DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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THE ARIZONA BUREAU OF GEOLOGY
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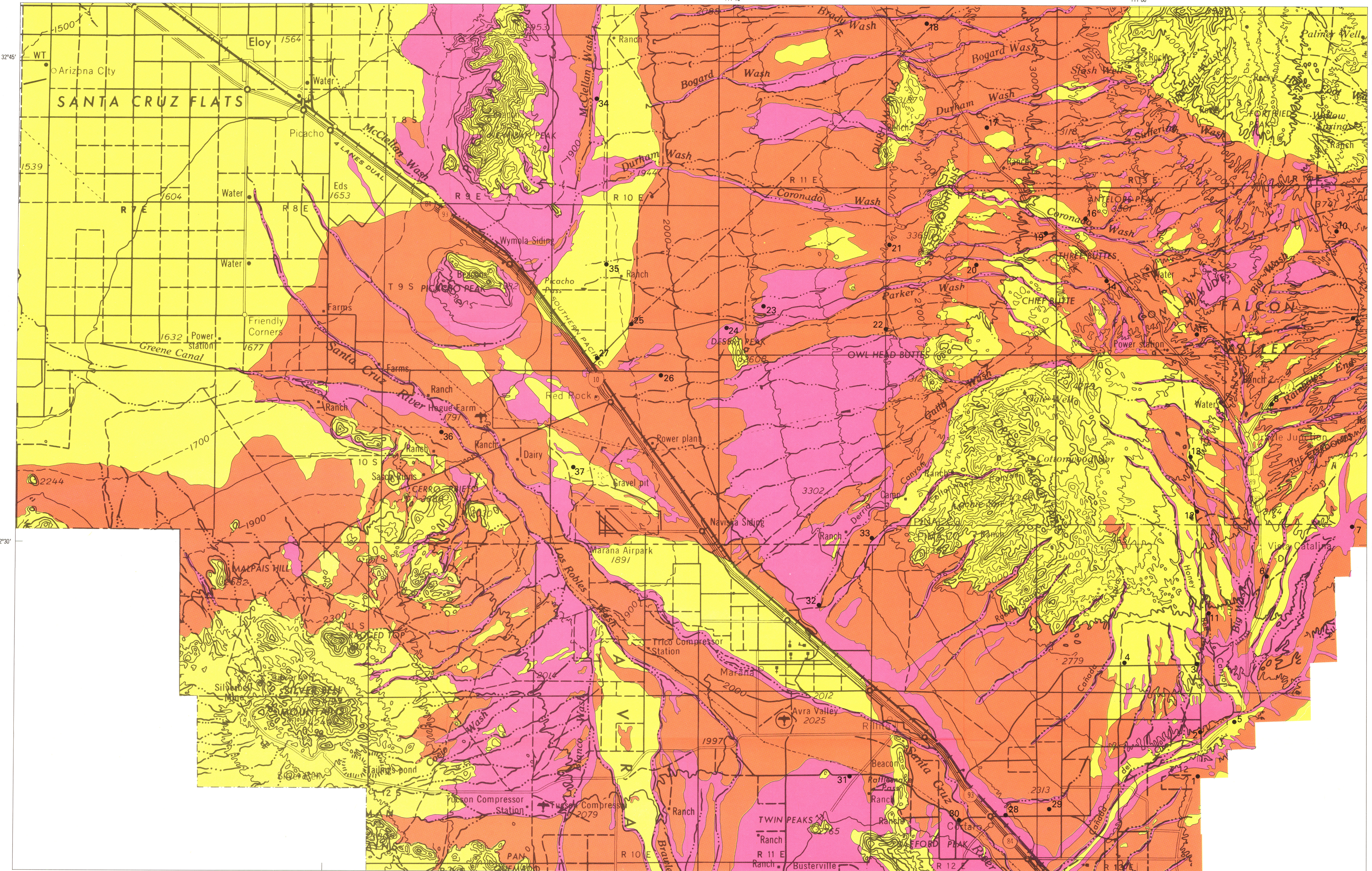
MISCELLANEOUS INVESTIGATIONS SERIES
MAP I–844–O (SHEET 2 OF 2)



