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HYDROLOGY OF THE MEADOW  
CREEK DRAINAGE, SAN LUIS OBISPO  
COUNTY, CALIFORNIA

for

Meadow Creek Wetlands Evaluation  
California Dept. of Parks and Recreation

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## EXECUTIVE SUMMARY

The configuration, past history, and rainfall information are presented for the Meadow Creek watershed. The 3,735 acre upper watershed drains into Pismo Lake, which in turn contributes to the lower watershed of 2,688 acres, where much of the runoff is derived from the streets of Grover City. Annual average rainfall is 16 inches, but highly variable. The present Meadow Creek channel below Pismo Lake was formerly the channel of Pismo Creek, which drained into Oceano Lagoon. The present mouth of Pismo Creek developed in 1911.

The peak runoff characteristics of the creek above Pismo Lake are presented, and the flood volumes entering the lake are calculated using a simple triangular hydrograph model. Flow into the lower watershed is constrained by the capacity of the railroad bridge, and in 100-year storms flooding over the railroad tracks will occur. The recent modifications to Pismo Lake are seen to have much reduced its flood retention capacity. Calculations from theoretical hydrographs are compared with the data from the 1969 storm, supposedly a 100-year storm. FEMA flood maps are seen to show the degree of flooding experienced in 1969.

Hydrologic conditions downstream of the railroad bridge are examined. The channel has a low capacity, due to low levees and low channel slope, and will flood at discharges of 200 cubic feet per second. This may be compared to 100-year storm discharges of 1,000-2,000 cubic feet per second. Flood volumes are calculated, and the flood height is largely determined by the flow from Carpenter Creek, and the ability of the outlet culverts in Oceano Lagoon to flow freely. Flood heights of about 10 feet can be expected over the Oceano Lagoon area after a 100-year storm. Creek restoration between Grand Avenue and Oceano Lagoon will have little effect on flood characteristics, but creation of islands could much diminish flood storage and increase flood height. Proposed modifications to Oceano Lagoon could similarly have a deleterious effect on flood storage.

It is the opinion of the author that Carpenter Creek should be maintained as a flood relief channel, and that it will be vital <sup>to</sup> reducing flood damage in the Oceano Lagoon area. The role of Carpenter Creek in the past is discussed, as is the potential for sea water intrusion, which is not considered a serious hazard. A flooding sequence for the Carpenter Creek area is presented for the present landform configuration.

Sedimentation is not considered a major problem for the watershed below Pismo Lake.

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## I - A DESCRIPTION AND BRIEF HISTORY OF THE MEADOW CREEK WATERSHED

### DESCRIPTION

The Meadow Creek watershed can be divided into two sections (see figure I-1). The larger section lies on the east and northeast side of Pismo Lake and the Southern Pacific Railroad tracks, and passes under the tracks into the lower section, which drains the bulk of Grover City and the surface of the Grover City- Oceano Mesa. The channel in the lower section drains to the south southeast parallel to, and behind, the line of coastal dunes, and enters the north end of the Oceano Lagoon. Water finally reaches the ocean through culverts under the levees of Arroyo Grande Creek, entering the latter at its mouth.

The upper section of the watershed, including Pismo Lake, has an area of 3,735 acres. Most of the watershed lies in gently sloping hills on the east side of the Highway 101 freeway, and drains into Pismo Lake via Meadow Creek and creeks in Canyon No.1 and Canyon No.2, all of which unite above the freeway culvert. These portions of the watershed either have been, or are likely to be, developed with both housing and commercial structures. The geology is dominated by relatively poorly consolidated Pliocene marine sands, called the Squire Member of the Pismo Formation, or by similar but younger sands of similar composition that were derived from the Pismo Formation and which today lie in a veneer above the Pismo Formation.

The channels, united as Meadow Creek below the freeway, flow almost due west into Pismo Lake. The south side of the channel is the northern flank of the Grover City- Oceano Mesa, dominated by Pleistocene stabilized dune sands. It is likely that the original courses of drainages in the area were diverted to the east and west by the advance of the ancient dune sands.

