Larkspur Landing - Marriott's Hotel

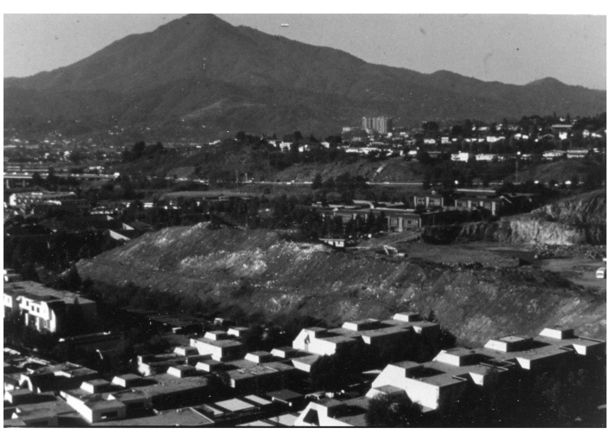
By Wes Bender

In late 1985, I got a call from Dick Hall of Kiewit Pacific asking if I was available to assist them on a contract that they had been awarded for site preparation for a new Marriott's Hotel and Condominiums in Larkspur, California. The project involved a considerable amount of blasting in close proximity to apartment buildings and a shopping center.

The site where the hotel was to be built was in a portion of an abandoned quarry. Previously, the eastern half of the quarry had been recontoured and now contained a complex of 342 apartments. The remaining half of the quarry needed to be developed for the hotel. Across the street from the site was a shopping center and on the western edge was an office complex.

I met with Dick and with Jim Murray, the project superintendent and Phil Mitchell, the project engineer, and we reviewed the site. There was a total of 220,000 cubic yards of excavation, an estimated 160,000 cubic yards of which required blasting. The main concern was a rock ridge that ran north and south along the eastern edge of the site. It had not been quarried previously due to the poor quality of the rock. It was 80 feet tall and the base was approximately 50 feet from the nearest row of apartments. This ridge made up most of the 160,000 cubic yards to be blasted. Of this, 136,000 cubic yards had to be crushed and stored on site for later use.

After reviewing the site and the specifications, we laid out a plan to accomplish the work in the six months allocated, with a mind to minimizing the adverse effects on the surrounding neighbors. I developed a letter that we could distribute to everyone concerned in the vicinity. It explained what we were doing, that there would be controlled blasting, what the blasting signals were and what they might expect to feel. It also gave names and phone numbers to call if they had any concerns. I determined that I should accomplish pre-blast condition surveys on the closest 112 apartments and on one building in the shopping center. The office complex on the west side was at a sufficient distance that pre-blast surveys there were not deemed necessary.



Kiewit completed their mobilization while I conducted the pre-blast surveys. After the surveys were complete, documenting all of the existing defects in the apartments, we started the blasting program. We felt that we would be better served if we started blasting on the opposite side of the ridge from the apartments and then slowly blast nearer, taking out the east side of the ridge last. By that time, the apartment dwellers would be accustomed to the blasting. Work was restricted to the hours between 8 a.m. and 5 p.m. We usually shot twice a day, timing the blasts to be detonated at times when there was a considerable amount of distant activity and traffic noise.

During the pre-blast surveys, the apartment complex manager indicated to me that several of the occupants were concerned about a rock pinnacle that was high on the top of a slope behind the apartments. It was rumored that the pinnacle had been slipping and they were worried that vibration from the blasting might bring it down into the rearmost apartment buildings. Phil and I went up and inspected it and determined that it had not moved and appeared to be stable. He painted a small target on the back of it and a matching target on a bedrock outcrop about 50 feet behind it. After each of the early blasts and occasionally thereafter, Phil and a technician measured the distance between the targets. There was no evidence of the pinnacle moving.

Prior to the start of blasting, a meeting was held with all project personnel concerned and I laid out four standard blasting patterns to be utilized. Kiewit owned an REO BM 125-10Z sequential blasting machine that would be used to initiate all blasts. In effect, this machine is ten electric blasting machines in one, which we programmed to fire 10 milliseconds apart. The machine checked each circuit just before firing and would shut down if the next circuit to fire didn't show continuity. The sequential machine, coupled with Atlas Rockmaster electric detonators in delays 6 through 23, allowed the design of fairly large blasts where no two holes would detonate simultaneously. By using the 6th delay (125 ms) as the first detonator, all of the detonators would have seen their firing current before the first hole detonated. (We would have used Nonels to initiate the blasts, but Nonel surface delay units were not competitive price-wise at the time and, in any case, project personnel were more familiar with standard electric detonators.)

