.59	
18. Flow length, L	ft	3200'	500'	
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	.14 +	.02	= .16

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) .... hr 1.67

* see attached

** Assumed 8' bottom width, 5' depth and 1:1 side slopes.



$A = 5[(8+18)/2] = 65\ FT^2$

*** per sht. 8 of Rock Blvd. Ext. plans (210-VI-TR-55, Second Ed., June 1986)

**** assumed from extrapolation of slope determined in existing channel to west of Rock Blvd.

Greiner

Job No. E0241.12 Project RENO CANNON INTL AIRPORT Sheet 7 of 8

Subject TIME OF CONCENTRATION CALC

By DRG Date 11-3-92 Checked By Date

ASSUMPTIONS:

*use $n=.06$ for grass areas per Nasir Raza 11-3-92

revised to use $n=.14$ for grass area SK-2 per Nasir Raza 11-4-92

P_2 values are per Nimbus Engineers' study values. See highlighted attachment.

Segment ID's per applicable exhibit. Elevation drop between pt. G & pt. H for subarea R1.1 is 3' per Nasir Raza 11-3-92.

Subarea SK-2

$$T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$$ where $n = 0.14$*(see above), $L = 300'$, $P_2 = 1.6$ in, $s = 0.04$ ft/ft

$$T_t = \frac{0.007\,((0.14)(300))^{0.8}}{(1.6)^{0.5}\,(0.04)^{0.4}} = \frac{0.007\,(42.0)^{0.8}}{(1.2649)(.2759)} = \frac{0.007\,(19.8884)}{.3490} = \underline{\underline{.3989\text{ hr.}}}$$

Subarea R-1.1

$$T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$$ where $n = 0.06$*(see above), $L = 300'$, $P_2 = 1.6$ in., $s = 0.04$ ft/ft

$$T_t = \frac{0.007\,((0.06)(300))^{0.8}}{(1.6)^{0.5}\,(0.04)^{0.4}} = \frac{0.007\,(18.0)^{0.8}}{(1.2649)(.2759)} = \frac{0.007\,(10.0976)}{.3490} = \underline{.2025\text{ hr}}$$

Subarea R-1.2

$$T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,S^{0.4}}$$ where $n = 0.06$*(see above), $L = 300'$, $P_2 = 1.6$ in, $s = 0.017$ ft/ft

$$T_t = \frac{0.007\,((0.06)(300))^{0.8}}{(1.6)^{0.5}\,(0.017)^{0.4}} = \frac{0.007\,(18.0)^{0.8}}{(1.2649)(.1960)} = \frac{0.007\,(10.0976)}{.2479} = \underline{.2851\text{ hr.}}$$

JOB 8901

SHEET NO. ______ OF ______

CALCULATED BY JSS DATE 11/9/90

CHECKED BY ______ DATE ______

SCALE ______

R1

SHEET 8 OF 8

Sheet Flow

$$t_t = \frac{(.007)[(n)(L)]^{.8}}{[P_{2(24hr)}]^{.5}(S)^{.4}}$$

$t_t = .43$

$n = .14$

$L = 300$

$P_{2yr\,24hr} = 1.6''$

$S = .035$

Shallow Concentrated Flow

Subreach 1

$L = 3{,}000'$ $\Delta H = 30$ $S = .027$ $V = 3.3$ $t_t = .25hrs$

Subreach 2 (Same as routing reach for Skyline Wash to Longley Lane) $t_t = 1.6hrs$

Subreach 3 '' $t_t = 1.9hrs$

$t_t = 3.93$

$t_p = .6(3.93) = 2.4$

P$_{2YR24HR}$ VALUE USED IN GREINER CALCS. OF T$_C$.

BACKUP DATA FOR OFFSITE DRAINAGE AREAS PROVIDED BY NIMBUS ENGINEERS

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FAX TRANSMITTAL SHEET

DATE: 11/5/92

TO: NASIR RAZA

COMPANY: GREINER

FAX NUMBER: 602-943-1891

FROM: P. FROST

JOB NUMBER: 9219

COMMENTS: NASIR, HERE IS A MAP SHOWING THE Tc + ROUTING PATHS USED IN OUR REPORT. Paul

THERE ARE A TOTAL OF 2 PAGES, INCLUDING THIS COVER PAGE. IF ALL PAGES ARE NOT RECEIVED PROPERLY, PLEASE NOTIFY US IMMEDIATELY.