Below the freeway culverts the channel of Meadow Creek is a densely vegetated riparian corridor that terminates in Pismo Lake. Some water is added to the Lake from the drainage of a narrow zone of streets on the edge of the Mesa, and by water flowing under the freeway from smaller drainages west of Canyon No.1. Some additional water is developed from a narrow but dense commercial strip between the lake and the freeway.

Pismo Lake used to be a swampy area, with relatively little open water surface, but has recently <sup>been</sup> deep dredged and deepened, and island wildlife refuges have been constructed in the center of the lake.

Runoff from the lake flows under the railroad into a leveed channel that passes on the east side of the California Division of Parks and Recreation North Campground, past the golf course, under Grand

Avenue, and into a densely vegetated riparian zone that terminates in the South Campground and Oceano Lagoon. The North Campground and Golf Course have been constructed in the flood plain of the creek. Drainage from the west-sloping Mesa reaches the riparian corridor and creek through a series of storm drains and as channel flow. The collection area for the lower section of the watershed is about 4.2 square miles, or 2,688 acres, and is dominated by developed, urban land.

As can be seen in the following section, the lower section of the watershed was once the channel of lower Pismo Creek, which now flows to the ocean north of the Meadow Creek channel.

#### A BRIEF HISTORY OF THE PISMO-MEADOW CREEK WATERSHED

The first maps of the watershed are dated at about 1837. Map Espediente 513 shows Arroyo Grande Creek and the land to the south and east. This is a very crude sketch with notations in Spanish, developed for the purposes of illustrating the bounds of a land grant, and does not reveal any information on the Oceano Lagoon area (see figure I-2).

In 1837 a Diseno, or Picture Map, was filed by Frances Branch as part of a filed request for a land grant from Mexico for the Rancho Santa Manuela. This and the first-mentioned map were prepared by the same person. The map shows Pismo Creek and/or Meadow Creek joining Arroyo Grande Creek at the Oceano Lagoon area, although a lagoon is not specifically shown. The width of the channel behind the dunes is shown to be substantial (see figure I-3).

In 1873 the first of a number of subdivision maps was filed, indicating the economic end, and resultant breakup, of the Ranchos. The map was titled 'Map of Parts of the Ranchos, Corral de Piedra-Pismo- Bolsa de Chamisal, San Luis Obispo County, California, subdivided by Jas. T. Stratton'. The map shows Arroyo Grande Creek entering the eastern end of Oceano Lagoon, at which point it is shown joining a stream from the north, presumably Pismo Creek (see figure I-4).

In September of 1874 an 'official' County Map was produced. The 'Map of San Luis Obispo County, California, surveyed by R.R. Harris' can be seen today in the County Assessors Office and at Cal Poly's Special Collections Library, where the maps clearly show Pismo Creek flowing southward behind the dunes to Oceano Lagoon. There is no indication of a Pismo Creek mouth at the present location (see figure I-5).

A map filed in April 1880, was titled 'Plat of Part of the Ranchos El Pismo and San Miguelito, San Luis Obispo Co. Cal., owned by J.M. Price, subdivided by H.C. Ward'. The map shows Pismo Creek running behind the dunes to Oceano Lagoon, and being clearly labelled as 'Pismo Creek' as it entered the lagoon (see figure I-6). Oceano

Lagoon is shown extending a considerable distance inland through the area presently occupied by the airport and sewer plant. The Oceano Lagoon is shown to be a different shape than that shown in the Stratton 1873 map. It is clear from both maps that Oceano Lagoon's primary drainage is Arroyo Grande Creek, and that the lagoon is elongated along the line of that creek. Pismo Lake is shown to be extensive and reaching well above 4th Street to close to the present freeway bridge. The lower end of Pismo Lake is not receiving inflow from Pismo Creek, but drains westward to connect with Pismo Creek in the area of the North Campground.

