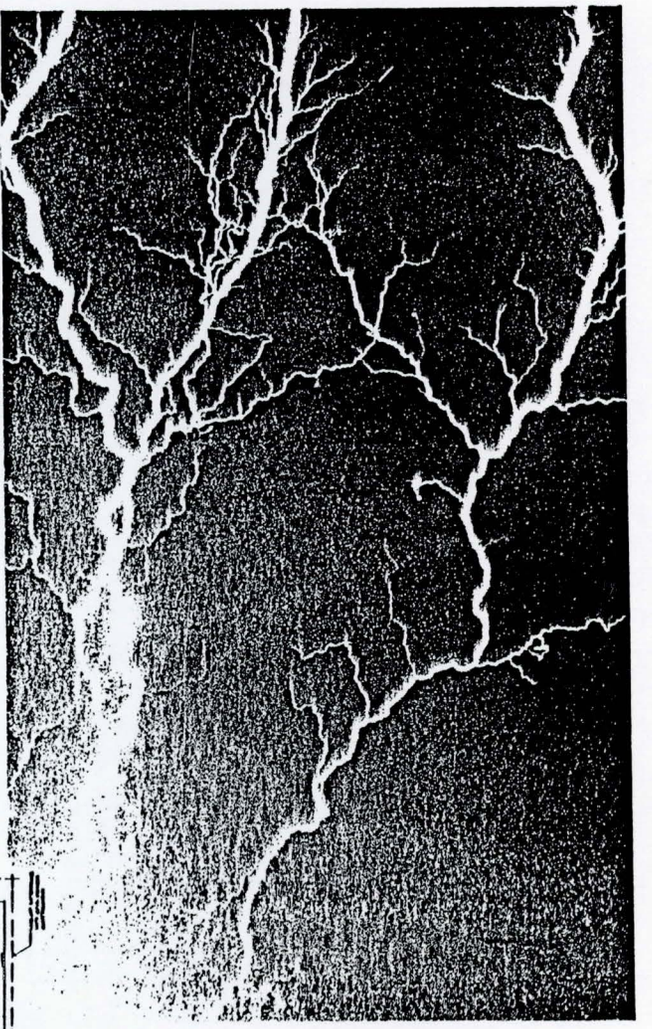
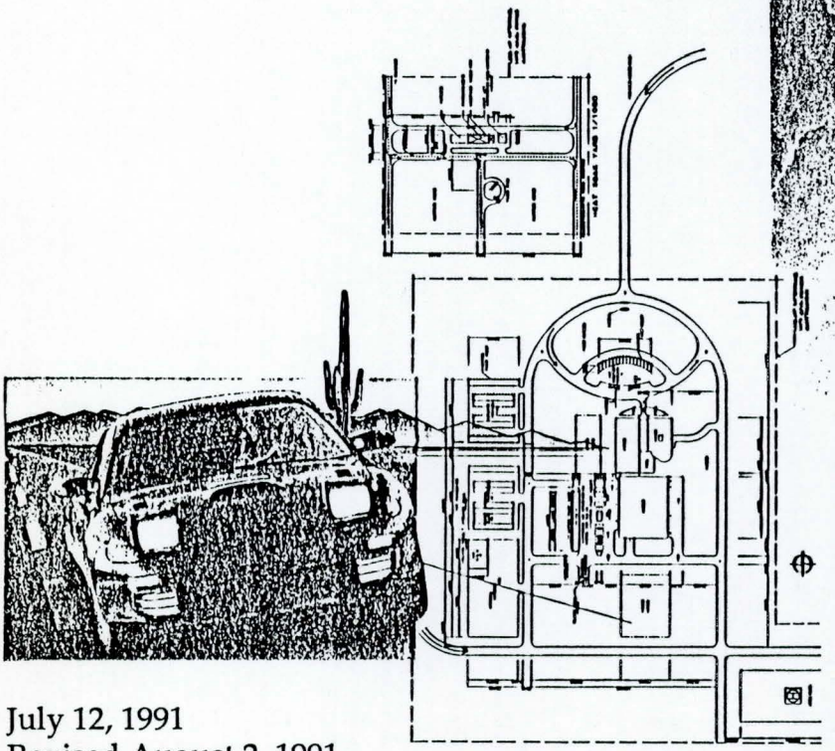
TAISEI/BECHTEL
JOINT VENTURE
TOYOTA ARIZONA
PROVING GROUNDS

PROJECT HYDROLOGY REPORT





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In Association with

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TOYOTA ARIZONA PROVING GROUNDS
PROJECT HYDROLOGY REPORT

AUGUST 1991

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TABLE OF CONTENTS

		PAGE
LIST OF FIGURES		ii
LIST OF TABLES		iii
1.	INTRODUCTION	1
	1.1 Authority and Purpose	1
	1.2 Project Setting	2
2.	PREVIOUS STUDIES	3
3.	DRAINAGE BASIN PARAMETERS	4
	3.1 Basin Boundaries and Areas	4
	3.2 Soils	5
4.	HEC1 MODEL	5
	4.1 Existing Conditions	6
	4.2 Model Methodologies and Parameters	7
	4.3 Precipitation	8
5.	PROPOSED DRAINAGE SYSTEM	8
	5.1 Concept	9
	5.2 Culverts	9
	5.3 Channelization	10
	5.4 Detention/Retention	10
6.	RESULTS	11
	6.1 Jackrabbit Wash vs. Revised Model	11
	6.2 Property Boundary Conditions	11
7.	CONCLUSIONS	12

LIST OF FIGURES

(All figures are located at the end of the report.)

FIGURE		REFERENCED ON PAGE NUMBER
1.	Project Features Phase 1	1
2.	Project Features Phase 1 and Future	1
3.	Location Map	2
4.	Star Wash and Daggs Wash Drainage Areas	3
5.	Drainage Basin Boundaries	4

LIST OF TABLES

(All tables are located at the end of the report.)

TABLE		REFERENCED ON PAGE NUMBER
1.	Comparison with Jackrabbit Wash FIS Data	6
2.	Hydrologic Input Parameters to MCUHP2	7
3.	Hydrograph Routing Parameters	8
4.	Precipitation Depth-Duration-Frequency	8
5.	Culvert Hydraulic Summary	9
6.	Existing vs. Proposed Flows at So. Boundary	11

TOYOTA ARIZONA PROVING GROUND
HYDROLOGY REPORT

1. INTRODUCTION

The Toyota Technical Center, USA, Inc. is proposing to construct a vehicle test facility to be located approximately 15 miles south-southwest of Wickenburg, Arizona. The purpose of the facility is to field test vehicles under a variety of road conditions. The facility will include a paved 10-mile oval track; approximately 35 miles of associated paved and unpaved tracks for testing acceleration, braking, handling, and other vehicle performance and durability characteristics; an aircraft landing strip; office and maintenance buildings; and access roads to the site. The facility will be developed in phases with the initial phase consisting of the paved 10-mile oval track, a paved cornering course, various access roads and return loops, a site access road, and a building site. The phase 1 project features, and phase 1 with future project features are shown on figures 1 and 2 respectively.

1.1 Authority and Purpose

This study was authorized by and completed for the Toyota Technical Center, USA, Inc. as part of the overall final design process for completion of the proposed facility. Project features are designed with sizes and grades established based upon the flood flows and volumes documented herein. Minor adjustments to structure sizes and grades may be necessary prior to and during construction to meet site conditions.

The purpose of this study is to determine existing hydrologic conditions within the project area and to analyze the impact of proposed drainage structures upon downstream lands. This study considered the effect of only the drainage structures to be constructed as phase 1 of the total project. However, the study does consider the additional runoff from impervious areas resulting from the total project (phase 1 and future).

The proposed project lies within the jurisdiction of Maricopa County. The Flood Control District of Maricopa County (FCDMC) has responsibilities for review and approval of the project drainage features. The FCDMC requires that new developments are designed consistent with their drainage regulations and hydrologic procedures as documented in the 'Hydrologic Design Manual for Maricopa County, Arizona' (Hydrologic Design Manual) and the 'Drainage Regulations for the Unincorporated Areas of Maricopa County'. The FCDMC also requires that new developments do not result in diversion of flows to downstream properties, and do not result in increases of either the peak discharge nor the runoff volume from the 100-year, 6-hour storm.

1.2 Project Setting

The project site occupies approximately 11,000 acres (about 17 square miles). The site is located within sections 16 through 22, 25 through 35, and a portion of section 23, Township 5 North, Range 5 West. Figure 3 shows the general location of the project lands.

The major topographic features in the area are the Vulture Mountains to the north and the Hassayampa River to the east. The project lands lie within the Star Wash and Daggs Wash watersheds which originate in the Vulture Mountains. The Star Wash is tributary to Jackrabbit Wash which flows southerly joining the Hassayampa River about 16 miles to the south of the project. Daggs Wash, crosses the eastern property boundary flowing southerly to join the Hassayampa River about 6 miles north of the Jackrabbit Wash - Hassayampa River confluence. Ground slopes within the project site slope toward the south-southeast at about a one percent slope (53 ft per mile). The site terrain is generally uniform with topographic contours nearly parallel.

Drainage patterns in the area are typical of the Sonoran Desert bahada formations with the general land form gently undulating and laced with small incised washes. The washes are

generally not capable of conveying the 100-year frequency floods and are capable of conveying only the smaller frequently occurring flows. Runoff from larger storms exceed the wash capacities and the excess flows spread and cross the ground surface as sheet flows.The excess flows tend to spill from one wash to the next making delineation of drainage area boundaries difficult. The steep land slopes result in the washes flowing at high velocities with high sediment transport capabilities. The wash bank and bed materials are easily eroded. Headcutting is evident within the project area in both the washes as well as the desert floor.

2. PREVIOUS STUDIES

Two hydrologic studies, which include the project lands, have been recently completed. The 'Toyota Arizona Preliminary Drainage Analysis', March 1990, was completed as part of the planning and preliminary design phase of this project. The study was completed to establish the overall design philosophy and conceptual designs of project drainage features. The Corps of Engineers HEC1 computer program was used to compute flood hydrographs originating above the project site. The design storm for the purposes of the study was based upon a precipitation event with a 50-year recurrence frequency, and a 2-hour duration. The study was completed prior to adoption of the Hydrologic Design Manual by the FCDMC. The FCDMC now requires that all new developments be analyzed using the hydrologic methodologies as presented in the Hydrologic Design Manual.

