Chapter 9

A QUESTION OF SETTLEMENT: EMERYVILLE'S LANDFILL PROBLEMS

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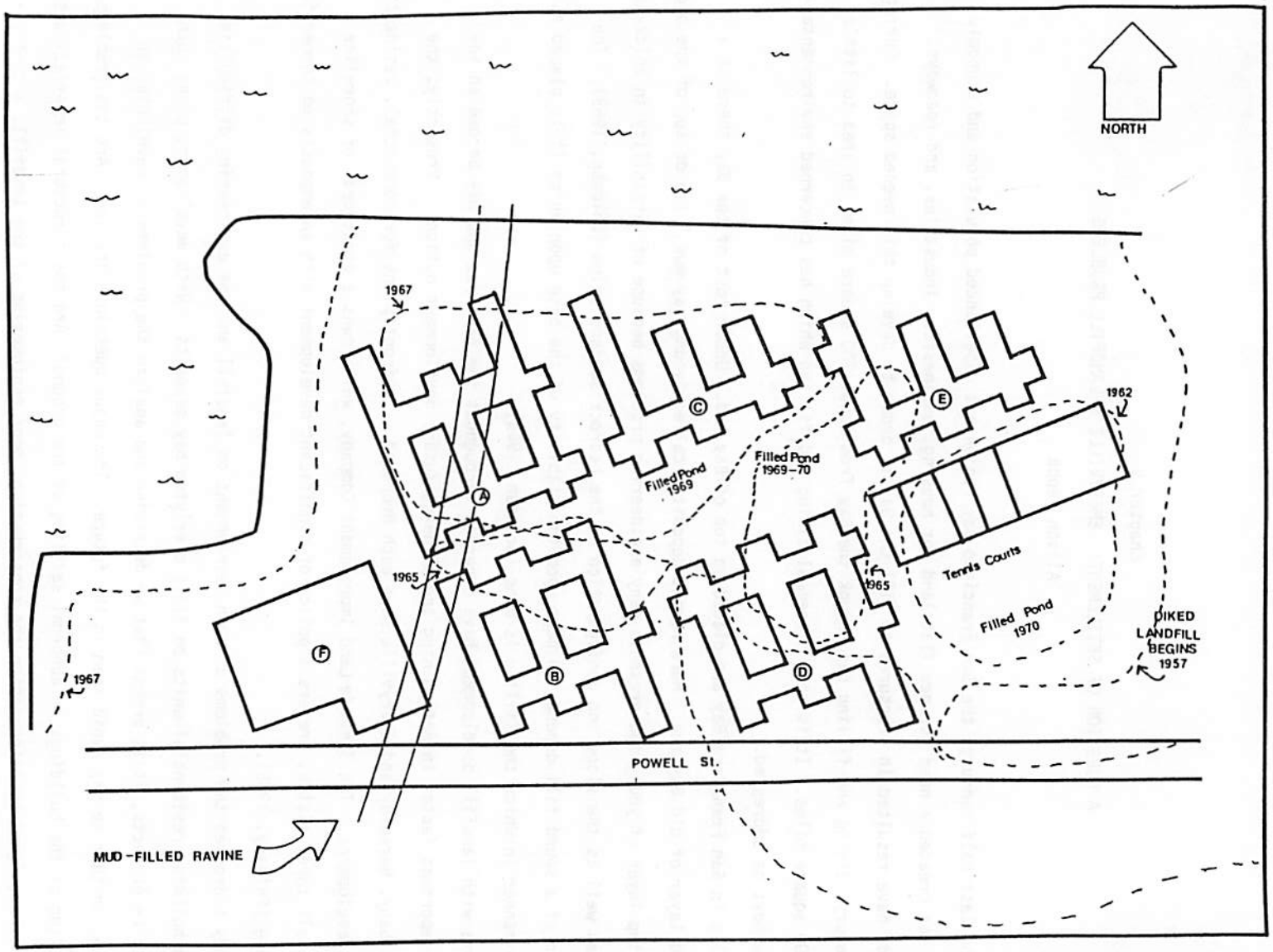
Over the last half century, the San Francisco Bay region has experienced population and economic growth that has created a need for new flat land for housing, businesses, industries, and roadways. These demands have resulted in pressures to fill the Bay in order to develop this needed space. During the last century, diking and filling has shrunk the Bay from about 700 square miles in area to little more than 400 square miles. It is this piecemeal diking and filling which has concerned environmentalists and now must be addressed.

