DYSART DRAIN DETENTION BASIN

PROPOSED BASIN MODIFICATIONS

Prepared
for

Luke Air Force Base
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1.0 BACKGROUND

The Flood Control District of Maricopa County (FCDMC) completed the White Tanks Area Drainage Master Study (White Tanks ADMS) in October 1992. The White Tanks ADMS consisted of a hydrologic study and floodplain delineation within a drainage area of approximately 220 square miles (see figure 1). A HEC-1 computer model of the area was developed to compute flow hydrographs at concentration points throughout the area. The model estimates the runoff hydrographs for a 100-year frequency precipitation with a 24 hour duration. The White Tanks ADMS identified the need to develop flood protection features within the area. The drainage improvement for one of the areas is identified as the "Dysart Drain Improvement Project". The Dysart Drain Improvement Project construction of drainage channels and a detention basin. Planning studies and designs completed by the FCDMC resulted in the requirement of a detention basin with a capacity of approximately 500 acre feet to be located at the northeast corner of the intersection of Northern Avenue and Reems Road.

The White Tanks ADMS HEC-1 model was modified for the Dysart Drain Improvement Project to model the inclusion of the proposed drainage features and to refine the drainage subareas, showing greater detail in the vicinity of the proposed detention basin. Designs for the detention basin have been completed and a construction contract awarded.

Funding is anticipated to modify the detention basin into a multi-use facility by incorporating a golf course into the detention basin. Funding sources for the detention basin were authorized specifically for flood control facilities and cannot be used for a golf course. To assure proper use of the funding, the detention basin will be completed and subsequently a construction contract will be issued for the golf course. However, modification of the design of the detention basin could result in significant savings to the golf course construction costs by reducing the duplication of earthwork excavation.

This project was initiated to evaluate the potential savings to the golf course construction contract by altering the detention basin geometry to more closely approximate the ultimate geometry of the golf course. This study established design criteria to assure that the modified basin geometry maintains the hydraulic integrity of the original basin design, and documents the effect of the golf course modifications.

2.0 AS-DESIGNED HYDRAULIC MODEL SUMMARY

The final HEC-1 model simulating the hydraulic performance of the detention basin as currently designed was provided by the FCDMC, on 26 January 1995. The following data was obtained from the HEC-1 files (DD0421.dat and DD0421.out); the "Dysart Drain Improvement Project, 160 Acre Detention Basin, Contract FCD 93-01, 30 percent submittal", dated 11 February 1994, and the construction plans for the project FCD 94-36, LAFB No. 87-3002.

The detention basin has inlets at the northeast (East Collection Channel), northwest (North Collection Channel), and southwest (Reems Road Collection Channel) corners of the basin and an outlet at the southeast corner of the basin. The outlet structure from the basin is a one barrel 6ft x 6ft concrete box culvert with an inlet invert elevation of 1089.89. The basin is an excavated basin about 10 feet deep and intercepts runoff from a 36.84 square mile drainage area.

The as-designed outflow and storage volume for various water elevations in the basin are given in Table 1. Modifications to the basin will need to maintain a storage volume equal to or greater than the values shown in Table 1 at each corresponding elevation.

Table 1
Dysart Drain Detention Basin
As-Designed Conditions

Elevation	Outflow (CFS)	Storage (acre-feet)
1089.89	0	0
1092.50	67	0
1093.50	110	10.4
1094.50	160	42.8
1095.50	211	99.0
1097.00	300	202.1
1102.00	555	561.6