The 'Jackrabbit Wash Floodplain Delineation Study' was completed for the FCDMC to determine ? update flood insurance rate mapping in the area. The study included the Star Wash and Daggs Wash drainage basins which include the project site. The Star Wash and Daggs Wash were designated in the study as basins 10 and 12 respectively. Basin 10 was subdivided into subbasins 10a through 10ab and basin 12 was subdivided into subbasins 12a through 12e. The Star Wash and Daggs Wash drainage basins and subbasins are shown on figure 4 along

with the Toyota project site boundary. The basin and subbasin boundaries and basin parameters used in the study were determined based upon US Geological Survey 7-1/2 minute quadrangle topographic mapping, with 10 or 20 foot contour intervals at a scale of 1 foot equals 2,000 feet. The methodologies contained in the Hydrologic Design Manual were used and the HEC1 computer program was used. The HEC1 model developed for the Jackrabbit Wash study was adopted as base data in completing this study.

3. DRAINAGE BASIN PARAMETERS

3.1 Basin Boundaries and Areas

The drainage basin boundaries established in the Jackrabbit Wash study were used and modified to meet the purposes of this study. The drainage basin boundaries were established in the Jackrabbit Wash study utilizing US Geological Survey 7 1/2 minute quadrangle mapping with 10 and 20 foot contour intervals and a scale of one inch equals 2,000 feet. Detailed topographic mapping with two foot contour intervals at a scale of one foot equals 1,000 feet was developed from photogrammetrically generated topographic data for the project lands. The basin and subbasin boundaries from the Jackrabbit Wash study were transferred to the detailed mapping. The increased accuracy of the detailed mapping allowed for more accurate delineation of the subbasin boundaries and resulted in modifications to the boundaries within the project site. The subbasin boundaries as delineated on the two foot contour mapping were then transferred back to the 7-1/2 minute quadrangle mapping.

The centerline alignment of the Toyota Arizona Proving Ground project features were then transferred to both maps and concentration points identified at intersections of the project features with existing washes. The areas contributing to each of the new concentration points were delineated on the detailed maps and transferred to the 7 1/2 quadrangles (see figure 5).

The new subareas were named according to the subbasin in which they were located. For example subbasin 10U was divided into subareas 10U1 through 10U20. Using the detailed mapping resulted in more accurate basin boundary locations and computing the basin parameters on the 7 1/2 minute quadrangles resulted in accuracy consistent with the data used in the Jackrabbit Wash model. Hydraulic parameters for the basins (e.g. elevations at the rim, centroid, and outfall;flow lengths from the rim and centroid to the outfall) were determined from the quadrangle maps.

3.2 Soils

The model parameters affecting the rainfall-runoff and routing infiltration losses were determined from the soil classification data as presented in the USDA Soil Conservation Services (SCS) publication 'Soil Survey of Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona', April 1986 and criteria published in the FCDMC's 'Hydrologic Design Manual'. The SCS soils maps show the areas of different soils labeled as numeric map symbols. The numeric map symbols indicate the soils name for which various properties have been determined. Loss rate parameters for these soils have been included in Appendix A of the FCDMC Hydrologic Design Manual. These parameters were used in completing the Jackrabbit Wash study and were used in modifications incorporated in this study.

4. HEC1 MODEL

Consistent with the Jackrabbit Wash study and in accordance with the FCDMC requirements, the US Army Corps of Engineers HEC1 computer program was used to complete the study. The general approach to the model was to utilize the methodologies and parameters used in the Jackrabbit Wash study.

4.1 Existing Conditions

The existing Jackrabbit Wash model was based upon the methodologies adopted by the FCDMC in the Hydrologic Design Manual. The purpose of that study was to document existing flooding conditions within the Jackrabbit Wash watershed. The Star Wash and Daggs Wash basins are tributary to the Jackrabbit Wash and were modeled as part of the study. The Jackrabbit Wash study contained several concentration points in the vicinity of the Toyota Proving Grounds property at which flood hydrographs were computed.

The existing model was modified to incorporate the additional subareas and concentration points required to complete project designs and to analyze property boundary conditions. The modified model was then compared to the original model to verify that the results were compatible and reasonable. A comparison of the basin areas, peak discharges, and volumes is presented in table 1. As discussed in section 3.1, the revised drainage area boundaries resulted in changes in peak flows and volumes. The most significant changes were the boundary between subbasins $10K_2$ and 10N. This is reflected in table 1 at Node 63. The revised drainage areas were checked by totaling drainage areas at nodes downstream of the project. The combined drainage areas at node nos. 83, 80, 77, 71, 68, and 61 total 111.33 square miles in the Jackrabbit Wash model and total 111.31 in the revised model. Considering the scale of the base mapping used in the study (1 inch = 2,000 ft), this is considered as a very accurate correlation between the two models. The data shown in table 1 is for the once-in-100 year recurring precipitation with a 6-hour storm duration. Data are shown for concentration points common to both models located within the vicinity of the Toyota property. Considering the revisions made to the drainage areas and added hydrograph channel routings, the modified model is considered reasonable and consistent with the Jackrabbit Wash model. Therefore, the modified model was used as representing base conditions from which the impact of the project was measured.

4.2 Model Methodologies and Parameters

The HEC1 model was developed to incorporate most of the commonly accepted methodologies for analysis of precipitation areal and temporal distribution, rainfall-runoff computation, unit hydrograph computation, and hydrograph channel and storage routing. The FCDMC has established specific methodologies for use on project analysis for which they have administrative review responsibilities. Detailed descriptions of the FCDMC methodologies are documented in the FCDMC Hydrologic Design Manual. Additionally the FCDMC developed the computer program titled Maricopa County Unit Hydrograph Procedure 2 (MCUHP2) to compute input data for the HEC1 program using FCDMC methodologies. The MCUHP2 program was used in developing HEC1 data cards for the Jackrabbit Wash model and was also used in this study to make modifications to the Jackrabbit Wash model.

Precipitation data for the 100-, 50-, and 10-year recurrence intervals were developed using the FCDMC procedures for both the 6- and 2-hour durations. The Green and Ampt equation option in HEC1 was used to compute rainfall infiltration. The regional S graph methodology was used to generate unit hydrographs for the basins. Routing of hydrographs through channels and ponding areas were simulated using the storage routing options in HEC1 along with the channel loss option to simulate infiltration losses.

Input data to the MCUHP2 program for the revised subareas were determined from the topographic and soils mapping as described above. Table 2 shows the hydrologic basin parameters used in developing the HEC1 models. The data used in the Jackrabbit Wash model are presented as subbasins with the subbasin names shown in the first column. The data for the subareas which replaced the subbasins in the revised model are listed following the assigned subarea names listed in the second column.

The data developed as input for the channel routing of hydrographs is summarized in table 3. The first column indicated the subbasin in which the routing occurs and the second column indicates the concentration points between which the routing occurs.

4.3 Precipitation

The total point storm precipitation depths were derived from depth-duration-frequency data developed by the US Dept. of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Office of Hydrology. This point source total precipitation was adjusted to determine the average total precipitation which could be expected over areas of varying sizes. These precipitation depth-area adjustments were made according to FCDMC procedures. The time distribution of the precipitation over the specified storm duration was also specified according to FCDMC procedures. The precipitation total depths for both the 6- and 2-hour storm durations are shown in table 4. Depths for the 100-, 50-, and 10-year recurrence intervals are shown for varying basin areas.

5. PROPOSED DRAINAGE SYSTEM

To assess the impact of the proposed proving ground facilities upon existing flooding conditions, the HEC1 model of existing conditions described above was modified to incorporate the proposed project drainage features. The modeled flow conditions at concentration points where flows exit the property were compared for existing conditions and future conditions with the proving grounds. The proposed drainage structure details are documented in the project drainage report.

5.1 Concept

The proposed drainage system is designed to prevent floodwater from a 100-year, 6-hour storm from over topping the test track roadway surface. Culverts were utilized where possible to convey water under the roadway. The culverts were located at existing significant washes. The roadway embankments will intercept sheet flows and redirect the flows into the culverts. The northeast portion of the track is in an excavated section and it was necessary to provide an interceptor channel to divert runoff toward the southeast around the eastern end of the track. The drainage structures are designed to maintain or improve flow conditions exiting the property.

5.2 Culverts

Culverts are located at nodes shown in table 5, and are sized to convey flows resulting from the 100-year, 6-hour storm without overtopping the roadway surface. Hydraulic procedures developed by the Federal Highway Administration were utilized in completing the hydraulic designs. The reservoir routing routine of the HEC1 computer program was utilized to verify required sizes and grades of the culvert and to compute maximum pool conditions at the culvert inlets. Inlet flow conditions in the culverts were used in the reservoir routing analysis. Stage volume data was determined from 1 inch = 100 feet scale mapping with two foot contours. Infiltration losses from the ponded water at the culvert inlets were also modeled. Culvert sizes and grades were established to minimize the roadway embankments and to prevent the volume of water ponded at the culvert inlets from exceeding 50 acre-feet. Results of the analysis for the 100-, 50-, and 10-year, 6 hour events as well as the 100-year, 2-hour event are summarized in table 5.

5.3 Channelization

At the northeast corner of the oval track, the roadway is in an excavated section and culvert under crossings are not practical. A diversion channel will intercept flood flows and divert the flows around the east end of the track. These flows are returned to their existing water course at the channel outlet.

5.4 Detention/Retention

The Flood Control District of Maricopa County requires that retention areas retain runoff from a 100-year, 2-hour event with outlet piping of 24 inches in diameter or less. These areas are not to receive runoff from areas outside the retention area. The Arizona Department of Water Resources considers impoundments storing greater than 50 acre-feet water as reservoirs. Therefore, at culvert locations where the natural storage upstream of the roadway embankment was available to retain the runoff from the 100-year, 2-hour event, the site was designed to function as a retention basin. The available storage was limited to less than 50 acre-feet. These areas are shown on figure 5. At locations where the volume of runoff exiting the Toyota property exceeded the existing conditions, retention basins designed and located to collect runoff from the roadway surface were included. These basins will include drainage channels along the downstream side of the roadway which drain to retention basins sized to store runoff from the roadway surface resulting from the 100-year, 2-hour event. These basins were included along portions of the north straight-a-way of the oval track where flood water intercepted by the roadway is directed toward nodes (culvert sites) 67A, 67B, 67C, 67D,67E, 67F, 69, 70C, and 70E.