In 1886 a map was filed on April 30, titled 'Map of the Subdivisions of a Part of the Ranchos El Pismo and San Miguelito, San Luis Obispo Co., California: R.R.Harris'. Pismo Creek is shown heading to the north end of Pismo Lake, although the junction is covered by notations. Pismo Lake is shown covering about the same area as the present lake, and is elongated to the northwest into what is presumably the inflow channel from Pismo Creek. It would appear to have connected with the lake at present low spot on the railroad, adjacent to the northwest corner of the present lake (see figure I-7).

This map has an inset Plan of the Town of El Pismo, which shows two coastal lagoons (?) flanking the north and south edges of the odd shaped parcel at the western end of Main and Pismo Streets.

In 1887 the developer of Pismo Beach prepared a colored map for promotional purposes. Two coastal lagoons or drainage swales (?) are clearly shown in the vicinity of the western ends of Main and Pismo Streets. The map is on file in Special Collections, Cal. Poly. State Univ. Library, San Luis Obispo, Ca. It is presumed that the map was based on a more official 1887 map, filed on June 11, and titled 'Map of the Town of El Pizmo' (Book A, Page 156, San Luis Obispo County Book of Maps, County Assessor's Office). In this map there is a suggestion that lakes (?) or drainage swales (?) still exist in the vicinity of the western end of Pismo and Main, based on the shape of the subdivided map boundaries. Neither of these maps provides significant information on the Meadow Creek drainage.

Again in 1887, a 'Map of the Town of Grover, San Luis Obispo County' (Book A, Page 6, San Luis Obispo County Book of Maps, County Assessor's Office) was filed (see figure I-8). It shows a channel for Meadow Creek which leaves Pismo Lake at, or close to, the present railroad bridge, running more-or-less along the line of the present channel through the North Campground area, but running well to the west of the present channel through the area of the present golf course, past Grand Avenue, and through the northern portion of the riparian corridor north of the South Campground. There is another channel shown entering Pismo Lake from the northwest side, possibly the Pismo Creek inflow channel shown in 1886 maps. A Southern Pacific Railroad right-of-way is shown on the map, but it is presumed that no track or embankment had been constructed, and that there was no interference with the Pismo Lake inflow and

outflow. At this time the railroad's southern termination was Paso Robles (Kreiger, 1988, p.77).

Similar to the above, the 1887 Map of the Grover and Gates Tract, El Pismo Rancho, San Luis Obispo County is filed in Book A, Page 114, San Luis Obispo County Book of Maps, County Assessor's Office.

Of historical interest only, a map was filed on May 19, 1888, titled 'Map of the Pismo Avenue Addition to the Town of El Pismo, surveyed by R.F.Parsons'. It shows a subdivision on the north side of Pismo Avenue, which runs from the western termination of Pismo Street to connect first with the west end of Main Street, and then to the beach. This could indicate that the southern of the two lagoons had been filled to provide land for this subdivision.

At the south end of the drainage, an 1893 map was filed as 'Map of Subdivision No.2, Ocean Beach, San Luis Obispo County' (Book A, Page 150, San Luis Obispo County Book of Maps, County Assessor's Office). It shows Oceano Lake with Gray, Surf, York, and Brook Streets as today, the lake much altered, and Brook St. acting as a creek channel joining the lake to the sea (see figure I-10). Brook is presently parallel to, and just north of, the Arroyo Grande Creek channel outlet. The map would appear to be a plan for future development, as it shows little resemblance to the channel and lagoon configuration shown in the following map. Among other things, Oceano lagoon is shown dredged into a straight edged, rectangular pond.