All fills in San Francisco Bay are placed on top of Bay mud. Under most of the Bay there is a deep, packed layer of old Bay mud. More recent deposits, called "young bay mud," lie on top of the older muds. The top layer of young mud presents many engineering problems because of variability in thickness of the mud as well as the slope and configuration of the bedrock surface below (Goldman, 1969). The construction of a sound fill depends in part upon the stability of the base upon which it is placed as well as the manner in which the filling is done (Goldman, 1969).

Problems with landfill development have occurred throughout the Bay Area and may become an increasingly important factor in determining and planning future development options. Presently, the cities of Albany, Berkeley and Emeryville have each proposed waterfront plans for commercial, residential and office development. The Santa Fe Land Improvement Company, which owns a great deal of shoreline property in all three cities, prefers a policy of significant development with an emphasis on commercial and hotel use (Phinney, 1985).

My study addresses the problems of such development on landfill and the engineering difficulties inherent in building residential units on fills overlying bay deposits. With development plans such as the Santa Fe projects, it is urgent that we determine and analyze the problems of developing on landfill now, so that we may avoid them in the future. The major questions include: Are the problems due to settling of the buildings or abnormal settling of the ground? Are the structural imperfections a function of negligent building design and construction, poor engineering of the landfill, a combination of both or perhaps only a function of normal settling of the landfill itself? These questions and others have not been formally addressed. Even today, there is not a great deal of information readily available suggesting guidelines for Bay landfills. Thus it is my intention to bring these problems



WATERGATE SITE PLAN

FIGURE 1

and their possible causes into focus.

The specific site I researched is the 25-acre Watergate Apartment Complex, located at the west end of Powell Street in Emeryville, California. The project consists of an apartment complex of 1,249 units in six buildings (Figure 1), on a promontory consisting of man-made fill (WCA, 1969). There are landscaped tennis courts, recreation areas, swimming pools and a clubhouse.

Background

The project was built between 1970 and 1972 (WCA, 1969). The landfill, consisting of industrial waste, wood, asbestos, and rubble, was placed over compressible Bay mud deposits, and was not completed until just prior to the start of construction. Consequently, ground settlement has occurred, causing structural damage to the buildings, such as cracking, slumping and breaking up of sidewalks, garages and landscaping. The project has been plagued with problems almost from its inception. Leaks were reported before construction of the first building was completed, and continues to be a problem today (Burns, 1978).

Policy concerning landfill engineering and development had not been legally defined at the time of the Watergate development. In 1970, the California Environmental Quality Act (CEQA) did not exist; therefore an Environmental Impact Report was not required for the Watergate project. The San Francisco Bay Conservation and Development Commission (BCDC) had not yet established guidelines for landfills. The developers were issued permits by Emeryville and the U.S. Army Corps of Engineers (Splitter, 2/19/85, personal communication).

The private consulting firm of Woodward-Clyde and Associates (WCA) was contracted as the consulting soil engineers and geologists for the Watergate project. They performed several detailed soil investigations prior to construction in late 1970. The first major report describes the soil conditions at the site (WCA, 1969). Its purpose was to establish subsurface conditions and to develop recommendations for the foundation and grading (the process of levelling the land for drainage purposes), and to estimate future land settlement. The report also concentrated on determining the most suitable type and depth of foundations and construction problems related to pile placement. A final pile inspection was made for each building site and also for the clubhouse, swimming pool and tennis courts (Nishkian, 1972). Also in May, 1971, Woodward-Clyde finished a Tower I report (WCA, 1971) which discussed the risks of lurching, liquefaction, and spreading -- all phenomena which occur when the soft mud has been compressed too quickly or unevenly.

On June 7, 1982 the Watergate Homeowners Association, representing the homeowners and renters, filed a $90 million lawsuit against the original contractor, Lathrop/McCloskey, the developer, the the architect and the converters (the company that converted the units to condominiums in 1979) (Bay City Journal, 1982). The suit was filed for failure to follow plans and specifications and for alleged

defective architectural details. To date, litigation is still in progress, and the suit has expanded to include over 25 entities being sued by the Watergate Homeowners Association. Woodward-Clyde Associates are also cross-defendants in the suit.