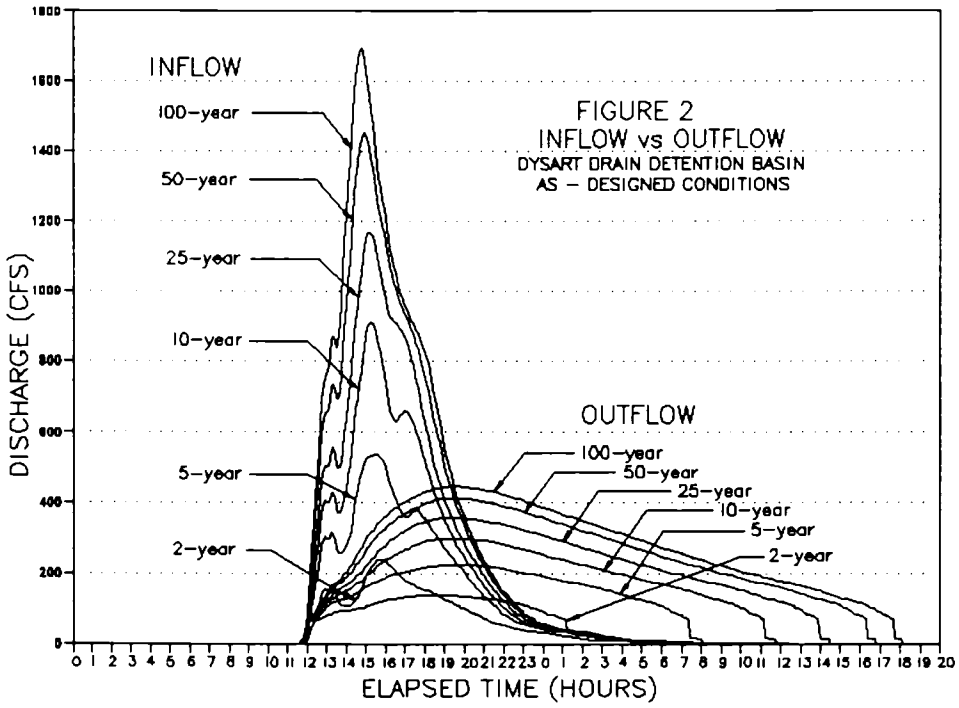
The 100-year 24-hour precipitation is used in the HEC-1 input file DD0421.DAT with the basin data presented in Table 1 to route the 100-year 24-hour flood inflow through the detention basin. The resulting peak inflow is 1,694 cfs. Water ponds in the basin reaching a maximum elevation of 1,099.9 with a corresponding maximum storage volume of 407.9 ac-ft and a peak outflow of 446 cfs.

To estimate the hydraulic performance of the as-designed basin with precipitation events of recurrence intervals 2, 5, 10, 25, and 50 years, the 100-year model was modified by inserting the precipitation depth for each recurrence interval in the model DD0421.DAT. The time of concentration for each subbasin computed for the 100-year 24-hour event were used for all recurrence intervals. Table 2 shows the peak conditions for the basin resulting from the storms with varying recurrence intervals.

Table 2
Dysart Drain Detention Basin
As-Designed Conditions

Recurrence Interval	Peak Inflow (CFS)	Peak Water Elevation	Peak Storage (AC-FT)	Peak Outflow (CFS)
2-Year	239	1094.1	28.5	138
5-Year	539	1095.7	114.0	224
10-Year	912	1097.0	202.1	300
25-year	1,168	1098.1	279.6	355
50-year	1,454	1099.2	358.6	411
100-year	1,694	1099.9	407.9	446

The detention basin inflow and outflow hydrographs are shown in Figure 2 for recurrence intervals of 2-year through 100-year. As shown in Figure 2, water will pond in the basin for approximately 19 hours during a 2-year storm and approximately 30 hours during a 100-year storm.



3.0 GOLF COURSE DESIGN CRITERIA

3.1 General Criteria

1. The inter-governmental agreement for construction of the detention basin does not allow for use of the funds for the golf course. Therefore, redesign of the detention basin geometry, to obtain subsequent savings to the golf course, must not result in increased costs to construct the detention basin.

2. The modifications to the basin must result in a fully functioning basin which provides the same level of flood protection as the original design.

3. Modifications which may result in slightly increased maintenance costs to Luke AFB, if the golf course is not completed, was acceptable.

4. The basin inlet and outlet structures are not to be modified to assure hydraulic performance, and the perimeter low flow channel was not to be modified.

5. Half of the cost savings (Luke AFB portion) which result from redesign or elimination of basin features (e.g. elimination of ABC for maintenance roads and lining of low flow channels) can be used to offset construction cost increases for modification of the earthwork geometry.

3.2 Hydraulic Design Criteria

The as-designed hydraulic criteria was established from the HEC-1 model supplied by the Flood Control District of Maricopa County (file DD0421.DAT). This HEC-1 model simulates the 100-year 24-hour storm runoff routed through the detention basin as designed. The following criteria will be followed in completing modifications to the basin for the golf course.

1. The basin storage volume is to be equal to or greater than 408 acre feet at an elevation of 1099.9 and a volume equal to or greater than 555 acre feet at elevation 1102.0. The basin is to drain such that a volume of at least 408 acre feet is evacuated within 36 hours.