To minimize low frequency concussion, I designed the blasts such that the rate of blast progression along any row of holes was at or below half the speed of sound. Blasting patterns, using 3" diameter holes, ranged from 5' x 5' for the shallower and/or smaller blasts, to 8' x 8' for most of the production blasts. Maximum hole depths were 22 feet. Blasts were designed to keep vibration at the nearest apartments at or below 0.4 in/sec. Vibration in the shopping center and at the office buildings on the west side of the project would be much lower.

Because the rock had to be shot rather lightly, both to reduce vibration and to prevent flyrock, it was anticipated that there would be some oversize material in the upper regions of many blasts. For this reason, a Cat with a ripper was used to dig out each blast. A Hy-Ram hydraulic breaker mounted on a Cat 235 excavator was utilized to reduce any oversize material so that it would go into the 42 x 48 jaw crusher.

I emphasized the need to properly stem the holes with crushed stone to prevent flyrock caused by a hole “rifling”. In most blasting situations, holes are stemmed with the closest available material, the drill cuttings that are mounded around the hole. This isn’t the most efficient stemming material, however. Jim had ¼” crushed gravel delivered to the site. At least a couple feet of this were poured down each hole on top of the explosives column and then the hole was stemmed to the collar with drill cuttings. When explosive energy pushes upward on the crushed stone, it tends to lock into place and hold for a longer period before finally yielding. This helped with fragmentation in addition to preventing flyrock.

After the crusher, screening plant and portable generator were in place and operational, I conducted a stray current check in the surrounding area. An unacceptable level of stray current was found that would have precluded using electric detonators. A heavy ground cable was then used to bond all of the powered equipment together, reducing stray current in the ground to safe levels.

Initially, I had Kiewit monitor blasts with three blasting seismographs. These were placed at the three closest buildings. Also, for the first four blasts, I placed an additional unit nearer to the blasts, providing a greater range of data to assist in developing more accurate vibration regression rates. It turned out that, due to site response characteristics, blast vibration attenuated more quickly with distance than I had anticipated. After a reasonable amount of data had been gathered, we reduced the seismographs to two for the remainder of the blasting program.

Once blasting was well underway, with vibration and airblast below the intensities that might cause problems, there was no need for my constant presence on site. I did, however, continue to visit the site every two to three weeks or whenever Jim felt I needed to address some specific problem. I would review the blasting program, the blast reports and vibration and air blast records and then provide them with a report on my findings.

122 blasts, utilizing a total of just under 111,000 lbs of explosive, about two thirds of which was AN/FO, were required to remove the rock.

In spite of all of our efforts, there were some complaints of damage. Early in the blasting program, a complaint was received from a homeowner on the opposite side of the Highway 101 freeway, approximately ½ mile away. He complained that his home was slipping down a slope because of the vibration from blasting. The city indicated to us that he was a chronic complainer, but we investigated his claim anyway. I attempted to record blast vibration near his home, but any vibration that managed to reach his location was masked by the traffic on the freeway. He didn't pursue the matter further.

Part way through the program, one hole blew out, resulting in a broken bathroom window in one apartment, a broken glass-topped patio table, a car's rear window being broken and a car that suffered scratched paint. Kiewit promptly addressed the situation and had repairs effected. We held a meeting with the blasting crew, re-emphasizing the need for good stemming practice. No more flyrock occurred from any of the blasts.

Just as the blasting was coming to an end, a complaint was received from a lady in one of the more distant apartments that an antique plate had fallen and broken. This occurred while she was away for a few days, but she was sure that blasting had caused it to fall. The cost of my traveling to the site and investigating her claim would have far exceeded the amount she was asking, so Kiewit opted to pay her. At my suggestion, however, they delayed agreeing to the payment until after all blasting had been completed. This served to preclude other claims that might have been forthcoming when she told all of her friends about her good fortune. (I found out later that a small earthquake had occurred in the bay area during the time frame when the plate was supposed to have fallen. That was probably the true cause of the breakage, but unfortunately there were no witnesses to the actual occurrence.)