6. RESULTS

6.1 Jackrabbit Wash vs. Revised Model

The Jackrabbit Wash HEC1 model was modified as described above to include concentration points at intersections of project roadways with significant existing washes. Flows at concentration points common to both models, in the vicinity of the Toyota property, were compared to verify consistency of the two models. The results of the comparison are shown in table 1. The differences in discharges and volumes are attributed to modifications to the drainage areas and added routing reaches. The comparison indicates that the modified model is compatible with the original Jackrabbit Wash model and is suitable for use as baseline existing hydrology.

6.2 Property Boundary Conditions

Comparison of the flow conditions along the southern Toyota property boundary is shown in table 6. The 100-year, 6-hour flows are compared for existing conditions and conditions with the project at significant wash locations. The project will not adversely affect existing flow conditions as flows are passed through the project site without diversion of flows between drainage basins. Peak runoff flow rates are significantly reduced where intercepted by project drainage structures. Runoff volumes are maintained or reduced for both the phase 1 and future features except for the area above node 67N where flows are increased by only 2 acre-feet. With an existing runoff volume of 639 acre-feet for the 100-year, 6-hour event, the added volume represents an increase of only 0.3 percent. This is not considered significant and is considered within the accuracy of the modeling procedures. The one acre-foot increase at node 88F is also not considered significant and is considered as within the accuracy of the modeling procedure.

Note that HEC1 does not balance volumes during routing procedures, and a small change in volume may result only due to the mathematical procedures applied, e.g. in table 5, culverts 7 and 8, the outflow exceeds the inflow by 1 acre-foot for the 100-year, 6-hour event. Therefore, a slight change in volume is considered within the accuracy limits of the model.

7. CONCLUSIONS

The revised HEC1 model of existing conditions compares favorably with the Jackrabbit Wash model and is acceptable as documentation of existing hydrologic conditions within the vicinity of the Toyota property.

The proposed development, as documented herein with the drainage structures located and sized to protect the facility, will result in lower peak discharges exiting the property where intercepted by the culvert drainage structures. Also, the runoff volumes will be reduced or maintained as computed within the accuracy of the HEC1 model.

TABLE 1
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
COMPARISON WITH JACKRABBIT WASH FIS DATA
7/11/91

	JACKRABBIT WASH FIS			TOYOTA EXISTING CONDITIONS		
	100 YR - 6 HR			100 YR - 6 HR		
NODE	BASIN AREA (SQMI)	DISCHARGE (CFS)	VOLUME (AC-FT)	BASIN AREA (SQMI)	DISCHARGE (CFS)	VOLUME (AC-FT)
58	20.29	2059	585	20.29	2059	585
59	36.99	3429	894	36.99	3429	894
61	51.00	3984	1041	51.19	4097	1039
63	5.44	2328 427.94	233	12.74	2971 3126 245.37	637
68	15.08	2504	723	15.51	2964	703
69	3.81	2296	199	3.81	2296	199
70	3.92	3046	267	3.92	3046	267
71	11.99	3826	508	11.75	4039	509
76	16.77	5658	929	16.42	5722	917
77	19.89	5220	1008	20.04	5124	958
79	8.04	3906	614	8.04	3906	614
80	11.74	3344	696	10.99	3475	686
83	1.63	1226	104	1.83	679	113
87	4.79	1449	152	4.79	1449	152
88	13.31	2748	618	13.33	2748	619
89	18.6 243.29	2221	753	18.52 250.16	2177	698

NOTE: Toyota data reflect's subbasin boundary modifications based upon 2 foot contour, 1 in. = 1,000 ft. mapping.

250.16
243.29
6.87

diff 6.2
7.3

SOURCE: SFC ENGINEERING COMPANY

TABLE 2
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
HYDROLOGIC INPUT PARAMETERS TO MCUHP2
7/11/91

SUBBASIN NAME	SUBAREA NAME	BASIN AREA (ACRES)	BASIN AREA (SQ-MI)	GREEN-AMPT LOSS COEFFICIENTS IA	DTHETA	PSIF	XKSAT	RTIMP	FLOW LENGTH (MI)	BELOW CENTROID (MI)	ELEV. AT RIM	ELEV. AT OUTFALL	COURSE SLOPE (FT/MI)	MEAN MANNINGS ~N~	LAG (HOURS)	LAG (MIN)	S GRAPH
	10J1	1539	2.40	0.35	0.34	4.4	0.61	0	4.73	2.84	2060	1735	68.7	0.03	0.72	43	VALLEY
	10J2	74	0.12	0.35	0.34	4.4	0.61	0	0.95	0.47	1800	1740	63.2	0.03	0.20	12	VALLEY
	10J3	73	0.11	0.35	0.34	4.4	0.61	0	1.1	0.55	1810	1745	59.1	0.03	0.23	14	VALLEY
	10J4	815	1.27	0.35	0.34	4.4	0.61	0	1.9	0.95	1745	1640	55.3	0.03	0.35	21	VALLEY
	10J4A	67	0.10	0.35	0.34	4.4	0.61	0	0.83	0.34	1690	1650	48.2	0.03	0.18	11	VALLEY
	10J4B	37	0.06	0.35	0.34	4.4	0.61	0	0.57	0.23	1675	1645	52.6	0.03	0.13	8	VALLEY
	10J5	85	0.13	0.35	0.34	4.4	0.61	0	1.2	0.5	1715	1658	47.5	0.03	0.24	14	VALLEY
	10J6	90	0.14	0.35	0.34	4.4	0.61	0	1.2	0.63	1775	1705	58.3	0.03	0.25	15	VALLEY
	10J7	100	0.16	0.35	0.34	4.4	0.61	0	1.23	0.6	1725	1660	52.8	0.03	0.25	15	VALLEY
	10J8	181	0.28	0.35	0.34	4.4	0.61	0	1.4	0.6	1700	1630	50.0	0.03	0.27	16	VALLEY
	10J9	96	0.15	0.35	0.34	4.4	0.61	0	0.36	0.18	1640	1625	41.7	0.03	0.10	6	VALLEY
	10J10	1497	2.34	0.35	0.34	4.4	0.61	0	2.9	1.5	1670	1549	41.7	0.03	0.52	31	VALLEY
10 K1		563	0.88	0.16	0.35	5.5	0.43	0	2.54	1.36	2343	2043	118.1	0.04	0.52	31	PHX. MTN
10 K2		2918	4.56	0.35	0.35	4.9	0.42	0	6.21	3.26	2043	1655	62.5	0.03	0.86	52	VALLEY
	10K21	891	1.39	0.35	0.35	4.9	0.42	0	4.1	2.1	2020	1740	68.3	0.04	0.81	49	VALLEY
	10K22	789	1.23	0.35	0.35	4.9	0.42	0	5	2.8	2120	1745	75.0	0.04	0.96	58	VALLEY
	10K23	1206	1.88	0.35	0.35	4.9	0.42	0	4.2	2.3	2043	1745	71.0	0.04	0.84	51	VALLEY
	10K24	259	0.40	0.35	0.35	4.9	0.42	0	2.16	1	1880	1740	64.8	0.04	0.49	29	VALLEY
	10K25	508	0.79	0.35	0.35	4.9	0.42	0	1.7	1.1	1745	1655	52.9	0.04	0.48	29	VALLEY
10 L		4058	6.34	0.35	0.35	3.9	0.69	0	6.93	3.22	1720	1452	38.7	0.03	0.98	59	VALLEY
	10L1	120	0.19	0.35	0.35	3.9	0.69	0	0.85	0.28	1685	1645	47.1	0.03	0.17	10	VALLEY
	10L2	131	0.20	0.35	0.35	3.9	0.69	0	0.49	0.2	1645	1620	51.0	0.03	0.12	7	VALLEY
	10L3	2988	4.67	0.35	0.35	3.9	0.69	0	4.7	2.68	1620	1452	35.7	0.03	0.80	48	VALLEY
10 M		3949	6.17	0.21	0.32	7	0.17	0	6.06	3.33	2915	2015	148.5	0.043	1.05	63	PHX. MTN
10 N		2220	3.47	0.35	0.36	4.6	0.47	0	8.41	3.3	2100	1560	64.2	0.03	0.96	58	VALLEY
	10N1	373	0.58	0.35	0.36	4.6	0.47	0	2.4	1.08	1890	1750	58.3	0.03	0.40	24	VALLEY
	10N2	37	0.06	0.35	0.36	4.6	0.47	0	0.5	0.23	1780	1745	70.0	0.03	0.12	7	VALLEY
	10N3	14	0.02	0.35	0.36	4.6	0.47	0	0.3	0.13	1658	1645	43.3	0.03	0.09	5	VALLEY
	10N4	17	0.03	0.35	0.36	4.6	0.47	0	0.43	0.2	1663	1645	41.9	0.03	0.12	7	VALLEY
	10N5	449	0.70	0.35	0.36	4.6	0.47	0	1.93	0.94	1745	1640	54.4	0.03	0.35	21	VALLEY
	10N6	168	0.26	0.35	0.36	4.6	0.47	0	1.93	1	1742	1640	52.8	0.03	0.36	22	VALLEY
	10N7	52	0.08	0.35	0.36	4.6	0.47	0	1.14	0.6	1700	1640	52.6	0.03	0.24	15	VALLEY
	10N8	44	0.07	0.35	0.36	4.6	0.47	0	0.66	0.27	1675	1640	53.0	0.03	0.15	9	VALLEY
	10N9	192	0.30	0.35	0.36	4.6	0.47	0	0.66	0.3	1640	1610	45.5	0.03	0.16	9	VALLEY
	10N10	336	0.53	0.35	0.36	4.6	0.47	0	1.51	0.85	1630	1560	46.4	0.03	0.32	19	VALLEY
	10N11	88	0.14	0.35	0.36	4.6	0.47	0	0.61	0.3	1645	1615	49.2	0.03	0.15	9	VALLEY
10 R		2928	4.58	0.16	0.36	5.8	0.31	0	6	3.11	2301	2017	47.3	0.04	1.05	63	MOUNTAIN
10 S		2509	3.92	0.3	0.36	5.5	0.23	0	6.16	2.73	2320	1775	88.5	0.033	0.81	49	VALLEY
10 T		2438	3.81	0.34	0.35	5.4	0.36	0	6.06	3.52	2240	1740	82.5	0.031	0.84	51	VALLEY
10 U		2726	4.26	0.35	0.36	4.9	0.47	0	5.61	2.58	1860	1572	51.3	0.03	0.78	47	VALLEY