2. The basin outlet is to maintain a maximum outflow of 446 cubic feet per second with the water elevation in the basin at elevation 1099.9 and a maximum outflow of 550 cubic feet per second with the water elevation in the basin at elevation 1101.9.

3. Basin inlet locations and hydraulic characteristics are not to be modified.

4. Storage below the invert elevation of the uncontrolled outlet (elevation 1089.89) can be included in the available storage volume of 408 acre feet (see item 1) if pumping facilities capable of evacuating the water within 36 hours are incorporated into the design.

4.0 MODIFIED DETENTION BASIN HYDRAULIC SUMMARY

The limits of excavation and fill have been modified consistent with the criteria listed above. The modified basin is shown in the planimetric drawing inserted at the end of this report. The drawing shows the topographic contours of the basin and appurtenant project features. These modifications have been completed in coordination with representatives from the FCDMC and the construction contractor. It is intended that any increased costs to complete the proposed modifications can be offset with modifications eliminating construction items currently required under the existing contract. The low flow channel which conveys "nuisance flows" from the Reems Road Collection Channel to the basin outlet structure has been modified by eliminating the shotcrete channel lining. The basin interior maintenance roads have been modified by eliminating the ABC roadway surfacing.

The basin inlet and outlet structures will not be modified and the modifications to the basin geometry have been made to maintain the structures' hydraulic characteristics. The low flow channel, which conveys "nuisance flows" from the North and East Collection Channels to the basin outlet structure, will not be modified. This channel has a shotcrete lining and has a capacity of about 120 to 125 cfs. Both the North and East Collection Channels discharge into this low flow channel. The 100-year peak discharge from the North Collection Channel is about 996 cfs and the 100-year peak discharge from the East Collection Channel is about 682 cfs. Flows exceeding the capacity of the low flow channel will flow across the bottom of the basin to the outlet structure. The basin is designed with the basin floor sloping toward the outlet with a slope of approximately 0.00318 ft/ft and a minimum bottom width of about 165 feet. Flows of 200 to 400 cfs flow with a velocity ranging from 2.4 to 3.1 feet per second which are not considered to be erosive and a velocity of about 4.5 feet per second at a flow of 1,000 cfs which is considered to be erosive. These velocities are similar to the velocities which would occur with the current design.

The low flow channel which conveys nuisance flows from the Reems Road Collection Channel to the basin outlet structure will not be lined. The channel has a slope of about 0.0008 feet per foot, a bottom width of 10 foot, side slopes of 4 to 1, a depth of 2 feet, and a bank full capacity of about 85 cfs. The velocity in the channel is about 2.35 feet per second which is not considered erosive. Flows exceeding the channel capacity flow across the basin floor which has a maximum slope of about 0.00216 feet per foot. The modified geometry results in a maximum velocity of 2.07 feet per second which is not considered erosive.

The modified basin geometry was established to maintain the same elevation vs volume characteristics as the original design. The modified volumes are compared to the original volumes in Table 3.

Table 3
Modified Dysart Drain Detention Basin

Elevation	Outflow (CFS)	Original Design Storage (acre-feet)	Modified Storage (acre-feet)
1089.89	0	0	0
1092.50	67	0	13.5
1093.50	110	10.4	41.4
1094.50	160	42.8	83.5
1095.50	211	99.0	133.6
1097.00	300	202.1	216.3
1102.00	555	561.6	563.7

The modified elevation vs volume data was inserted into the HEC-1 model to verify the hydraulic performance of the modified basin. The resulting maximum water surface elevation in the basin was 1099.9 with a peak outflow of 447 cfs compared to elevation 1099.9 and 446 cfs respectively for the original basin design.