The 1893 'Map of the Town of Oceano and Adjoining Subdivision' (Book A, Page 147, San Luis Obispo County Book of Maps, County Assessor's Office) shows a complex of creeks and channels at the junction of Arroyo Grande Creek and Oceano Lake (see figure I-9). Arroyo Grande Creek ran through the area of the present airport, joining the Oceano Lagoon at the southeastern end. Outflow from the lagoon was from the southwest corner of the lagoon. The north end of Oceano Lake is not shown, and the lagoon is shown to remain wide through the southern portion of the present South Campground.

In 1894, the Southern Pacific Railroad Company produced a map titled 'Pismo Beach and Vicinity from the Official Map of the Southern Pacific Railroad Company, December 15'. This map clearly shows Arroyo Grande Creek entering the Oceano Lagoon at its southern end, and a narrow lake is drawn all the way up to Grand Ave. and into the North Campground. Pismo Creek is called Villa Creek, and is shown joining the lake at the northern end of what is now the North Campground. No flow of Pismo Creek into Pismo Lake is shown, and the present channel of Meadow Creek is shown, but the creek joins the lake just north of the present Carpenter Creek.

The first train reached San Luis Obispo in 1894, and it is presumed that railroad construction would have started across the Meadow Creek drainage.

On January 30, 1899, Map No.2 of the Town of Oceano, San Luis Obispo County, California was created (see figure I-11). This is an apparently promotional map which shows Arroyo Grande Creek flowing into Oceano Lagoon, but no other creeks entering the "Lake Oceano". The map, which bears realtors notations, is on file with Special Collections, Cal. Poly. State Univ. Library, San Luis Obispo, California.

Modifications around the North Campground area are shown in the 1902 'Map of Grand Beach, California, San Luis Obispo County, California' (Book A, Page 7, San Luis Obispo County Book of Maps, County Assessor's Office). It shows an older channel for Meadow Creek seen on earlier maps, and a new channel cut close to the present channel for Meadow Creek south of Pismo Lake to south of Grand Avenue (see figure I-12). The new channel is shown to leave Pismo Lake somewhat south of the earlier channel, and appears to be artificial.

In 1902-1903 a 'Map of the Town of El Pizmo' (Book A, Page 155, San Luis Obispo County Book of Maps, County Assessor's Office) indicates shows no sign of lakes or gullies west of Pismo St. and Main St. Again, this is of historic information only and has no bearing on the Meadow Creek drainage.

The first detailed geologic map of the area was created in 1904 by H.W. Fairbanks. Titled 'Description of the San Luis Quadrangle, California: U.S. Geological Survey Geologic Atlas, San Luis Folio 101', it shows Pismo Creek passing through a series of channels to the west of Pismo Lake, with a minor connection to the lake (see figure I-12). The area of Pismo-Meadow Creek south of Grand Avenue is mapped as open wide channel, rather than the narrow line of a creek, and opens to the south into Oceano Lagoon, which is fed from the south by Arroyo Grande Creek.

It seems that the present mouth of Pismo Creek was still not present in the major storms of 1905. On March 15, the Morning Tribune describes the loss of the old wharf, Post Office, and Cafe Royale at Pismo Beach after exceptionally high tide, and high wave and wind conditions. The damage is again described on March 18 in the Morning Tribune.

In an article titled 'When Mother Nature wept, her tears moved land' in the column called Echoes, by Jean Hubbard, (Five Cities Times-Press Recorder, Arroyo Grande, California, date not found, probably 1960's), she describes a flood in 1905 when: "Pismo Beach took the brunt of the storm that year and the old Cafe Royale, a tavern and dance hall, and 100 feet of the wharf were lost. Pismo Creek previously had meandered to a merger with Arroyo Grande Creek and drained into the ocean near Oceano. Now it cut across the sand dunes and reopened an old channel to the sea." I am not sure that this is wholly correct, and the breakthrough to the sea may have been in 1911. The Telegram-Tribune articles from 1905 make no mention of a break through the dunes.