Another possibly hazardous situation developed with a young lady who lived in one of the upstairs apartments immediately adjacent to the project. Occasionally she would arrive home in the afternoon, take off her clothes and wander about her apartment with the curtains open. It was all that the drillers could do to keep their feet out from under the tack drills. (We were pretty sure that she knew what she was doing.)

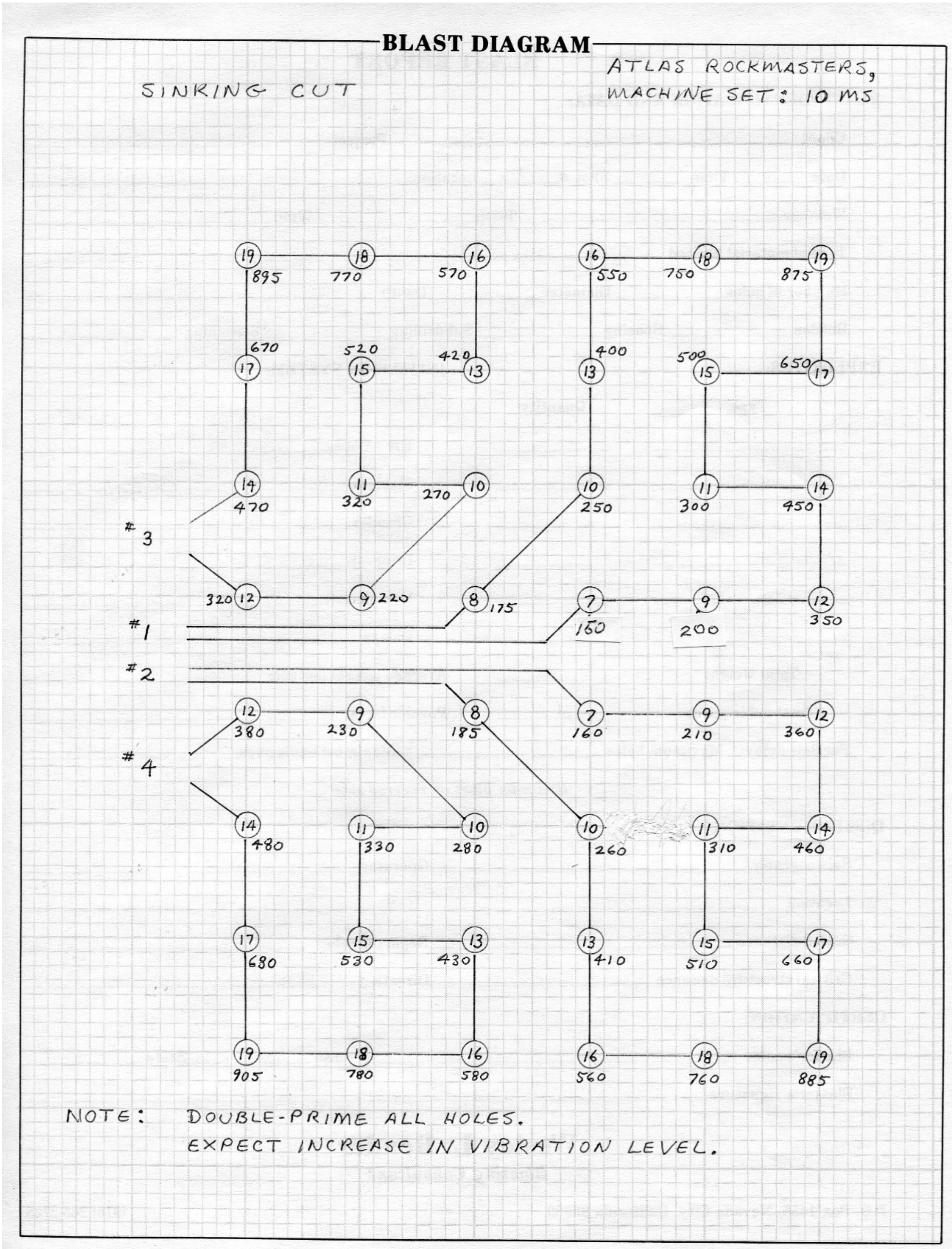
The project owner was so impressed with Kiewit's performance on this contract that before it was completed, they awarded Kiewit the next contract for paving and utilities without taking any bids. This new contract was received before final grade was reached in the ridge blasting. Jim and Phil overlaid the utilities excavation drawings over the shot patterns for the final lift and then drilled and loaded holes in those blasts to also break the rock deeper in the trenches that would be required. That saved them a considerable amount of money in the follow-on contract.