OUR FAX NUMBER IS (702) 689-8614

— WATERSHED BNDRY
- - - Tc FLOW PATH
→ → ROUTING

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JOB ~~8912~~ 8901
SHEET NO. 1 OF
CALCULATED BY JSS DATE 11/4/97
CHECKED BY DATE
SCALE

Travel Times and Lag Times
(Using methodology in TR-55)

Watershed: R2 DA = 4.1
CN = 85 C+D soils in highly urbanized Areas
Subbasin:

1. Sheet Flow

t_t = .20 hrs

$$t_t = \frac{(.007)[(n)(L)]^{.8}}{[P_{2(24hr)}]^{.5}[S]^{.4}}$$

n = .13
L = 300
$P_{2yr, 24hr}$ = 1.6
S = ~~30~~ .1

2. ~~Shallow Concentrated Flow Using Charts in TR-55~~

Subreach 1
L = 2500 ΔH = 200 S = .07 V = 5.5' t_t = .14
~~small [illegible]~~ → small upland gulley

Subreach 2
Through Golf Course used grass waterway from Upland Chart.

L = 6400' ΔH = 340 S = .053 V = 3.5 t_t = .5

Subreach 3 Pave TR-55

L = 15,100 ΔH = 140 S = .0093 V = 2 ft/sec t_t = 2.1

t_t = 3.0 hrs
t_p = (.6) 3.0 = 1.8 hr

JOB

SHEET NO. OF

CALCULATED BY DATE

CHECKED BY DATE

SCALE

Travel Times and Lag Times (Continued)

Watershed: DT2

Subbasin:

3. Channel Flow

n = manning's n value
S = slope
L = Length
BW = Bottom Width
V = Velocities
d = depth

Subreach 1 S=.027 BW=5 d=2.5 t_t=.29
L=7000 n=.045 V=7 ft/sec

t_c= .52

t_p= .33

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JOB 8901

SHEET NO. 1 OF

CALCULATED BY DATE

CHECKED BY DATE

SCALE

Travel Times and Lag Times
(Using methodology in TR-55)

Watershed: DA = .94 CN = 85 (from KJC report)

Subbasin: DT2

1. Sheet Flow $t_t = .33$

$$t_t = \frac{[.007][(n)(L)]^{.8}}{[P_{2(24hr)}]^{.5}[S]^{.4}}$$

n = .14 (between range, short grass, and smooth surfaces)
L = 300'
$P_{(2yr,24hr)}$ = 1.6"
S = .066

2. Shallow Concentrated Flow Using Charts in TR-55

Reach 1 L = 2600' S = .062 V = 5 ft/sec t_t = .15
ΔH = 160

```
****************************** MUSKINGUM ANALYSIS ******************************


LAKE TO LONGLEY LANE

  LENGTH      HEIGHT     SLOPE     VEL  TRAVEL TIME  WAVE TIME   Vw/V
16300.0000   80.0000    0.4908    1.4000   3.2341     3.2341    1.0000
                                           ------
                                          3.234127


Lc =  16300
TOTAL HEIGHT =  80
AVERAGE SLOPE (%) =  .4907976

MUSKINGUM K = 3.234127
MUSKINGUM X = .15
NMIN (HEC-1 VARIABLE) = 5

NUMBER OF STEPS MUST BE BETWEEN  65.9762 AND  11.64286
```

JOB

SHEET NO. OF

CALCULATED BY DATE

CHECKED BY DATE

SCALE

Routings

Flow Dam to Virginia Lake (DT1 to Lake)

use 5 ft/sec some channel and ~~some~~ overland (as on average

	K	X
2600	.30	.3

DT 2

DA .94 uD = .33 CN 85 (from KJC Calculations)

(Virginia Lake to Longley Lane PTM)

RT Dent Dam Drain from Lake to Longley (overland flow) through Virginia Lake

L = 16,300 ΔH = 30 S = .005

using chart in TR-20 V = 1.4 ft/sec

Travel Time = 2.3 hrs (use 1.3 ft/sec) 2.2 hr

Steps	K	X
35	3.2	.10

R2

DA 4.1 CN 92 uD 2.31

(Route flow from ~~[illegible]~~ SS Ditch Confluence to Longley Lane PTM)