TABLE 2
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
HYDROLOGIC INPUT PARAMETERS TO MCUHP2
7/11/91

SUBBASIN NAME	SUBAREA NAME	BASIN AREA (ACRES)	BASIN AREA (SQ-MI)	GREEN-AMPT LOSS COEFFICIENTS IA	DTHETA	PSIF	XKSAT	RTIMP	FLOW LENGTH (MI)	BELOW CENTROID (MI)	ELEV. AT RIM	ELEV. AT OUTFALL	COURSE SLOPE (FT/MI)	MEAN MANNINGS ~N~	LAG (HOURS)	LAG (MIN)	S GRAPH
	10U1	350	0.55	0.35	0.36	4.9	0.47	0	2.27	0.85	1790	1665	55.1	0.03	0.36	22	VALLEY
	10U2	44	0.07	0.35	0.36	4.9	0.47	0	0.25	0.11	1665	1655	40.0	0.03	0.08	5	VALLEY
	10U3	121	0.19	0.35	0.36	4.9	0.47	0	1.17	0.42	1818	1740	66.7	0.03	0.21	12	VALLEY
	10U4	192	0.30	0.35	0.36	4.9	0.47	0	1.61	0.8	1842	1740	63.4	0.03	0.30	18	VALLEY
	10U5	90	0.14	0.35	0.36	4.9	0.47	0	0.76	0.28	1792	1748	57.9	0.03	0.15	9	VALLEY
	10U6	228	0.36	0.35	0.36	4.9	0.47	0	1.38	0.75	1740	1668	52.2	0.03	0.29	17	VALLEY
	10U7	23	0.04	0.35	0.36	4.9	0.47	0	0.25	0.23	1668	1655	52.0	0.03	0.10	6	VALLEY
	10U8	107	0.17	0.35	0.36	4.9	0.47	0	0.78	0.44	1742	1708	43.6	0.03	0.20	12	VALLEY
	10U9	135	0.21	0.35	0.36	4.9	0.47	0	0.85	0.47	1702	1658	51.8	0.03	0.20	12	VALLEY
	10U10	151	0.24	0.35	0.36	4.9	0.47	0	1.36	0.8	1744	1670	54.4	0.03	0.29	17	VALLEY
	10U11	115	0.18	0.35	0.36	4.9	0.47	0	1.42	0.66	1720	1665	38.7	0.03	0.29	18	VALLEY
	10U12	44	0.07	0.35	0.36	4.9	0.47	0	0.76	0.34	1702	1667	46.1	0.03	0.17	10	VALLEY
	10U13	150	0.23	0.35	0.36	4.9	0.47	0	1.14	0.57	1650	1600	43.9	0.03	0.25	15	VALLEY
	10U14	190	0.30	0.35	0.36	4.9	0.47	0	0.85	0.47	1640	1610	35.3	0.03	0.22	13	VALLEY
	10U15	48	0.08	0.35	0.36	4.9	0.47	0	0.47	0.23	1675	1650	53.2	0.03	0.12	7	VALLEY
	10U16	46	0.07	0.35	0.36	4.9	0.47	0	0.45	0.23	1667	1640	60.0	0.03	0.12	7	VALLEY
	10U17	30	0.05	0.35	0.36	4.9	0.47	0	0.45	0.27	1665	1640	55.6	0.03	0.13	8	VALLEY
	10U18	38	0.06	0.35	0.36	4.9	0.47	0	0.3	0.19	1655	1640	50.0	0.03	0.10	6	VALLEY
	10U19	43	0.07	0.35	0.36	4.9	0.47	0	0.28	0.15	1655	1640	53.6	0.03	0.08	5	VALLEY
	10U20	411	0.64	0.35	0.36	4.9	0.47	0	1.7	0.9	1650	1580	41.2	0.03	0.35	21	VALLEY
10 V		1997	3.12	0.35	0.35	4.9	0.46	0								48	
	10V1	223	0.35	0.35	0.35	4.9	0.46	0	1.9	0.76	1862	1741	63.7	0.03	0.31	19	VALLEY
	10V2	515	0.80	0.35	0.35	4.9	0.46	0	3.7	1.7	2003	1740	71.1	0.03	0.54	32	VALLEY
	10V3	299	0.47	0.35	0.35	4.9	0.46	0	2.3	0.76	1850	1720	56.5	0.03	0.34	21	VALLEY
	10V4	16	0.03	0.35	0.35	4.9	0.46	0	0.6	0.2	1738	1710	46.7	0.03	0.13	8	VALLEY
	10V5	192	0.30	0.35	0.35	4.9	0.46	0	1.4	0.76	1730	1660	50.0	0.03	0.29	18	VALLEY
	10V6	283	0.44	0.35	0.35	4.9	0.46	0	2.3	1.3	1800	1660	60.9	0.03	0.42	25	VALLEY
	10V7	30	0.05	0.35	0.35	4.9	0.46	0	0.3	0.2	1670	1650	66.7	0.03	0.09	6	VALLEY
	10V8	381	0.60	0.35	0.35	4.9	0.46	0	1.4	0.9	1770	1606	117.1	0.03	0.26	16	VALLEY
	10V9	268	0.42	0.35	0.35	4.9	0.46	0	1.4	0.8	1741	1670	50.7	0.03	0.30	18	VALLEY
	10V10	68	0.11	0.35	0.35	4.9	0.46	0	0.8	0.4	1720	1670	62.5	0.03	0.18	11	VALLEY
	10V11	24	0.04	0.35	0.35	4.9	0.46	0	0.4	0.1	1685	1672	32.5	0.03	0.09	5	VALLEY
	10V12	51	0.08	0.35	0.35	4.9	0.46	0	0.5	0.2	1606	1588	36.0	0.03	0.13	8	VALLEY
10 Y																	
	10Y1	199	0.31	0.35	0.36	4.7	0.49	0	1.86	0.8	1755	1660	51.1	0.03	0.33	20	MOUNTAIN
	10Y2	703	1.10	0.35	0.36	4.7	0.49	0	4.07	1.7	1890	1660	56.5	0.03	0.58	35	MOUNTAIN
	10Y3	300	0.47	0.35	0.36	4.7	0.49	0	1.25	0.7	1660	1610	40.0	0.03	0.28	17	MOUNTAIN
	10Y4	554	0.87	0.35	0.36	4.7	0.49	0	1.74	1.3	1610	1547	36.2	0.03	0.41	25	MOUNTAIN
	10Y5	131	0.20	0.35	0.36	4.7	0.49	0	1.17	0.5	1660	1615	38.5	0.03	0.24	15	MOUNTAIN
10 AA																	
	10AA1	228	0.36	0.35	0.36	6.3	0.29	0	1.67	0.8	1740	1665	44.9	0.03	0.33	20	MOUNTAIN
	10AA2	148	0.23	0.35	0.36	6.3	0.29	0	1.97	0.98	1755	1665	45.7	0.03	0.37	22	MOUNTAIN
	10AA3	262	0.41	0.35	0.36	6.3	0.29	0	2.37	1.1	1770	1665	44.3	0.03	0.42	25	MOUNTAIN
	10AA4	108	0.17	0.35	0.36	6.3	0.29	0	1.19	0.6	1665	1610	46.2	0.03	0.25	15	MOUNTAIN

TABLE 2
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
HYDROLOGIC INPUT PARAMETERS TO MCUHP2
7/11/91

SUBBASIN NAME	SUBAREA NAME	BASIN AREA (ACRES)	BASIN AREA (SQ-MI)	GREEN-AMPT LOSS COEFFICIENTS IA	DTHETA	PSIF	XKSAT	RTIMP	FLOW LENGTH (MI)	BELOW CENTROID (MI)	ELEV. AT RIM	ELEV. AT OUTFALL	COURSE SLOPE (FT/MI)	MEAN MANNINGS ~N~	LAG (HOURS)	LAG (MIN)	S GRAPH
	10AA5	246	0.38	0.35	0.36	6.3	0.29	0	1.25	0.75	1665	1610	44.0	0.03	0.29	17	MOUNTAIN
	10AA6	182	0.28	0.35	0.36	6.3	0.29	0	0.79	0.4	1610	1590	25.3	0.03	0.21	13	MOUNTAIN
12 D																	
	12D1	230	0.36	0.35	0.34	5.9	0.35	0	1.27	0.57	1715	1670	35.4	0.03	0.27	16	VALLEY
	12D2	23	0.04	0.35	0.34	5.9	0.35	0	0.55	0.28	1690	1670	36.4	0.03	0.15	9	VALLEY
	12D3	14	0.02	0.35	0.34	5.9	0.35	0	0.27	0.06	1690	1680	37.0	0.03	0.06	4	VALLEY
	12D4	14	0.02	0.35	0.34	5.9	0.35	0	0.15	0.07	1685	1680	33.3	0.03	0.05	3	VALLEY
	12D5	34	0.05	0.35	0.34	5.9	0.35	0	0.26	0.095	1670	1660	38.5	0.03	0.07	4	VALLEY
	12D6	21	0.03	0.35	0.34	5.9	0.35	0	0.28	0.15	1675	1665	35.7	0.03	0.09	5	VALLEY
	12D7	3000	4.69	0.35	0.34	5.9	0.35	0	5.68	2.3	1800	1570	40.5	0.03	0.79	47	VALLEY

SOURCE: SFC ENGINEERING COMPANY

TABLE 3
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
HYDROGRAPH ROUTING DATA
7/11/91