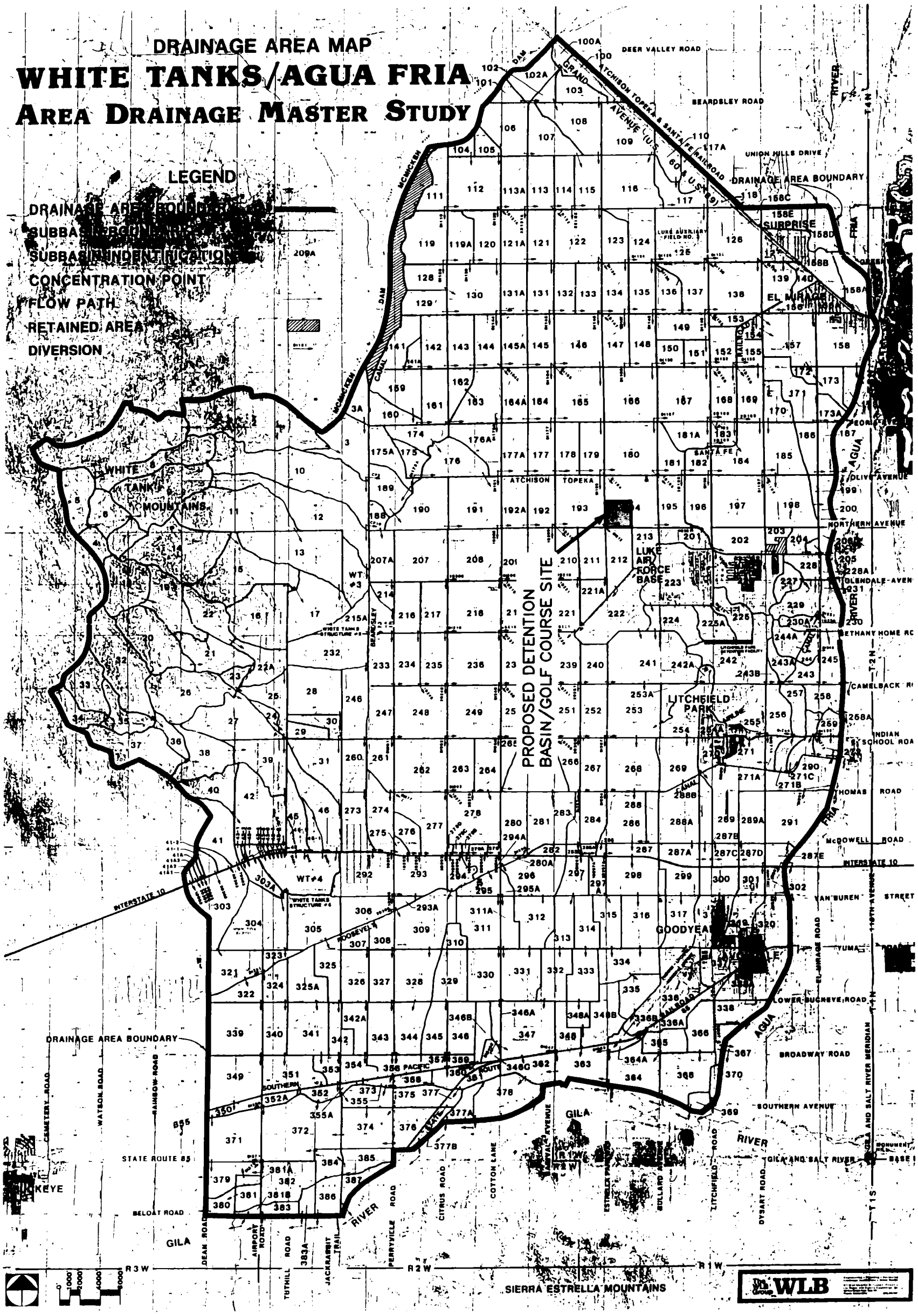


FIGURE I
HEC-I DRAINAGE SUBBASINS
DYSART DRAIN DETENTION BASIN

FIGURE1.DWG I=1

Dysart Drain Detention Basin 11/30/93 Rm FILE LUKE-VOL.WQ1
Modified Volumes

Elevation	Area (Sq-FT)	INCREMENT CONIC Volume (Ac-Ft)	CUMULATIVE CONIC Volume (Ac-Ft)	INCREMEN AVG ENDS Volume (Ac-Ft)	CUMULATIV AVG ENDS Volume (Ac-Ft)
1989.9	0.0		0 *		
1990	0.0				
1091	0.0	0.00	0	0	0
1092	491,734.8 1092.5	3.76	3.76 13.5 *	5.64	5.64
1093	1,255,702.3 1093.5	19.38	23.15 41.42 *	20.06	25.70
1094	1,953,840.2 1094.5	36.55	59.69 83.54 *	36.84	62.54
1095	2,203,193.6 1095.5	47.69	107.38 133.61 *	47.72	110.26
1096	2,368,132.5	52.46	159.84	52.47	162.73
1097	2,549,080.7	56.43	216.27 *	56.44	219.17
1098	3,003,785.1	63.67	279.94	63.74	282.91
1099	3,059,043.3	69.59	349.53	69.59	352.50
1100	3,087,866.7	70.56	420.09	70.56	423.06
1101	3,126,178.6	71.33	491.41	71.33	494.39
1102	3,173,211.1	72.31	563.72 *	72.31	566.69
1103	3,201,577.6	73.17	636.89	73.17	639.87