Photos are courtesy of Jim Murray and Kiewit Pacific Co.

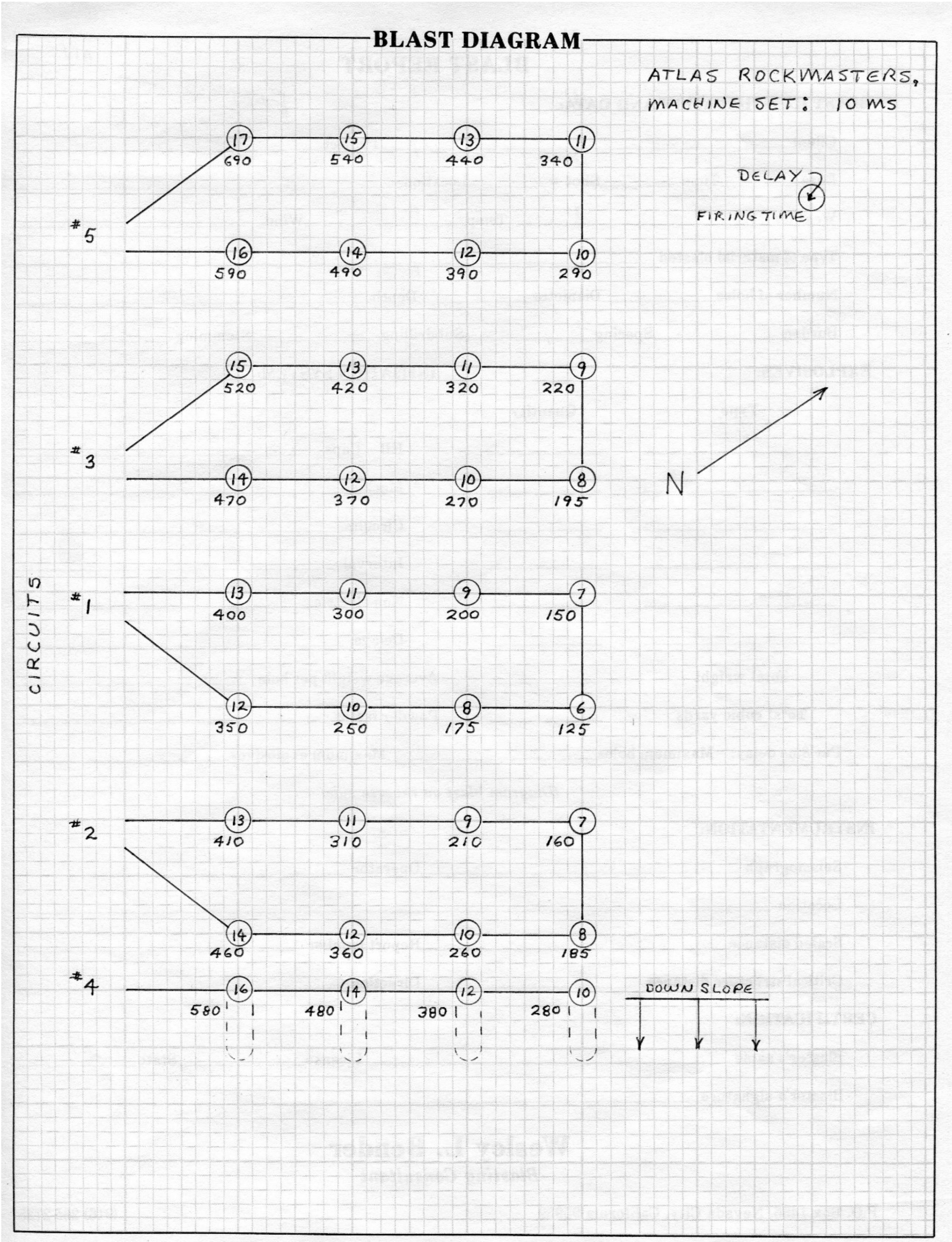
Larkspur Landing site as it appears today (courtesy of Google Earth).

Marriot's Hotel in center. White buildings in lower left are the apartments.