Some of the major damages incurred throughout the past decade include shifting hall corridors, cracked and leaning cement stairways, and broken electric, plumbing, and sewage piping between buildings. Masonry block walls surrounding the garage area of each building are designated in part as shear walls. Analysis of these walls with respect to seismic resistance indicates many are stressed by as much as 500% (Degenkolb, 1984). There are over 300 feet of cracks on these walls throughout the complex (Wagner et al., 1984). In one year alone there were over 100 apartments which experienced water damage (Burns, 1979). Ground settlement of up to 18 inches has occurred in garages and streets. Boring samples have even been found to contain broken pieces of pavement seven feet below the surface (Nishkian, 1979).

Past Work

Background studies include an important study of the potential problems of placing fills upon soft Bay mud (Lee and Praszker, 1966). A special report prepared initially for BCDC, in which the latest data on geology, mineral deposits, earthquake hazards and fill problems was discussed and analyzed, was also important at the time (Goldman, 1969).

Methods

At the time I began my research, the litigation was still in process. Therefore many of the needed documents, reports, surveys and written correspondence were deemed confidential and unavailable to the public. Since the Emeryville Redevelopment Agency refused to allow me access to their files, I began my search at the new city hall. Here, I was able to peruse the Condominum Conversion file which gave me a good summary of the problems to date and a lead to some of the more influential people involved at the time right before conversion in 1978 and 1979.

The Alameda Superior Court has records of all permits, transactions and cross references dealing with Watergate, and those which I needed had to be ordered from the Hayward Superior court where they have been housed.

The Berkeley campus libraries provided background information, surveys and studies done in the past, Building Codes and Fill Standards, as well as many federal and local studies on the sedimentation and geology of the Bay mud. Four libraries in particular, the Intergovernmental Studies, Government Documents, Environmental Design and the Earth Sciences library were especially helpful in supplying local news, guidelines and City Plans.

The last and most important phase of my study involved personal interviews with the attorney representing the Watergate Homeowners Association, who referred me to an Investigative Report done by

private consultants (Wagner et al., 1984) and another attorney, Ann Rankin, who is the main researcher for the case.

Other sources of information included the construction consultants and soil engineers, Woodward-Clyde Associates, who laid out the plans for the foundation and directed the last stages of the fill for the project; the Watergate Homeowners Association, and Bill Davenport, vice president of the Board of Directors of the WHA.

The biggest problems that I encountered were not being able to obtain enough relevant studies on landfill operations in the Bay Area, and compiling and analyzing thousands of pages of data and description from various scattered reports. Another problem was that many of the companies involved in the litigation were unable to discuss the project; thus a large amount of technical firsthand knowledge was unavailable.

Geology

The geologic formations underlying the Watergate Complex are typical of East Bay shoreline deposits and fall into two distinct categories: a bedrock composed of sandstone, siltstone, chert, and greenstone of the Franciscan Complex; and a younger unconsolidated sedimentary sequence which has been divided into older Bay mud, sand deposits and younger Bay mud (WCA, 1969).

During the geologic events that led to the formation of the present bay, hundreds of feet of soft, unconsolidated sediments accumulated on an old bedrock surface. The Watergate site is constructed over some 600 feet of geologically young sediments. Young Bay mud blankets the site in thicknesses of less than 10 feet to over 45 feet. This soft, compressible silty clay was deposited in the Bay over the past 6,000 to 8,000 years. Since it is soft, the recent Bay mud is consolidated only under its own weight.

Construction

In general, the area between the Eastshore Freeway and the Watergate site was filled over the Bay mud using waste from industrial and construction activities (WCA, 1969). Random Bay fill by the Pabco and Fibreboard plants began during WW II and was terminated in 1968 as a result of mounting concern for the Bay environment. The waste consists mainly of rolls and fragments of roofing, tarpaper, linoleum and asbestos mixed with soil. The low-rise site has also been filled with rubble, broken concrete, extensive amounts of broken wood from demolished houses, soil, asbestos pipe and some steel mill slag from the Murphy Pacific Company. All of the waste fill is combined with various percentages of clayey and sandy soil imported from off the site.