In 1905 a 'Map of Subdivision No.1, Ocean Beach, San Luis Obispo County' (Book A, Page 149, San Luis Obispo County Book of Maps, County Assessor's Office) shows Oceano Lake, the lake much altered, and Brook Ave. acting as a creek channel joining the lake to the sea. Brook Ave. is presently parallel to, and just north of, the Arroyo Grande Creek channel outlet. The alterations to the lagoon are similar to those shown in the 'Map of Subdivision No.2', filed in 1893 (see figure I-10), and may not represent a real alteration of the lagoon.

A 1906 'Map of the Ocean View Terrace Subdivision #1' (Book 1, Page 1, San Luis Obispo County Book of Maps, County Assessor's Office) shows "Pismo Creek" crossing "Pier Avenue Blvd.", presently Air Park Drive, in the Oceano Lagoon vicinity.

Again in 1906, a 'Map of the Ocean View Terrace Subdivision #2' (Book 1, Page 9, San Luis Obispo County Book of Maps, County Assessor's Office) shows "Pismo Creek" entering "Oceano Lake". Also indicates a complex knot of channels joining Pismo Creek to the northeast of the lagoon, these possibly being part of Arroyo Grande Creek.

At Pismo Beach in 1906, a 'Map of the Kruckman's Addition to the Town of Pismo, San Luis Obispo Cty., Cal.' shows Pismo Creek running parallel to Ocean and Peerless (? now Park Ave.), and bending to the southwest at Cypress St. The creek would appear to be too far west to have drained into Pismo Lake, but would have bent to the south through the campgrounds at, and west of, Highway 1.

A major storm hit the coast in 1909. Reported in the January 21 Morning Tribune is the loss of 300 feet of track at Oceano, washed out along Arroyo Grande Creek (location not identified but likely at the Oceano Packing Sheds). On January 22, the Morning Tribune describes Oceano as being inundated by flood, with 5 feet of water at 'Wheeler's Store' and a 400 feet washout of the S.P. railroad tracks. On January 26 the Morning Tribune describes the fall of 4.35 inches of rain in 15 hours on top of 19.53 inches for the season. It reports that water cuts through Dockery Town and washes away three 'Harvey Houses'. This appears to be destruction of the southern fringe of Pismo Beach by Pismo Creek. Jean Hubbert (ibid) said of this storm: "It was said that Pismo Creek that year 'ran as wide as the Mississippi river and four cottages and two barns were washed out to sea'".

1911 is a momentous year in Pismo Creek history. Emma Boxfold provided photographs of the 'Villa Creek' flood of 1911 (see figures I-14,-15). An explanation written on photocopies of photographs at County Historical Society Museum states that: "This creek followed the present Highway 1 into Oceano Creek along the side of the sand hills. After days and days of constant rain Pismo Creek backed up little by little into the southern portion of Pismo (Dockery Town). In order to stop this Hans Skov and Temple Boxold opened up an outlet in the sand hills with a spade and the pictures show the

result." The pictures show that houses (or more properly, shacks) in Dockery Town were undercut and fell into the channel.

In 1913 B.R. Wood authored the Gazetteer of Surface Waters of California, Part III. Pacific Coast and Great Basin Streams, U.S. Geological Survey Water Supply Paper 297. Page 259 describes Pismo Creek as "flows southwestward to Pismo, then east of south through a tidal marsh to the Pacific". This would seem to be in conflict with the breakthrough to the ocean in 1911, but it is likely that the Gazetteer used out-of-date information, or at least did not recognize the permanence of change. Of interest is the description of the Meadow Creek drainage as 'tidal marsh'.

Some of the sedimentation problems in the area were illustrated by the February 2 edition of The Morning Tribune. The article describes accretion of sediment on the Arroyo Grande flood plain following a major flood. Alluvial flats were raised from an initial elevation of 8-12 feet below the railroad grade to 1-3 feet below the grade on the east side of the S.P. tracks, and were raised from 8 feet below grade to 2-4 feet below grade on the west side of the tracks.

In 1914, on March 6-8, The Morning Tribune describes major flood damage on the Arroyo Grande floodplain.