SUB BASIN	REACH	REACH LENGTH (MI)	REACH LENGTH (FT)	VEL	DELTA TIME	STEPS	START ELEV.	END ELEV.	SLOPE (FT/FT)
10J	60-60A	4.07	21500	5	5	14.3	2005	1725	0.0130
	60A-60D	1.72	9100	5	5	6.1	1725	1640	0.0093
	60B-60D	1.84	9700	5	5	6.5	1740	1640	0.0103
	60C-60D	1.86	9800	5	5	6.5	1745	1640	0.0107
	60F-60G	0.80	4200	5	5	2.8	1705	1660	0.0107
	60G-60H	0.63	3300	5	5	2.2	1660	1630	0.0091
	60E-60H	0.49	2600	5	5	1.7	1658	1630	0.0108
	60D-60I	0.38	2000	5	5	1.3	1640	1625	0.0075
	60I-61	2.03	10700	5	5	7.1	1625	1540	0.0079
	60H-61	2.22	11700	5	5	7.8	1630	1540	0.0077
	60J-60K	0.49	2600	5	5	1.7	1645	1620	0.0096
	60K-6082	4.79	25300	5	5	16.9	1620	1452	0.0066
10U	69-70A	2.27	11986	5	5	8.0	1740	1665	0.0063
	70A-70B	0.25	1320	5	5	0.9	1665	1655	0.0076
	70B-70Q	0.28	1478	5	5	1.0	1655	1640	0.0101
	70Q-71A	0.85	4488	5	5	3.0	1640	1610	0.0067
	71A-71	0.66	3485	5	5	2.3	1610	1572	0.0109
	70C-70F	1.38	7286	5	5	4.9	1740	1668	0.0099
	70E-70F	1.38	7286	5	5	4.9	1740	1668	0.0099
	70F-70G	0.25	1320	5	5	0.9	1668	1655	0.0098
	70G-70P	0.78	4118	5	5	2.7	1655	1640	0.0036
	70P-71AA	0.85	4488	5	5	3.0	1640	1610	0.0067
	70-70D	0.76	4013	5	5	2.7	1775	1748	0.0067
	70E-70F	1.38	7286	5	5	4.9	1740	1668	0.0099
	70H-70J	0.85	4488	5	5	3.0	1708	1658	0.0111
	70J-70O	0.3	1584	5	5	1.1	1658	1640	0.0114
	70O-71B	1.14	6019	5	5	4.0	1640	1600	0.0066
	70L-70N	0.45	2376	5	5	1.6	1667	1640	0.0114
	70N-71B	1.14	6019	5	5	4.0	1640	1600	0.0066
	71B-71	0.66	3485	5	5	2.3	1600	1572	0.0080
	70K-70O	0.45	2376	5	5	1.6	1665	1640	0.0105
	70M-71B	1.14	6019	5	5	4.0	1650	1600	0.0083
10K	62-67c	4.22	22300	5	5	14.9	2040	1742	0.0134
	67c-63	1.63	8600	5	5	5.7	1742	1657	0.0099
	67-67a	4.03	21300	5	5	14.2	2020	1740	0.0131
	67a-63	1.56	8250	5	5	5.5	1740	1657	0.0101
	67b-63	1.59	8400	5	5	5.6	1742	1657	0.0101
	67d-63	1.70	9000	5	5	6.0	1740	1657	0.0092
	63-67g	0.30	1600	5	5	1.1	1657	1644	0.0081
10N	67g-67N	0.59	3100	5	5	2.1	1644	1615	0.0094
	67h-67N	0.57	3000	5	5	2.0	1644	1615	0.0097
	67f-67i	1.89	10000	5	5	6.7	1743	1640	0.0103
	67I-67M	0.66	3500	5	5	2.3	1640	1612	0.0080
	67E-67J	1.91	10100	5	5	6.7	1743	1640	0.0102
	67J-67M	0.63	3350	5	5	2.2	1640	1612	0.0084

TABLE 3
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
HYDROGRAPH ROUTING DATA
7/11/91

SUB BASIN	REACH	REACH LENGTH (MI)	REACH LENGTH (FT)	VEL	DELTA TIME	STEPS	START ELEV.	END ELEV.	SLOPE (FT/FT)
	67K-67M	0.63	3300	5	5	2.2	1640	1612	0.0085
	67L-67M	0.64	3400	5	5	2.3	1640	1612	0.0082
	67M-68	1.17	6200	5	5	4.1	1612	1560	0.0084
	62-63	0.39	2040	5	5	1.4	2040	1657	0.1877
	63-68	2.27	11986	5	5	8.0	1657	1560	0.0081
	67-68	8.22	43402	5	5	28.9	2020	1560	0.0106
	63-67G	0.30	1600	5	5	1.1	1657	1644	0.0081
	67H-67M	0.74	3900	5	5	2.6	1644	1612	0.0082
	67M-68	1.17	6200	5	5	4.1	1612	1560	0.0084
	62-63	5.85	30900	5	5	20.6	2400	1560	0.0272
	63-68	2.22	11700	5	5	7.8	1657	1560	0.0083
	67N-68	1.29	6800	5	5	4.5	1615	1560	0.0081
10V	76-76H	1.08	5700	5	5	3.8	1717	1660	0.0100
	76H-77A	1.44	7600	5	5	5.1	1660	1606	0.0071
	76A-76E	1.42	7500	5	5	5.0	1741	1670	0.0095
	76B-76E	1.31	6900	5	5	4.6	1740	1670	0.0101
	76C-76E	0.93	4900	5	5	3.3	1720	1670	0.0102
	76E-76J	0.28	1500	5	5	1.0	1670	1650	0.0133
	76D-76F	0.72	3800	5	5	2.5	1710	1670	0.0105
	76F-76J	0.27	1400	5	5	0.9	1670	1650	0.0143
	76G-76J	0.30	1600	5	5	1.1	1772	1650	0.0763
	76J-77A	1.23	6500	5	5	4.3	1650	1606	0.0068
	76I-77A	1.46	7700	5	5	5.1	1660	1606	0.0070
	77A-77	0.47	2500	5	5	1.7	1606	1588	0.0072
	76B-76C	0.57	3000	5	5	2.0	1740	1720	0.0067
	76C-76D	0.19	1000	5	5	0.7	1720	1710	0.0100
	76D-76H	0.89	4700	5	5	3.1	1710	1660	0.0106
	76A-76B	0.27	1400	5	5	0.9	1743	1740	0.0021
10Y	79-79B	1.99	10500	5	5	7.0	1755	1660	0.0090
	79B-79D	1.17	6200	5	5	4.1	1660	1615	0.0073
	79D-80	1.74	9200	5	5	6.1	1615	1547	0.0074
	79A-79C	1.25	6600	5	5	4.4	1660	1610	0.0076
	79C-80	1.74	9200	5	5	6.1	1610	1547	0.0068
10AA	83A-83D	1.17	6200	5	5	4.1	1665	1610	0.0089
	83B-83E	1.17	6200	5	5	4.1	1665	1610	0.0089
	83C-83E	1.23	6500	5	5	4.3	1665	1610	0.0085
	83D-83	0.76	4000	5	5	2.7	1610	1590	0.0050
	83E-83	0.80	4200	5	5	2.8	1610	1590	0.0048
12D	88A-88E	0.19	1000	5	5	0.7	1670	1660	0.0100
	88B-88E	0.25	1300	5	5	0.9	1670	1660	0.0077
	88C-88F	0.27	1400	5	5	0.9	1680	1665	0.0107
	88D-88	0.02	100	5	5	0.1	1680	1675	0.0500
	88E-89	2.35	12400	5	5	8.3	1660	1570	0.0073
	88F-89	2.75	14500	5	5	9.7	1665	1570	0.0066

TABLE 4
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
PRECIPITATION DEPTH-DURATION-FREQUENCY
7/11/91

BASIN AREA SQ. MI.	REDUCTION FACTOR	6 HOUR			2 HOUR
		100 YR	50 YR	10 YR	100 YR
0.01	0.0000	3.30	3.00	2.10	2.74
0.5	0.9933	3.28	2.98	2.09	2.72
2.8	0.9788	3.23	2.94	2.06	2.68
16	0.9212	3.04	2.76	1.93	2.52
90	0.8091	2.67	2.42	1.70	2.22
500	0.5700	1.88	1.71	1.20	1.56

SOURCE: SFC ENGINEERING COMPANY

TABLE 5
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
CULVERT HYDRAULIC SUMMARY
7/11/91

CUL NO.	NODE	CULVERT SIZE	CULVERT INLET INVERT ELEV.	EXISTING CHANNEL INVERT ELEV.	DRAINAGE AREA SQ. MI.	PRECIP.	CULVERT INFLOW CFS	CULVERT INFLOW AC-FT	INLET STORAGE MAX. POOL ELEV.	INLET STORAGE MAX. VOLUME STORED	CULVERT OUTFLOW CFS	CULVERT OUTFLOW AC-FT
1	70E	5-10 X 5 CBC	1734.0	1737.0	4.36	100 YR-6 HR	2990	284	1741.83	15.9	2683	281
						50 YR-6 HR	2509	234	1740.95	10.5	2334	231
						10 YR-6 HR	1053	88	1737.68	0.4	1020	85
						100 YR-2 HR	3791	302	1743.13	30.4	3033	300
2	70C	1-24 IN. RCP	1732.0	1731.9	0.19	100 YR-6 HR	459	12	1740.00	8.7	41	12
						50 YR-6 HR	397	10	1739.67	7.7	40	10
						10 YR-6 HR	201	5	1738.33	3.5	36	5
						100 YR-2 HR	421	11	1740.00	8.7	41	11
3	69	3-10 X 4 CBC	1732.0	1732.4	3.81	100 YR-6 HR	2296	199	1742.47	27.9	1706	199
						50 YR-6 HR	1841	157	1740.83	12.8	1510	158
						10 YR-6 HR	517	39	1735.23	0.1	517	39
						100 YR-2 HR	3162	231	1744.06	49.6	1895	232
4	67E	1-10 X 4 CBC	1733.5	1734.2	0.58	100 YR-6 HR	915	38	1742.40	10.5	506	38
						50 YR-6 HR	779	32	1741.84	7.3	483	32
						10 YR-6 HR	387	15	1739.18	1.0	346	16
						100 YR-2 HR	863	34	1742.23	9.3	499	34
5	67F	1-36 IN. RCP	1736.5	1738.3	0.06	100 YR-6 HR	179	4	1742.25	2.1	68	4
						50 YR-6 HR	157	3	1742.13	1.8	67	3
						10 YR-6 HR	82	2	1740.58	0.4	50	2
						100 YR-2 HR	190	4	1742.13	1.8	67	4
6	67A	5-10 X 4 CBC	1730.5	1733.6	7.56	100 YR-6 HR	3177	492	1741.20	14.4	2891	491
						50 YR-6 HR	2588	403	1739.26	5.4	2502	402
						10 YR-6 HR	1076	167	1734.24	0.0	1041	161
						100 YR-2 HR	3833	538	1742.91	28.5	3210	538
7	67B	1-10 X 4 CBC	1733.0	1735.0	3.99	100 YR-6 HR	2133	192	1741.51	15.5	1697	193
	&					50 YR-6 HR	1651	149	1739.96	3.9	1452	149
8	67C	2-10 X 5 CBC	1732.5	1734.3		10 YR-6 HR	359	37	1734.89	0.0	306	31
						100 YR-2 HR	2982	233	1743.19	39.5	1928	232
9	67D	2-10 X 4 CBC	1734.5	1737.9	0.40	100 YR-6 HR	589	28	1739.43	0.0	590	28
						50 YR-6 HR	504	23	1738.83	0.0	505	23
						10 YR-6 HR	262	12	1737.16	0.0	262	12
						100 YR-2 HR	536	24	1739.01	0.0	532	24