* USED IN HEC-1 MODEL

SFC ENGINEERING COMPANY

Subject: LUKE GOLF COURSE STORAGE VOLUME

Project:

File Number:

Computed: Checked: Date: 3/30/95 Page ___ of ___ Pages

OK usl

CONTOUR ELEV	AREA SQ. FT			
1090	~~209,505.4~~ 0			
1091	~~481,781.3~~ 0			
1092	~~850,411.9~~			[illegible]781
1093	~~1,771,191.8~~	~~1,179,603.8~~		[illegible]2832
1094	1,609,590.1			
1095	1,772,763.3			
1096	1,872,038.6			
1097	2,276,576.4			
1098	3,351,140.7	-	347,355.6 =	3,003,785.1
1099	3,383,821.6	-	324,778.3 =	3,059,043.3
1100	3,398,784.3	-	310,917.6 =	3,087,866.7
1101	3,432,474.7	-	306,296.1 =	3,126,178.6
1102	3,470,949.0	-	297,737.9 =	3,173,211.1
1103	3,490,973.0	-	289,395.4 =	3,201,577.6
1104				

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled
Worksheet	luke
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

UN-LINED
NUISANCE CHANNEL

REEMS RD TO OUTLET

Input Data		
Mannings Coefficient	0.022	— earthen
Channel Slope	0.000800	ft/ft
Left Side Slope	4.00	H : V
Right Side Slope	4.00	H : V
Bottom Width	10.00	ft
Discharge	85.00	ft³/s

Results			
Depth	2.01	ft	— channel depth = 2.0'
Flow Area	36.19	ft²	
Wetted Perimeter	26.55	ft	
Top Width	26.06	ft	
Critical Depth	1.12	ft	
Critical Slope	0.007575	ft/ft	
Velocity	2.35	ft/s	— OK
Velocity Head	0.09	ft	
Specific Energy	2.09	ft	
Froude Number	0.35		
Flow is subcritical.			

sc-basin.out
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled
Worksheet	Luke Golf
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.019	
Channel Slope	0.000800	ft/ft
Left Side Slope	1.00	H : V
Right Side Slope	1.00	H : V
Bottom Width	10.00	ft
Discharge	125.00	ft^3/s

Results		
Depth	2.79	ft
Flow Area	35.67	ft^2
Wetted Perimeter	17.89	ft
Top Width	15.58	ft
Critical Depth	1.60	ft
Critical Slope	0.005334	ft/ft
Velocity	3.50	ft/s
Velocity Head	0.19	ft
Specific Energy	2.98	ft
Froude Number	0.41	
Flow is subcritical.		

? Ricons Road Collector Channel Outlet
to
Basin Outfall Channel Inlet

sc-east2.out

Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled
Worksheet	Luke Golf
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.019	Gunite
Channel Slope	0.002600	ft/ft
Left Side Slope	1.00	H : V
Right Side Slope	1.00	H : V
Bottom Width	10.00	ft
Discharge	125.00	ft³/s

Results		
Depth	1.98	ft
Flow Area	23.71	ft²
Wetted Perimeter	15.60	ft
Top Width	13.96	ft
Critical Depth	1.60	ft
Critical Slope	0.005334	ft/ft
Velocity	5.27	ft/s
Velocity Head	0.43	ft
Specific Energy	2.41	ft
Froude Number	0.71	
Flow is subcritical.		

2.0' TOP OF LINING

East Collector Channel Outlet
to
Basin Outfall Channel Inlet

sc-east1.out

Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled
Worksheet	Luke Golf
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

EAST CREEK NUISANCE SWALE

Input Data		
Mannings Coefficient	0.019	
Channel Slope	0.002200	ft/ft
Left Side Slope	1.00	H : V
Right Side Slope	1.00	H : V
Bottom Width	10.00	ft
Discharge	120.00	ft^3/s

Results		
Depth	2.03	ft
Flow Area	24.41	ft^2
Wetted Perimeter	15.74	ft
Top Width	14.06	ft
Critical Depth	1.56	ft
Critical Slope	0.005362	ft/ft
Velocity	4.92	ft/s
Velocity Head	0.38	ft
Specific Energy	2.40	ft
Froude Number	0.66	
Flow is subcritical.		