Route from SS ditch Confluence to Longley lane

ave vel 3 ft/sec

L = 3200 K = .1 X = .4

↑

Boynton Slough

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JOB 8901

SHEET NO. ______ OF ______

CALCULATED BY JSS DATE 11/12/90

CHECKED BY ______ DATE ______

SCALE ______

DT1

Combined D.A. from KJC report for the dam to one basin. Determined a new lagtime from lagtime on the basin with the longest lagtime and the routing. Used the same CN as used in KJC report. Stage-Storage-discharge curve same as in KJC report

DA 1.21 LS 85 Lagtime(4D) .42

t_+ 0.70

L = 16,000 (FROM 7.5' QUAD)

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JOB 8901
SHEET NO. OF
CALCULATED BY JSS DATE 11/9/90
CHECKED BY DATE
SCALE

R1

Sheet Flow

$$t_t = \frac{(.007)[(n)(L)]^{.5}}{[P_{2(24hr)}]^{.5}(S)^{.4}}$$

$t_t = .43$

$n = .14$
$L = 300$
$P_{2yr,24hr} = 1.6''$
$S = .033$

Shallow Concentrated Flow

Subreach 1
$L = 3{,}000'$ $\Delta H = 30$ $S = .027$ $V = 3.3$ $t_t = .25$hrs

Subreach 2 (Same as routing reach for Skyline Wash to Langley Lane) $t_t = 1.6$hrs

Subreach 3 " $t_t = 1.9$hrs

$t_t = 3.93$

$t_p = .6(3.93) = 2.4$

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JOB 3901

SHEET NO. ______ OF ______

CALCULATED BY JSS DATE 11/7/96

CHECKED BY ______ DATE ______

SCALE ______

For R1

DA = 5.5 Estimated % from Soil Survey Maps

Curve Type

A

.10 69

B 50% .B suburban/75 .20 92 commercial 76

residential industrial open space fair

C 30% .33 90 .33 91 .34 79 87

D 20% .70 87 .30 93 89

82

```
****************************** MUSKINGUM ANALYSIS ******************************

SKYLINE WASH(PLUMB TO LONGLEY LANE)

  LENGTH      HEIGHT      SLOPE      VEL  TRAVEL TIME  WAVE TIME   Vw/V
11600.0000  100.0000    0.8621    2.0000    1.6111    1.6111    1.0000
 8800.0000   30.0000    0.3409    1.4000    1.7460    1.7460    1.0000
                                            ------
                                           3.357143

Lc =  20400
TOTAL HEIGHT =  130
AVERAGE SLOPE (%) =  .6372549

MUSKINGUM K = 3.357143
MUSKINGUM X = .15
NMIN (HEC-1 VARIABLE) = 5

NUMBER OF STEPS MUST BE BETWEEN  68.48572 AND  12.08572
```

```
                TRAPEZOIDAL CHANNEL ANALYSIS
                  RATING CURVE COMPUTATION

                     November  7, 1990
                      DRAINAGE AREA SK1
                         SUBREACH 2
             FLOW AT THIS REACH BETWEEN 500 AND 80

==================================================================

PROGRAM INPUT DATA:
DESCRIPTION                                                  VALUE
------------------------------------------------------------------

Channel Bottom Slope (feet per foot)....................    0.0250
Manning's Roughness Coefficient (n-value)...............    0.0450
Channel Side Slope - Left Side (horizontal/vertical)....    2.00
Channel Side Slope - Right Side (horizontal/vertical)...    2.00
Channel Bottom Width (feet)............................    15.0

==================================================================

PROGRAM RESULTS:
Depth Flow Rate Velocity Froude Velocity  Energy Flow Area Top Width
 (ft)    (cfs)    (fps) Number Head(ft) Head(ft)  (sq ft)      (ft)
------------------------------------------------------------------

  1.0     81.1     4.77  0.889    0.353    1.353     17.0      19.0
  2.0    269.9     7.10  0.974    0.784    2.784     38.0      23.0
  3.0    559.3     8.88  1.024    1.224    4.224     63.0      27.0
  3.5    742.9     9.65  1.043    1.446    4.946     77.0      29.0

==================================================================
TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.3  (c) 1986
Dodson &  Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092
(713) 895-8322. A manual with equations & flow chart is available.
```

```
                 TRAPEZOIDAL CHANNEL ANALYSIS
                   RATING CURVE COMPUTATION

                       November  7. 1990
                        DRAINAGE AREA ~~2~~ JK
               SUBREACH 1 (APPROX CHANNEL DIMENSIONS)
             FLOW IN THIS REACH BETWEEN 200 AND 400 CFS

=====================================================================

PROGRAM INPUT DATA:
DESCRIPTION                                                     VALUE
---------------------------------------------------------------------
Channel Bottom Slope (feet per foot)....................      0.0720
Manning's Roughness Coefficient (n-value)...............      0.0450
Channel Side Slope - Left Side (horizontal/vertical)....       2.00
Channel Side Slope - Right Side (horizontal/vertical)...       2.00
Channel Bottom Width (feet).............................      10.0

=====================================================================

PROGRAM RESULTS:
Depth Flow Rate Velocity Froude Velocity  Energy Flow Area Top Width
 (ft)    (cfs)    (fps) Number Head(ft) Head(ft)  (sq ft)      (ft)
---------------------------------------------------------------------
  1.0     93.8     7.82  1.489   0.950    1.950     12.0       14.0
  2.0    321.9    11.50  1.625   2.053    4.053     28.0       18.0
  2.5    486.3    12.97  1.669   2.611    5.111     37.5       20.0
  3.0    686.3    14.30  1.706   3.175    6.175     48.0       22.0

=====================================================================
TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.3  (c) 1986
Dodson &  Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092
(713) 895-8322. A manual with equations & flow chart is available.
```