TABLE 5
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
CULVERT HYDRAULIC SUMMARY
7/11/91

CUL NO.	NODE	CULVERT SIZE	CULVERT INLET INVERT ELEV.	EXISTING CHANNEL INVERT ELEV.	DRAINAGE AREA SQ. MI.	PRECIP.	CULVERT INFLOW		INLET STORAGE		CULVERT OUTFLOW	
							CFS	AC-FT	MAX. POOL ELEV.	MAX. VOLUME STORED	CFS	AC-FT
10	60C	1-24 IN. RCP	1734.5	1734.3	0.11	100 YR-6 HR	243	7	1742.00	4.6	40	7
						50 YR-6 HR	207	6	1741.67	3.9	39	6
						10 YR-6 HR	98	3	1740.25	1.1	34	3
						100 YR-2 HR	215	6	1741.67	3.9	39	6
11	60B	1-24 IN. RCP	1731.0	1733.2	0.12	100 YR-6 HR	289	7	1739.50	5.2	43	7
						50 YR-6 HR	249	6	1739.25	4.6	42	6
						10 YR-6 HR	120	3	1738.00	1.4	38	3
						100 YR-2 HR	273	7	1739.25	4.6	42	7
12	60A	5-10 X 4 CBC	1717.5	1726.7	9.33	100 YR-6 HR	2619	468	1726.34	0.0	2517	449
						50 YR-6 HR	2107	373	1724.08	0.0	1996	352
						10 YR-6 HR	655	113	1719.96	0.0	587	101
						100 YR-2 HR	3277	568	1730.05	3.6	3234	567
13	60F	1-10 X 4 CBC	1698.5	1704.8	0.14	100 YR-6 HR	292	9	1703.39	0.0	292	9
						50 YR-6 HR	248	7	1702.77	0.0	248	7
						10 YR-6 HR	121	3	1701.01	0.0	121	3
						100 YR-2 HR	270	8	1701.07	0.0	270	8
14	60G	1-10 X 4 CBC	1661.0	1661.3	0.30	100 YR-6 HR	446	21	1664.99	7.8	229	21
						50 YR-6 HR	387	18	1664.65	6.3	204	18
						10 YR-6 HR	203	9	1663.59	2.9	126	9
						100 YR-2 HR	402	18	1664.76	6.8	212	18
15	60E	1-24 IN. RCP	1652.5	1652.0	0.13	100 YR-6 HR	291	9	1656.00	6.4	23	8
						50 YR-6 HR	249	7	1655.83	5.9	22	7
						10 YR-6 HR	121	4	1654.67	2.8	14	3
						100 YR-2 HR	260	7	1655.83	5.9	22	7
16	60D	5-10 X 4 CBC	1739.5	1737.9	10.98	100 YR-6 HR	2277	482	1744.97	16.8	2034	469
		&				50 YR-6 HR	1792	373	1744.19	8.2	1704	362
		1-10 X 4 CBC	1739.0			10 YR-6 HR	512	101	1741.32	0.1	488	95
						100 YR-2 HR	2961	634	1746.24	34.1	2466	627
17	60J-1	1-6 X 4 CBC	1643.0	1645.5	0.16	100 YR-6 HR	460	11	1649.63	4.0	241	12
						50 YR-6 HR	396	10	1649.17	3.0	227	10
						10 YR-6 HR	193	4	1648.02	0.3	181	4
						100 YR-2 HR	446	10	1649.27	3.2	230	10

TABLE 5
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
CULVERT HYDRAULIC SUMMARY
7/11/91

CUL NO.	NODE	CULVERT SIZE	CULVERT INLET INVERT ELEV.	EXISTING CHANNEL INVERT ELEV.	DRAINAGE AREA SQ. MI.	PRECIP.	CULVERT INFLOW		INLET STORAGE		CULVERT OUTFLOW	
							CFS	AC-FT	MAX. POOL ELEV.	MAX. VOLUME STORED	CFS	AC-FT
18	60J-2	1-10 X 4 CBC	1639.0	1643.5	0.16	100 YR-6 HR	241	12	1643.16	0.0	241	12
						50 YR-6 HR	227	10	1642.96	0.0	227	10
						10 YR-6 HR	181	4	1642.35	0.0	181	4
						100 YR-2 HR	230	10	1643.00	0.0	230	10
19	67H-1	7-10 X 4 CBC	1643.0	1644.8	12.78	100 YR-6 HR	2960	639	1649.93	10.8	2915	639
						50 YR-6 HR	2445	502	1648.64	4.9	2416	502
						10 YR-6 HR	891	151	1645.61	0.1	892	151
						100 YR-2 HR	4251	802	1652.62	39.8	3744	802
20	67H-2	8-10 X 4 CBC	1639.0	1641.7	12.78	100 YR-6 HR	2915	639	1644.92	0.0	2915	639
						50 YR-6 HR	2416	502	1644.02	0.0	2416	502
						10 YR-6 HR	892	151	1642.38	0.0	892	151
						100 YR-2 HR	3744	802	1646.96	0.0	3744	802
21	67I-1	1-10 X 4 CBC	1640.0	1640.0	0.74	100 YR-6 HR	1123	49	1648.75	17.2	500	49
						50 YR-6 HR	963	41	1648.10	11.1	474	41
						10 YR-6 HR	475	19	1645.51	1.7	336	19
						100 YR-2 HR	1173	46	1648.78	17.4	501	46
22	67I-2	1-10 X 4 CBC	1636.5	1636.8	0.74	100 YR-6 HR	500	49	1644.75	0.0	500	49
						50 YR-6 HR	474	41	1644.10	0.0	474	41
						10 YR-6 HR	336	19	1641.51	0.0	336	19
						100 YR-2 HR	501	46	1644.78	0.0	501	46
23	67J-1	1-10 X 4 CBC	1641.5	1641.6	0.98	100 YR-6 HR	504	56	1646.69	16.3	313	55
						50 YR-6 HR	424	46	1646.31	11.9	287	46
						10 YR-6 HR	261	24	1644.53	2.9	157	19
						100 YR-2 HR	565	54	1646.70	16.4	314	54
24	67J-2	1-10 X 4 CBC	1638.0	1638.0	0.98	100 YR-6 HR	313	55	1643.19	0.0	313	55
						50 YR-6 HR	287	46	1642.81	0.0	287	46
						10 YR-6 HR	157	19	1641.03	0.0	157	19
						100 YR-2 HR	314	54	1643.20	0.0	314	54
25	67L-1	1-24 IN. RCP	1642.0	1642.0	0.07	100 YR-6 HR	204	6	1647.20	3.8	31	6
						50 YR-6 HR	179	5	1647.00	3.3	30	5
26	67L-2	NOT MODELED				10 YR-6 HR	98	3	1646.25	1.4	27	3
						100 YR-2 HR	192	5	1647.20	3.8	31	5

TABLE 5
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
CULVERT HYDRAULIC SUMMARY
7/11/91

CUL NO.	NODE	CULVERT SIZE	CULVERT INLET INVERT ELEV.	EXISTING CHANNEL INVERT ELEV.	DRAINAGE AREA SQ. MI.	PRECIP.	CULVERT INFLOW CFS	CULVERT INFLOW AC-FT	INLET STORAGE MAX. POOL ELEV.	INLET STORAGE MAX. VOLUME STORED	CULVERT OUTFLOW CFS	CULVERT OUTFLOW AC-FT
27	70Q-1	2-10 X 5 CBNC	1638.0	1638.2	4.48	100 YR-6 HR	1373	222	1647.84	4.9	1284	223
						50 YR-6 HR	1200	174	1646.47	1.7	1147	174
						10 YR-6 HR	381	41	1641.49	0.0	379	41
						100 YR-2 HR	1545	267	1648.99	14.2	1399	268
28	70Q-2	2-10 X 5 CBC	1636.5	1638.2	4.48	100 YR-6 HR	1284	223	1646.34	0.0	1284	223
						50 YR-6 HR	1147	174	1644.35	0.0	1147	174
						10 YR-6 HR	379	41	1639.99	0.0	379	41
						100 YR-2 HR	1399	268	1647.45	0.0	1399	268
29	70P-1	5-10 X 6 CBC	1641.5	1643.5	5.00	100 YR-6 HR	2256	293	1647.73	6.8	2228	293
						50 YR-6 HR	1997	239	1647.18	5.0	81	239
						10 YR-6 HR	841	84	1644.69	0.4	42	84
						100 YR-2 HR	2469	322	1648.15	9.1	2418	322
30	70P-2	4-10 X 6 CBC	1637.0	1639.0	5.00	100 YR-6 HR	2228	293	1644.46	0.0	2228	293
						50 YR-6 HR	1981	239	1643.74	0.0	1981	239
						10 YR-6 HR	824	84	1640.65	0.0	842	84
						100 YR-2 HR	2418	322	1645.06	0.0	2418	322
31	70O	2-10 X 4 CBC	1637.0	1639.0	1.07	100 YR-6 HR	1131	72	1644.98	3.2	938	72
						50 YR-6 HR	937	59	1643.96	1.0	836	59
32	70M-1	NOT MODELED				10 YR-6 HR	394	24	1640.55	0.1	392	24
33	70M-2	NOT MODELED				100 YR-2 HR	1247	71	1646.03	5.6	1022	72
34	76J	1-10 X 4 CBC	1646.5	1646.5	0.59	100 YR-6 HR	984	42	1657.88	9.1	605	43
						50 YR-6 HR	839	35	1657.08	6.1	573	36
						10 YR-6 HR	440	18	1653.52	0.4	421	18
						100 YR-2 HR	946	38	1657.70	8.5	598	38
35	70A	3-10 X 5 CBC	1663.5	1663.5	4.36	100 YR-6 HR	1681	222	1671.12	1.2	1582	218
						50 YR-6 HR	1470	174	1670.33	7.7	1388	171
						10 YR-6 HR	457	43	1666.33	0.2	430	41
						100 YR-2 HR	1882	262	1672.07	18.1	1749	260
36	70F	5-10 X 6 CBC	1663.5	1665.2	4.91	100 YR-6 HR	2631	296	1670.40	6.1	2528	290
						50 YR-6 HR	2258	242	1669.64	3.2	2187	237
						10 YR-6 HR	919	86	1666.83	0.1	889	84
						100 YR-2 HR	2958	319	1671.15	10.5	2858	317