The fill plan consisted of constructing a series of closure dikes of concrete rubble, soil, wood and slag, then filling the inside ponds with softer soil and wood (WCA, 1969). By October, 1957, the dikes had reached the east edge of the site (Figure 1), hence no fill was more than 13 years old when

construction began. By late 1965, all of the dikes had been completed and most fill had been placed on the east and south parts of the site. As of 1969, three diked interior ponds under Buildings A, C, D and E (Figure 1), totalling about ten acres in area, remained to be filled; these were completed by February 1969 when the site was turned over to Lathrop Construction Company.

As the development plans began to evolve in early 1969, the nature of the filling operation was modified, and all further importation of wood, rubble, or waste fill was halted (WCA, 1969). Only clean soil fill or reworked fill from overfilled areas over the 1965 ponds was used. The large north pond was filled by May 1969. The oldest fill, closest to the freeway, is mostly roofing paper and linoleum, whereas the fill towards the Bay is predominantly clay, then asbestos and wood at depth (WCA, 1969).

The final result of all filling operations as of mid-1969 produced about fifty acres of older fill about 25 feet thick, which had caused nearly normal consolidation of the mud beneath, except for in the ravine area (a wide band of very deep Bay mud) under Buildings A, B and F (Figure 1) on the west side of the site, in addition to the ten acres of recent pond fill.

Since total filling was not complete until late 1969, and construction was due to begin in 1970, there was not enough time to complete primary settlement (squeezing out of the interstitial water from the mud); therefore, fill surcharging, a process used to accelerate compaction, was recommended by the engineers, Woodward-Clyde Associates. However, due to financial and construction schedule consideration, it was decided to use sand drains and a five-foot thick earth-fill surcharge in mid-1970 to accelerate the normal settlement rates in the Bay mud under the pond fill. This method requires less time and money than the aforementioned fill surcharging.

After the pond areas were pre-settled by sand drains, building and street grades were prepared, and the Watergate apartment buildings were constructed on deep piles (WCA, 1979). Deep pilings were used extensively under all apartment buildings themselves and under all pools, clubhouses, and tennis courts. All piles were designed to extend below all fill and Bay mud to as deep as 125 feet below street grade.

The six buildings designated A through F consist of a ground level garage with reinforced concrete columns supporting a post-tensioned, concrete slab which in turn supports three floors of wooden frame construction (Nishkian, 1972). There are also three-story frame wings continguous with the concrete structure which are supported on grade beams at grade level (i.e., equal to the top level of the fill) and reinforced concrete bridges between certain buildings with three floors of frame construction on the bridges (Nishkian, 1979).

Settlement

Site surface settlement occurs primarily due to surface fill loading and the resulting compression of the soft Bay mud (WCA, 1979). Since all buildings are pile-supported, and little settling of the

piles themselves has occurred, site settlement has occurred mainly in the paved and landscaped surface areas between the structures and in the garages under the apartments.

The total settlement is composed of two parts: (1) the theoretically predictable settlement due to Bay mud consolidation, and (2) the generally unpredictable settlement due to waste fill compression. The Bay mud consolidation is a function of mud thickness, mud softness, and the past history of fill surcharge on the mud, whereas the settlement due to waste fill is dependent upon density of fill, materials used and overburden pressure (Goldman, 1969). When these two variables were put together, settlements approached 18 inches, whereas areas areas located over dense slag fill, placed in the mid-sixties, settled less than two inches.

Where the Bay mud is thickest, the settlements are the greatest. The thickest mud occurs in a buried ravine (50-70 feet wide, over 45 feet deep) located under paved areas under Buildings A, B and F, hence these areas experience the greatest settlement. The next greatest settlement area occurs under the ten acres of 1969 recent pond fill.

There are two basic settlement areas: the south half, which had been filled for longer than four years before construction; and the north half, which had been filled for less than a year. The south ares was not only completely filled for a longer time, but it had been piled up to ten feet higher than the rest of the site.