2.0 TOP OF BANK

North Collector Channel Outlet
to
East Collector Channel Outlet

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled
Worksheet	luke
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.022	
Channel Slope	0.003176	ft/ft
Left Side Slope	4.00	H : V
Right Side Slope	4.00	H : V
Bottom Width	165.00	ft
Discharge	1000.00	ft^3/s

Results		
Depth	1.31	ft
Flow Area	223.74	ft^2
Wetted Perimeter	175.84	ft
Top Width	175.51	ft
Critical Depth	1.04	ft
Critical Slope	0.007040	ft/ft
Velocity	4.47	ft/s HIGH
Velocity Head	0.31	ft
Specific Energy	1.62	ft
Froude Number	0.70	
Flow is subcritical.		

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled
Worksheet	luke
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.022	
Channel Slope	0.003176	ft/ft ?
Left Side Slope	4.00	H : V
Right Side Slope	4.00	H : V
Bottom Width	165.00	ft
Discharge	400.00	ft^3/s

Results		
Depth	0.76	ft
Flow Area	127.76	ft^2
Wetted Perimeter	171.27	ft
Top Width	171.08	ft
Critical Depth	0.56	ft
Critical Slope	0.008580	ft/ft
Velocity	3.13	ft/s
Velocity Head	0.15	ft
Specific Energy	0.91	ft
Froude Number	0.64	
Flow is subcritical.		

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled
Worksheet	luke
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

[illegible]

Input Data		
Mannings Coefficient	0.022	
Channel Slope	0.003176	ft/ft
Left Side Slope	4.00	H : V
Right Side Slope	4.00	H : V
Bottom Width	165.00	ft
Discharge	200.00	ft^3/s

Results		
Depth	0.50	ft
Flow Area	83.87	ft^2
Wetted Perimeter	169.14	ft
Top Width	169.02	ft
Critical Depth	0.36	ft
Critical Slope	0.009982	ft/ft
Velocity	2.38	ft/s
Velocity Head	0.09	ft
Specific Energy	0.59	ft
Froude Number	0.60	
Flow is subcritical.		

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled
Worksheet	luke
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.022	
Channel Slope	0.000800	ft/ft
Left Side Slope	250.00	H : V
Right Side Slope	250.00	H : V
Bottom Width	0.00	ft
Discharge	596.00	ft³/s

Results		
Depth	1.29	ft
Flow Area	417.44	ft²
Wetted Perimeter	646.10	ft
Top Width	646.10	ft
Critical Depth	0.81	ft
Critical Slope	0.009525	ft/ft
Velocity	1.43	ft/s
Velocity Head	0.03	ft
Specific Energy	1.32	ft
Froude Number	0.31	
Flow is subcritical.		

	DI210	0
	D192	131
	R192	124
	193	545
Combine 2	1I193	596
	D179	1000
	R179	996 *
2 Combined @	CP193	1248
	D179	841
	R179	682
	194A	217
2 combined @	CP194A	682
	194B	214 *
3 combined @	CP194B	1694
	SR194B	446

R192 124 — 193 545 — DI193

1I193 — D179

R179

CP193 — DI194A

D179 (341 cfs)

R179 (682 cfs)