TABLE 5
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
CULVERT HYDRAULIC SUMMARY
7/11/91

CUL NO.	NODE	CULVERT SIZE	CULVERT INLET INVERT ELEV.	EXISTING CHANNEL INVERT ELEV.	DRAINAGE AREA SQ. MI.	PRECIP.	CULVERT INFLOW		INLET STORAGE		CULVERT OUTFLOW	
							CFS	AC-FT	MAX. POOL ELEV.	MAX. VOLUME STORED	CFS	AC-FT
37	70B	3-10 X 5 CBC	1654.0	1654.0	4.43	100 YR-6 HR	1577	221	1660.85	32.4	1379	220
						50 YR-6 HR	1377	173	1660.03	21.1	1206	173
						10 YR-6 HR	416	41	1656.71	2.0	390	41
						100 YR-2 HR	1745	264	1661.59	42.7	1551	264
38	70G	4-10 X 5 CBC	1652.5	1652.5	4.95	100 YR-6 HR	2522	291	1660.75	28.5	2259	291
						50 YR-6 HR	2177	238	1659.76	19.2	2000	238
						10 YR-6 HR	869	84	1656.25	2.4	851	84
						100 YR-2 HR	2840	319	1661.84	39.6	2472	319
39	76E	3-10 X 4 CBC	1660.0	1660.0	0.40	100 YR-6 HR	817	29	1664.60	0.0	817	29
						50 YR-6 HR	706	24	1664.08	0.0	706	24
						10 YR-6 HR	371	13	1662.55	0.0	371	13
						100 YR-2 HR	770	25	1664.38	0.0	770	25
40	76F	1-6 X 4 CBC	1664.0	1664.0	0.10	100 YR-6 HR	262	7	1671.33	0.0	262	7
						50 YR-6 HR	229	6	1670.23	0.0	229	6
						10 YR-6 HR	123	3	1667.67	0.0	123	3
						100 YR-2 HR	260	6	1671.27	0.0	260	6
41	76G	1-6 X 4 CBC	1667.0	1667.0	0.04	100 YR-6 HR	127	4	1670.76	0.0	127	4
						50 YR-6 HR	113	3	1670.44	0.0	113	3
						10 YR-6 HR	67	2	1669.38	0.0	67	2
						100 YR-2 HR	136	3	1670.96	0.0	136	3

NOTE: SEE FIGURE 5 FOR NODE LOCATIONS

SOURCE: SFC ENGINEERING COMPANY

TABLE 6
TOYOTA ARIZONA PROVING GROUND - HYDROLOGY
EXISTING VS. PROPOSED FLOWS AT SOUTHERN PROPERTY BOUNDARY
7/11/91

	EXISTING CONDITIONS			WITH PROJECT			
	100 YR - 6 HR			100 YR - 6 HR			
NODE	BASIN AREA (SQMI)	DISCHARGE (CFS)	VOLUME (AC-FT)	BASIN AREA (SQMI)	DISCHARGE (CFS)	VOLUME (AC-FT)	CHANGE IN VOLUME (AC-FT)
60H	0.71	798	40	0.71	569	35	-5
60I	11.15	2151	472	11.13	2011	471	-1
60K	0.39	722	23	0.36	611	23	0
67N	12.93	3062	639	12.92	2894	641	2
67M	2.05	1260	104	2.02	817	104	0
71AA	9.81	4078	459	9.78	3216	457	-2
71B	1.3	1048	84	1.3	884	82	-2
77A	19.94	5378	995	19.94	5277	983	-12
79C	0.78	736	47	0.78	738	47	0
79D	9.34	3626	644	9.34	3626	644	0
83D	0.53	369	39	0.53	369	39	0
83E	1.02	586	69	1.02	587	69	0
88C	0.45	883	32	0.45	884	32	0
88F	0.05	139	3	0.05	140	4	1
TOTAL	70.45		3650	70.33		3631	-19