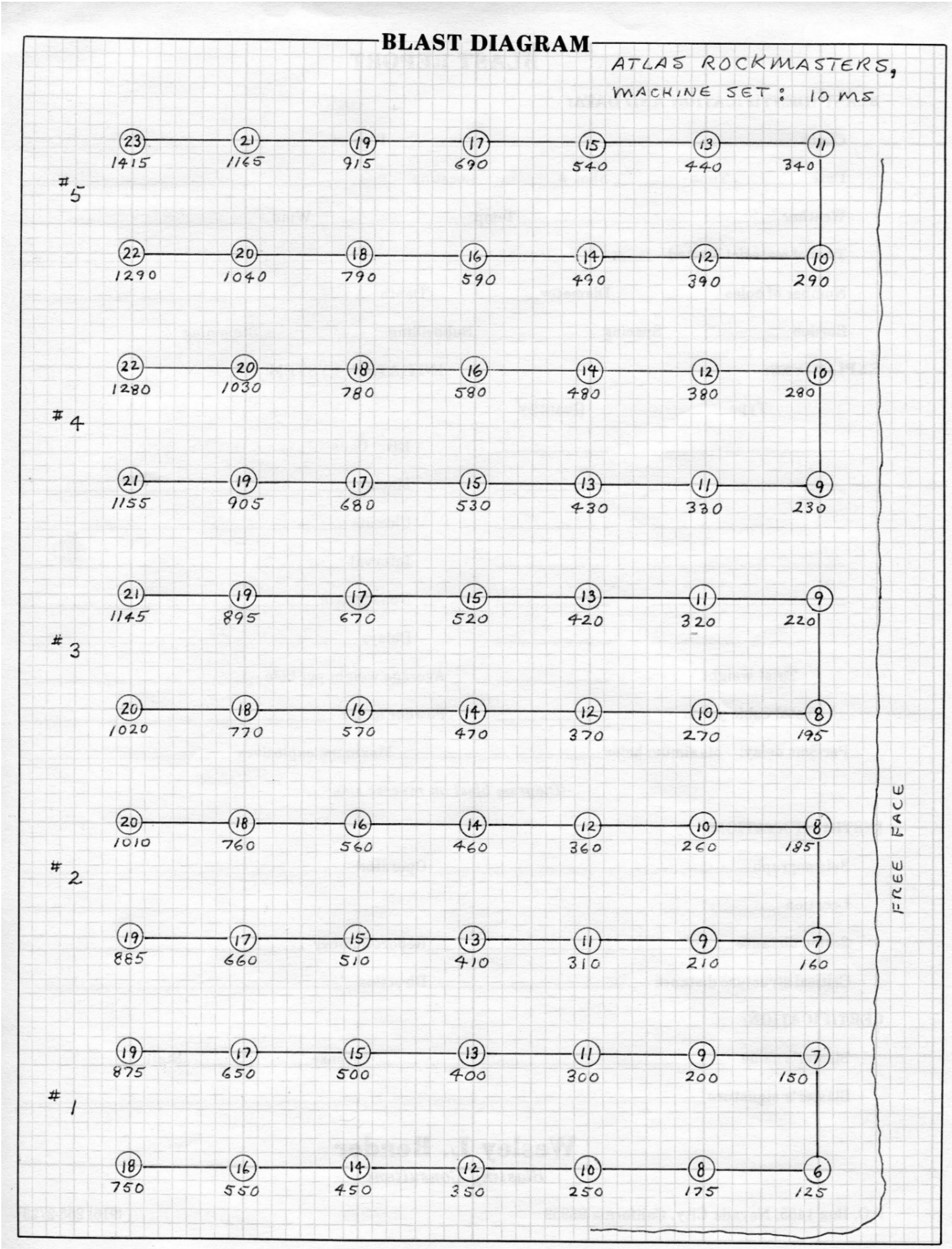
The following are some of the blast timing schemes that I developed for use with the sequential blasting machine that was used on this project. Numbers within the circles are the detonator delay number. Adjacent numbers are the actual firing time of the hole in milliseconds after pressing the fire button.



Sinking cut blasts where no free face exists



Blast design for blasting on the slope nearest the apartments. Gravity prevents pulling the rock upslope and tries to pull it downslope. This design tends to pull rock sideways along the slope and it worked quite well. A row of K-rail was placed along the edge of the street to catch any rock that rolled down the slope.



More conventional timing for blasts with one or more free faces. There are several duplications in firing times, but they are separated by a sufficient distance and do not co-operate to increase vibration appreciably. Total duration is a little more than 1-1/4 seconds for this 70-hole blast.