Building Damages

Subsidence of soil surrounding pile-supported structures at Watergate has resulted in numerous structural problems. Although the buildings were designed to comply with the Uniform Building Code and Earthquake Standards of the time, damage resulting from differential building movement can be observed throughout all six apartment buildings. Firstly, where the interconnecting bridges meet the buildings there exist a multitude of separation joints. The movement incurred has exceeded the anticipated amount substantially, and as a result, almost every joint cover has failed (Nishkian, 1979). Secondly, differential shrinkage has occurred in Buildings A, B and D. Approximately one inch of differential shrinkage can be observed across the 5'6" width of the second and third floor corridors.

Ir has also been necessary to make frequent repairs to the utility lines where they leave the pile-supported buildings. The sewer, water, and electrical lines are secured to the buildings, and where settlement of ground has occurred, the pipes have been pulled apart and broken.

Other structural deficiencies include cracked and leaning stairways, surface humps and valleys in the garages, broken paving, and garage cave-ins (Nishkian, 1979). Many more technical deficiencies exist in the building construction that are beyond the scope of this report.

Discussion

The problems occurring at Watergate involve many factors and cannot be attributed to one single failure. The responsibility to set up guidelines for the landfill was that of the engineers, Woodward-

Clyde Associates, as no federal or regional agencies had been set up as yet for the sole purpose of overseeing residential development. As the Emeryville Redevelopment Agency had not been formed at the time of the construction, the city engineer was the person responsible for officially overseeing the project and issuing a permit (Merrill, 11/19/84, personal communication). A permit requires that the recipient is willing and able to carry it out without frequent supervision by the regulatory agency at public expense.

Mr. F.P. Lathrop, the project's developer, held a lot of political clout at the time and received the land along the Emeryville Crescent in return for agreeing to pave the road from where the Oceanview Restaurant now stands to the Eastshore Freeway--approximately three miles of roadway. The landfill was not engineered specifically to hold large residential units (Goldman, 1969, p. 46ff) until Lathrop/ McCloskey finalized their plans one year before the actual construction began.

All of the filled pond areas and much of the older fill on the north and west sides of the site had not completely compacted by the time construction began. Thus, the engineers, Woodward-Clyde, recommended fill surcharging to accelerate this normal settlement rate; yet this also was not done and instead, a less efficient but cheaper and more time-efficient proces was implemented. As a result, secondary settlement (mud compaction) was not accelerated and therefore substantial settlements occurred after the buildings were completed.

Lee and Praszker (1966) also recommended that heavy compaction, heavy boulders or coarse rock not be used for residential fill in order to avoid mud waves and liquefaction. In fact, all of these recommendations were ignored (WCA, 1969) and as a result, mud waves, abnormal differential settlement and large voids did occur (Davenport, 2/19/85, personal communication).

The ravine area, located under Garages A, B and F shows the highest degree of settlement. Yet, looking at the settlement patterns, it is evident also that a large amount of settlement occurs in the recent pond fills as well. This suggests that the amount of primary settlement which is allowed to occur before construction begins is just as important as the mud thickness, when predicting settlement amounts. Also, in the areas where the fill is uniform, there is less settlement than in the surrounding areas. The same phenomenon occurs where the dense slag exists, further pointing to the fact that if the landfill had been carefully monitored from the beginning, such variable and large settlements might not have occurred.

In my opinion, the landfill has been an overlooked part of the problems occurring at Watergate. The lawsuit presently in litigation examines only the inadequacy of the building construction, while ignoring the effects of the mismanaged landfill. Due to the variability in fill consistency, Bay mud depth, settlement acceleration processes used, and time allowed for primary settlement, it would be very difficult to allow for these differential settlements in the construction of the buildings. The developers should have excavated the fill and replaced it with a monitored, clean fill; or waited

another year to complete the entire process of fill surcharging over the entire recent-pond-fill area.

The political maneuvering and negligent carrying out of the plans should be a thing of the past, yet unfortunately these are problems cities must still deal with today. It is my hope that organizations such as the Bay Conservation and Development Commission, the Association of Bay Area Governments, the U.S. Geological Survey, and city Development Agencies put more effort into research and enforcement of their policies as well as producing more viable guidelines for development. It is evident from the Watergate example that developers in the future will have to be very careful with the planning processes of any large development. The many commercial buildings planned in Berkeley should be many years in the future, as sufficient time must be given for the landfills to settle.

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