NOTE: SEE FIGURE 5 FOR NODE LOCATIONS

SOURCE: SFC ENGINEERING COMPANY

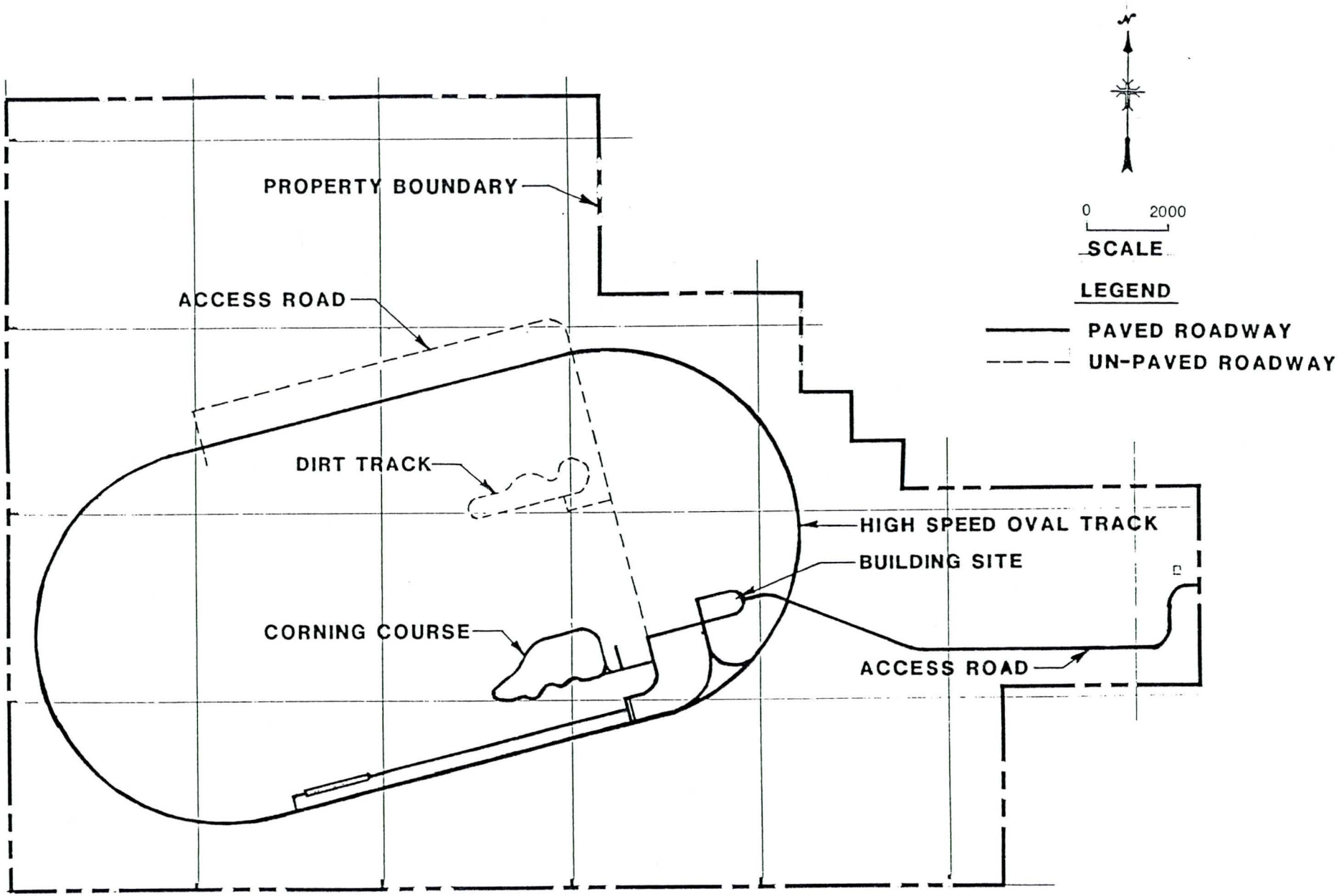


FIGURE 1
TOYOTA ARIZONA PROVING GROUND
PROJECT FEATURES PHASE 1

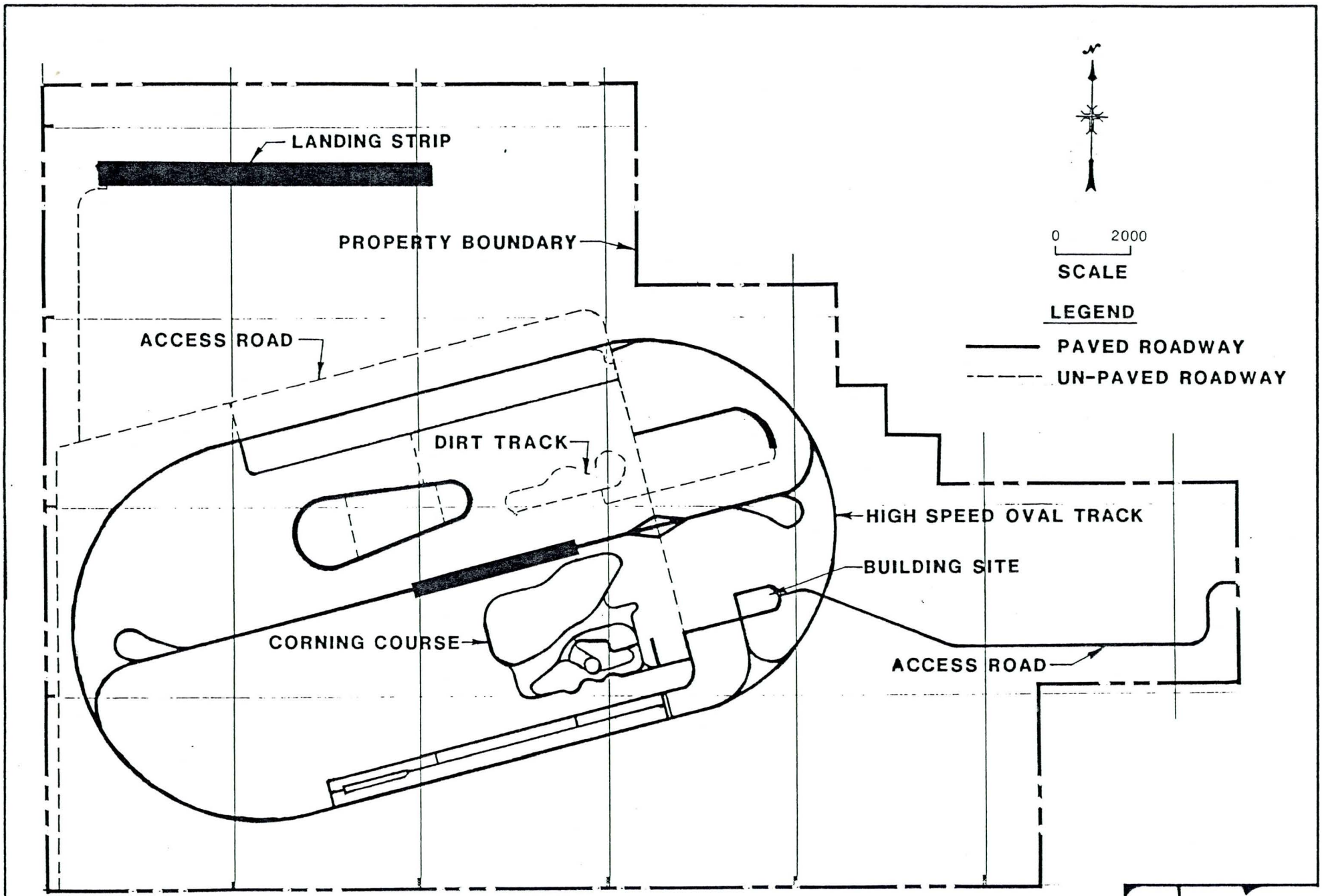


FIGURE 2
TOYOTA ARIZONA PROVING GROUND
PROJECT FEATURES PHASE 1 & FUTURE

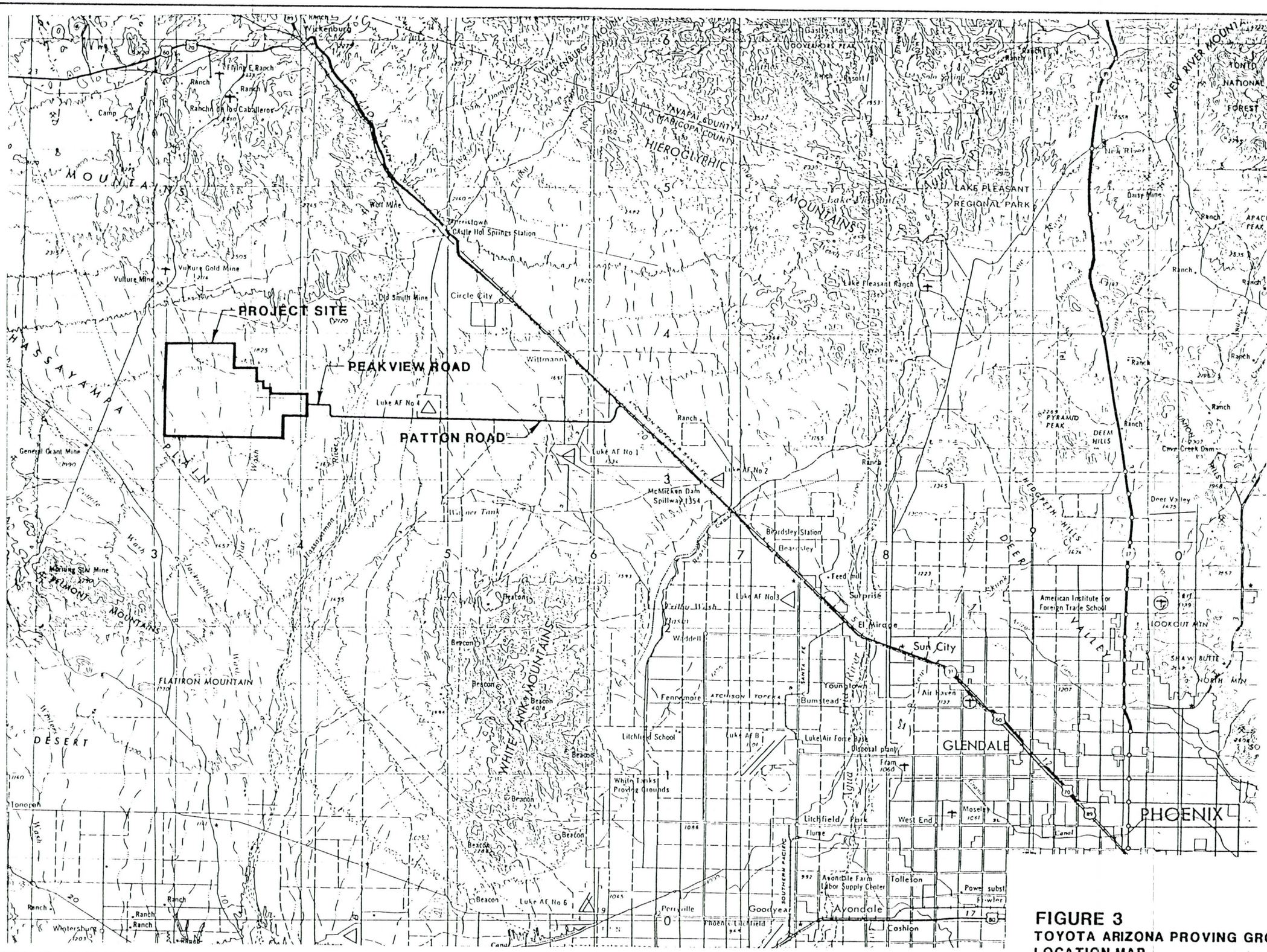
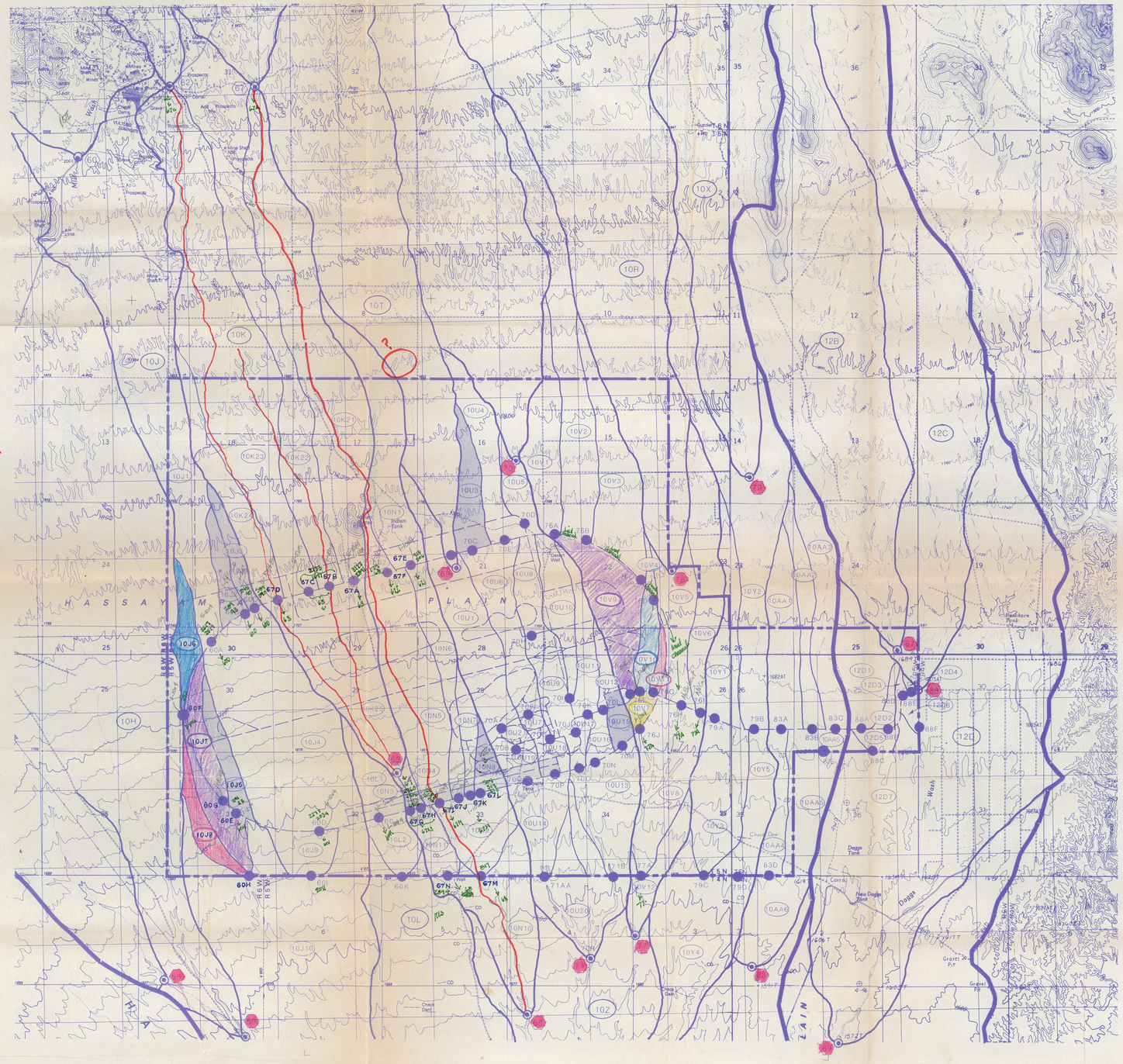


FIGURE 3
TOYOTA ARIZONA PROVING GROUND LOCATION MAP



N

SCALE: 1 INCH = 2000 FEET

0 2000

LEGEND

- DRAINAGE BASIN BOUNDARY
- SUBBASIN BOUNDARY
- 71 OR 67A — CONCENTRATION POINT NUMBER
- 10U9 — SUBBASIN OR SUBAREA NAME
- TOYOTA ARIZONA PROVING GROUND PROPERTY BOUNDARY
- SUBAREAS WITH STRUCTURES DESIGNED AS RETENTION BASINS

FIGURE 5

TOYOTA ARIZONA PROVING GROUND
DRAINAGE SUBAREA BOUNDARIES
AND CONCENTRATION POINTS

Sverdrup
CORPORATION
432 N. 44TH STREET, PHOENIX, ARIZONA 85008
(602) 244-8000

NO.	DATE	REVISION	BY	CH.

DRAWING TITLE:

DESIGNED:
DRN: CHKD:
SCALE:
H: V:
DATE:
JOB NO:
ACAD FILE:

DWG. NO.

SHEET
OF