Base from U.S. Geological Survey
Tucson 1:250,000, 1956–69

SCALE 1:125 000

5 4 3 2 1 0 5 MILES

5 4 3 2 1 0 5 10 KILOMETERS

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOUR AT 100 FOOT INTERVAL
NATIONAL GEODETIC VERTICAL DATUM OF 1929

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA—1980—W79323

MAP SHOWING RELATIVE ERODIBILITY, CENTRAL SANTA CRUZ RIVER VALLEY, TUCSON AREA, ARIZONA

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EXPLANATION

RELATIVE EROSION POTENTIAL

Lowest: The materials are less readily erodible by moving water and the erosion hazard is not significant in the selection of development sites. Slopes are generally flat to moderately gentle (0–10 percent). Surface indicators of erosion, such as gullying and rilling are either scarce or poorly developed, although local areas may be inundated by a few inches of sheet-flow during intense rainfall. Permeability of material is moderate to high (vertical infiltration rate of 0.6–20.0 inches/hour), except where underlain at shallow depth by nearly impermeable caliche or compacted clay. This zone of lowest erosion potential also includes areas of rock outcrop, infrequently inundated flood plains, and alluvial deposits with a rapid infiltration capacity. Vegetation also may reduce erosion in this zone

Moderate: Some development problems may exist that require judicious engineering solutions. Slopes are usually gentle to steep (up to 45 percent). Surface indicators of erosion are prevalent and may be well developed; erosion accomplished through a combination of channeling and sheetflow; permeability of material is generally moderate (vertical infiltration rate of 0.6–2.0 inches/hour), but may show a wide variance. This zone is principally on alluvial valley slopes

Highest: Zone of greatest erosion potential; includes potentially high-risk locations requiring costly remedial measures or special engineering solutions for development. Slope surfaces are variable; surface indicators of erosion are very extensive, and terrain may be nearly impossible to negotiate except on foot; gullies commonly are deeply incised with steep and usually unstable walls; gully walls are deeply cut by side flow; vertical infiltration rate is usually low (less than 0.6 inches/hour) but variable according to the type of material. This zone comprises stream channels, earth water storage, and associated flood plains; steep slopes in fine- to medium-grained silty sand and residual soils and areas that have been subjected to severe misuse through man's activities

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Site at which a soil sample was collected and analyzed. Number, 22, is the site number referred to in table

TABLE 1.—*UNIFIED SYSTEM CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES*

Major divisions			Group symbols	Typical names
Coarse-grained soils More than 50% retained on No. 200 sieve	Gravels 50% or more of coarse fraction retained on No. 4 sieve	Clean gravels	*GW*	Well-graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
		Gravels with fines	*GM*	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	Sands More than 50% of coarse fraction passes No. 4 sieve	Clean sands	*SW*	Well-graded sands and gravelly sands, little or no fines
			SP	Poorly graded sands and gravelly sands, little or no fines
		Sands with fines	*SM*	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
Fine-grained soils 50% or more passes No. 200 sieve	Silts and clays liquid limit 50% or less		*ML*	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	Silts and clays liquid limit greater than 50%		*MH*	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity

In locating urban developments, the physical properties of the surface materials must be considered if maximum safety is to be achieved and the aesthetic value of the land preserved. One such physical property is the relative erodibility of the land—the susceptibility of surficial materials to be worn away and removed by natural or man-induced processes. Moving water is the most significant erosive force in the central Santa Cruz Valley, although winds transport loose, fine-grained sediments, such as those on the Santa Cruz Flats (NW quadrangle area).

The purpose of this map is to show the probable relative response of different surface materials to the action of running water. The erosion zones are generalized and each may contain small areas that are more or less erodible than the general zone. Within these general zones, specialists can determine site-specific erosion potential and plan a suitable mitigation program.

Areas of active erosion were determined by a comparison of aerial photographs taken in 1956 and 1973. Four basic soil indices were determined for 37 sample locations using standard procedures as outlined in the Unified Soil Classification of the American Society of Testing Materials. The classification and group symbols are shown on table 1, the results for the 37 samples are shown in table 2. Areas that exhibit or possess the potential for similar responses to erosion were delineated in three categories, ranging from lowest to highest potential for erosion, on the basis of the inferred and probable response to the action of running water. These ratings do not imply that all materials in a designated zone will erode at the same rate, but that materials in that zone will exhibit similar erosional characteristics.