In 1927, on February 17, The Herald Recorder, (Vol. XXII, No. 42, p.1) reports the "Heaviest Storm in Many Years". The article states "The Arroyo Grande Creek at Oceano assumed flood proportions Wednesday morning and about 10 a.m. the banks began to give way before the rush of the water, and by noon it had covered the lowlands south of the Routsahn steel bridge and was rushing down toward Lakeside Park, following the low places. Late in the afternoon the home of W.C. Hart on the Lakeside Park road was threatened, the water flooding the yard." This suggests flooding in the vicinity of the present Oceano Airport and Oceano Lagoon caused by Arroyo Grande Creek levee failure and spillage of the creek northward.

In the 1940's a drain was cut through dunes at the location of Carpenter Creek, which up to this time had not appeared in any maps or historical descriptions.

During the 1950's the golf course area was graded, with dune sands being pushed into the Meadow Creek flood plain. It is thought that all vestigial remnants of the original Meadow Creek-Pismo Creek channel were destroyed at this time, except for a few ponds within the golf course.

The Carpenter Creek drain was destroyed by erosion in 1961 or 1962, and sea water intruded into the Meadow Creek drainage for a short time.

In the 1960's, Lopez Lake was created for water storage and flood control, and much of the flood risk from Arroyo Grande Creek was substantially reduced. <sup>No</sup>

In 1969, the watershed experienced what was probably close to the 100-year storm. Severe flooding took place in the North Campground area, and Carpenter Creek served as a major outlet for flood waters. The channel so-produced was sufficiently deeply excavated to enable sea water to intrude into the North Campground area, although after a few years the channel became blocked by dune sands, as it is today.

In 1984 and 1985 Floodway Maps are produced for various portions of the Meadow Creek drainage. These are included elsewhere in this text. These include the 'Flood boundary and floodway map, City of Pismo Beach, Community Panel Number 060309 0002, August 1, 1984, Federal Emergency Management Agency'. There are also the Community Panel Maps 060304-0727C and 060304-0729C for the Meadow Creek drainage between North Campground and Oceano Lagoon.

This map shows that floodwaters for the 100-year flood will cover all of the North Campground and the area between the dunes on the west side of the campground and the railroad tracks, submerging the travel trailer parks on the east side of Highway One. In addition, flood waters from Meadow and Pismo Creeks intermingle. The Oceano Lagoon-South Campground area is also inundated, and flood waters of Arroyo Grande Creek and Meadow Creek are seen to merge in the 100-year storm.

In 1987 the California Department of Fish and Game, partly in response to environmental degradation in the rapidly developing watershed, dredged the Pismo Marsh into the present Pismo Lake. During the late 1980's development plans in the Pismo Lake drainage provided some hydrologic information which is included below in the report.

#### RAINFALL CHARACTERISTICS

Long term rainfall information for the area has been stored by the San Luis Obispo County Engineering Department, and by California Polytechnic State University. Figure I-16 is taken from County Engineering Specification Book D, and shows a set of curves used to calculate rainfall intensity for storms of various return periods, or probability of occurrence. The average rainfall for the watershed is about 16 inches (1897 to 1947 data), and is contoured for the area in figure I-17. Another set of curves, developed for areas of higher average rainfall in the County, is shown in figure I-18, and may be applicable to some storms in this watershed.

Under figure I-16, the 100-year, one hour storm could deliver 1.5 inches of rain in an hour, and in figure I-18 the storm would deliver 1.9 inches. The 10-minute storms would deliver at rates of 4 inches and 5 inches per hour, but, of course, only for a duration of 10-minutes.

The rain then runs across the land and into drainage channels. The amount of rain that becomes runoff is defined by the Runoff Coefficient, where a coefficient of 1.0 indicates all rain enters the runoff, and 0.5 indicates half the rain enters the runoff. A table of coefficients used in this area are taken from the County Engineering Department's tables, and are shown in figure I-19.