194A

CP194A 682 cfs — 217 cfs

194B

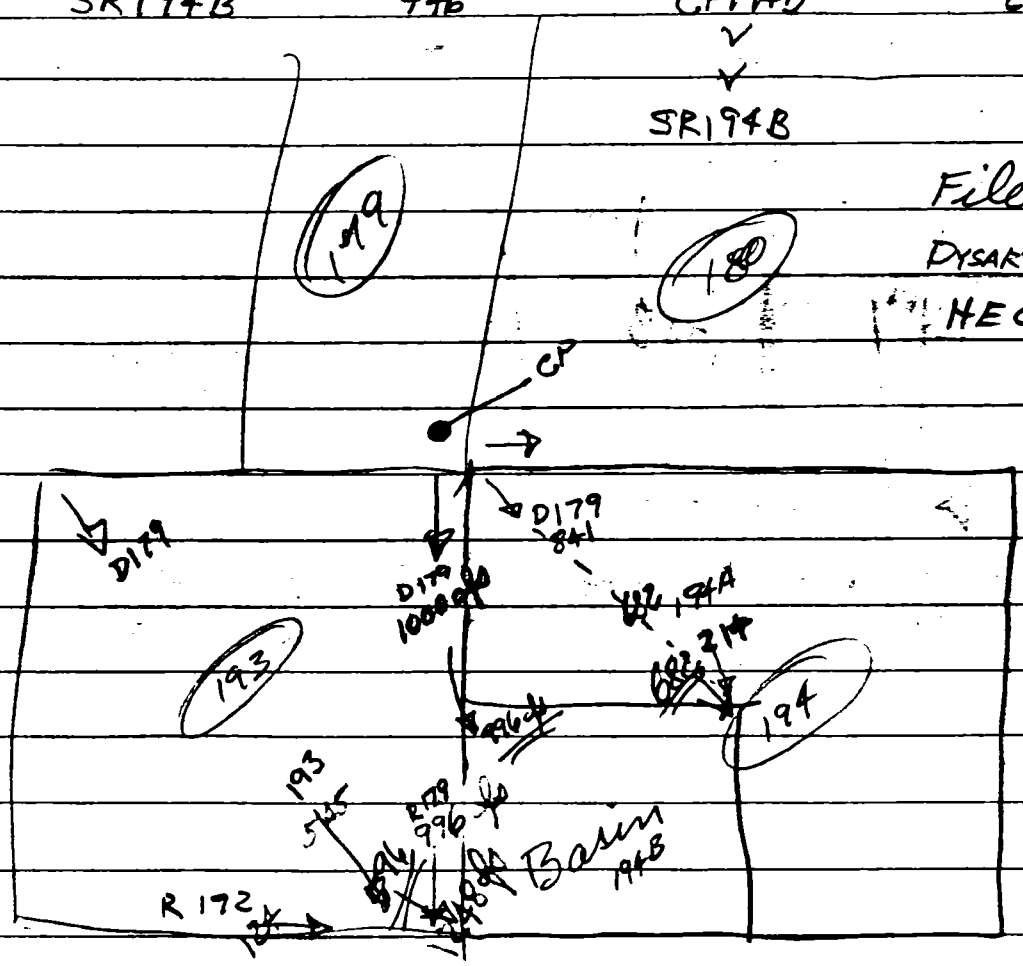
CP194B — 214 cfs

SR194B

File DD0241.DC

DYSART DRAIN DET. BASIN

HEC-1



Luke Air Force Base

NORTH

SCALE: 1" = 100'

0 50 100 200 400

DATE: 3-31-95

EARTHWORK VOLUMES

PRISMOIDAL METHOD

ORIGINAL SURFACE	orig_surface
FINAL SURFACE	FINAL3
CUT COMPACTION FACTOR	0.00 %
FILL COMPACTION FACTOR	17.50 % SWELL
*RAW CUT VOLUME	115737.78 CY
RAW FILL VOLUME	989862.41 CY
CMP FILL VOLUME	1163088.33 CY

*THIS VOLUME INCLUDE 3773 C.Y. FOR BASIN CHANNEL.

WATER STORAGE AREA

PRISMOIDAL METHOD

ORIGINAL SURFACE	FINAL3
FINAL SURFACE	Critical Water (1102)
CUT COMPACTION FACTOR	0.00 %
FILL COMPACTION FACTOR	0.00 %
RAW CUT VOLUME	1132286.44 CY
RAW FILL VOLUME	907302.74 CY

THE FILL VOUME OF 907302.74 CY DIVIDED BY 1613.33 CY/AC. FT. = 562.38 AC. FT.

BASIN CHANNEL DETAIL

BASIN CHANNEL PROVIDED TO MOVE NUISANCE WATER THREW DETENTION BASIN. SLOPE SIDES AS NEEDED, SO THAT THAT THE WHOLE DETENTION BASIN WILL STILL DRAIN.

FLOOD CONTROL DISTRICT RECEIVED MAR 31 1994

GILMORE GRAVES GOLF, INC.
Phoenix, AZ — MASTER PLANNING
Spring Green, WI — LAND PLANNING
Pierre, SD — GOLF COURSE DESIGN