Generally, many physical properties influence erodibility, and changes in one or more of the properties will change the erodibility even though the remaining properties, such as type of soil, are not changed. Physical and engineering properties that determine erodibility are slope length and inclination, type and structural characteristics of geologic material, cementing or binding agent, compaction, rain intensity, exposure, and vegetative cover. Materials were classified according to the relative potential severity of the cumulative response to erosion at a site, considering each of the above criteria. For example, areas with slopes from 10–15 percent of loosely packed, fine- to medium-grained sandy silt (soil types SM and ML in table 2) show extensive erosion and are in the highest erosion zone. Flat-lying sandy materials (SP and SM) with a high infiltration rate are less affected and are in the zone of lowest erosion potential. A correlation also exists between the age of the sediment and erodibility. Generally, the older materials contain more clay (SC, CL, and CH) and cement binder and hence are more erosion resistant at a given slope angle than younger materials; recently deposited alluvium is more loosely packed on flood plains or slopes and will be removed relatively faster than older deposits. Very old crystalline rocks cropping out at the surface are the most resistant to erosion. Laboratory tests on selected samples (see table 2) indicate a probable correlation between the proportion of silt-clay fraction of soils and the potential of erosion in that material. Nonplastic to slightly plastic fines are common in alluvial materials that have highest erosion potential. Clays of low to medium plasticity have a higher resistance to erosion.

Cattle grazing has increased erodibility in some areas by differentially compacting the surface and by overgrazing, which exposes poorly cemented sediment to extensive gullying. Erosion is also accelerated at construction sites where surfaces are stripped. The runoff in these areas is increased and the steeper slopes in the area are subject to greater erosion than before development. Foundations, fill pads, and roads may be exposed to scouring due to a change in overland flow or slope design.

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TABLE 2.—*BASIC SOIL INDICES CALCULATED FROM LABORATORY TESTS PERFORMED IN ACCORDANCE WITH THE ASTM DESIGNATIONS D421–58, D423–66, AND D424–59*

Site number	Zone designation (see explanation)	Soil type[2] (Unified soil classification)	Percent passing 200 mesh (0.074 mm)	Liquid limit (LL)	Plastic limit (PL)	Plasticity index (PI=LL–PL)
1	B	SP	4.5	Non-plastic	Non-plastic	—
2	B	GP-SP	7.5	Non-plastic	Non-plastic	—
3	A	SC	26.3	27	19	8
4	A	SM	23.0	23	20	3
5	A	SM	12.4	Non-plastic	Non-plastic	—
6	B	SC	18.2	48	27	21
7	C	SP	3.5	Non-plastic	Non-plastic	—
8	A	SM, CL-ML	11.1	22	18	4
9	B	SC	17.8	35	23	12
10	B	SC	13.4	40	27	13
11	B	SM	16.6	Non-plastic	Non-plastic	—
12	B	SC	13.2	31	22	9
13	A	SM-ML	32.3	22	18	3
14	B	SM, ML-CL	9.5	30	24	6
15	B	SP	14.7	Non-plastic	Non-plastic	—
16	B	SC	12.3	30	19	11
17	B	SM	12.0	21	18	3
18	B	SM	22.3	Non-plastic	Non-plastic	—
19	B	SM	17.2	22	18	4
20	B	SM	12.4	Non-plastic	Non-plastic	—
21	B	SM	15.6	Non-plastic	Non-plastic	—
22	B	SM	21.7	Non-plastic	Non-plastic	—
23	C	SM-ML	33.0	Non-plastic	Non-plastic	—
24	C	SM-ML	26.3	Non-plastic	Non-plastic	—
25	B	SM-ML	33.6	Non-plastic	Non-plastic	—
26	B	SM	23.2	23	19	4
27	A	SM-ML	26.0	28	25	3
28	C	SC	20.0	40	25	15
29	B	GP-SP	5.2	Non-plastic	Non-plastic	—
30	B	SP	13.4	Non-plastic	Non-plastic	—
31	C	SP	19.7	Non-plastic	Non-plastic	—
32	C	SM, ML-CL	32.4	27	21	6
33	B	GM-SM	6.7	24	20	4
34	C	ML	52.7	Non-plastic	Non-plastic	—
35	A	ML	55.4	Non-plastic	Non-plastic	—
36	B	SM	17.0	26	24	2
37	A	SM-ML	37.2	Non-plastic	Non-plastic	—

[1]The liquid limit LL is the water content in percent of the dry weight at which two sections of a pat of soil barely touch each other but do not flow together when subjected in a cup to the impact of 25 sharp blows from below.
[2]The plastic limit PL is the water content at which the soil begins to crumble when rolled out into thin threads.

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