JOB

SHEET NO. OF

CALCULATED BY DATE

CHECKED BY DATE

SCALE

Travel Times and Lag Times (Continued)

Watershed: SK1 CN 53

Subbasin ;

n = manning's n value
S = slope
L = Length
BW = Bottom width
V = Velocities
d = depth

3. Channel Flow

Approximate chart S

Subreach 1 S=.032 BW=10 d=3 t_t=.2
L=7400 n=.035 V=10 ft/sec

Subreach 2 S=.025 BW=15 d=3 t_t=.33
L=10,300 n=.045 V=9 ft/sec

t_t=.8hrs
t_p=.48

Routing Reach to Longley Lane
Overland flow

Reach 1
L=11,600 ΔH=100 S=.007 V=2 ft/sec 1.6hrs

Routing Reach to Longley Lane

L=3,500 ΔH=30 S=.0034 V=1.4 t_t=1.7hrs

Travel time 3.2hrs

35 3.4 .10

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JOB ~~[illegible]~~ 8901

SHEET NO. 1 OF

CALCULATED BY USS DATE 11/9/90

CHECKED BY DATE

SCALE

Travel Times and Lag Times
(Using methodolgy in TR-55)

Watershed:

Subbasin: SK1 D.A. 22 CN 85 (assume same as DT1 similar type watershed)

1. Sheet Flow

$t_t = .22$

$$t_t = \frac{(.007)[(n)(L)]^{.8}}{[P_{2(24hr)}]^{.5}[S]^{.4}}$$

$n = .15$ range
$L = 300$
$P_{2yr,24hr} = 1.6$
$S = 60/300 = .20$

2. Shallow Concentrated Flow Using Charts in TR-55

Reach 1 $L = 600$ $\Delta H = 160$ $S = .27$ $V = 3.3$ ft/s $t_t = .05$

Greiner

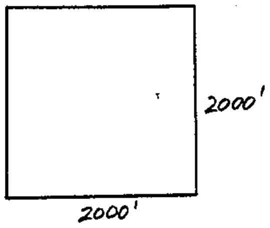
Job No. E024112 Project RENO CANNON INTERNATIONAL AIRPORT Sheet 27 of

Subject AREA CALCULATIONS FOR DRAINAGE SUB-AREAS MR-1 ₮ SK-2

By DRG Date 11-4-92 Checked By Date

SCALE FACTOR:

1" = 2000'



$.5967x = 4000000$ SF

$1x = 6703536.115$ SF

$x = 153.8920$ AC

SK-2

Planimeter reading ⇒ 2.13

$A_{SK-2} = (2.13)(153.8920 \text{ AC})$

$= 327.79$ AC

$= 0.51$ SQ. MI.

R-1.1

Planimeter reading ⇒ 11.60

$A_{R-1.1} = (11.60)(153.8920 \text{ AC})$

$= 1785.15$ AC

$= 2.79$ SQ. MI.

R-1.2

Planimeter reading ⇒ 1.10

$A_{R-1.2} = (1.10)(153.8920 \text{ AC})$ + REVISED AREAS TO THE EAST OF TERMINAL WAY

$= 168.7682$ AC + 37.66 AC + 5.59 AC

$= 212.0182$ AC

$= .3313$ SQ. MI.