

REDWOOD NATIONAL PARK

WATERSHED REHABILITATION PROJECT
UNIT 90-3

M-5, G-4, M-7 ROADS AND SLOPES

SUMMARY REPORT

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TABLE OF CONTENTS

INTRODUCTION	1
Location	1
Road and Logging History	1
Geology and Physiography	5
Soils	5
Erosion Processes / Hydrology	6
REHABILITATION WORK	7
Evaluation and Prescription Phase	7
Labor Intensive Phase	8
Heavy Equipment Phase	8
Haul Road Stream Crossing Excavations	10
M-5 Road	10
G-4 Road	10
M-7 Road	10
Rodger's Creek Bridge Removal	11
Skid Trail Stream Crossing Excavation	12
Outsloping	12
Exported Outsloping	14
Clearing and Scattering trees with Heavy Equipment	14
DISCUSSION	16
REFERENCES CITED	16
APPENDIX	16
Table 1: Rehabilitation Work Cost Summary, Unit 90-3	A-1
Table 2: Stream Crossing Excavation Costs, Unit 90-3	A-2
Table 3: Outsloping Excavation Costs, Unit 90-3	A-3
Table 4: Exported Outsloping Excavation Costs, Unit 90-3	A-4
Table 5: Other miscellaneous costs, Unit 90-3	A-5
Table 6: Road brushing	A-6

LIST OF TABLES

Table 1: Rehabilitation Work Cost Summary, Unit 90-3	A-1
Table 2: Stream Crossing Excavation Time, Rates and Costs, Unit 90-3	A-2
Table 3: Outsloping Excavation Costs, Time and Excavation Rates, Unit	A-3
Table 4: Exported Outsloping Excavation Time, Rates and Costs, Unit 90-3	A-4
Table 5: Miscellaneous Excavations Time, Rates and Costs, Unit 90-3	A-5
Table 6: Other Miscellaneous Costs, Unit 90-3	A-6
Table 7: Clearing and Scattering Trees, Time, Costs and Rates, Unit 90-3; M-5, G-4 and M-7 Roads	15

LIST OF FIGURES

Figure 1: Map A, Location Map of Watershed Rehabilitation Unit 90-3;	2
Figure 2: Map B, Topographic Map of Bridge Creek Watershed with Watershed Rehabilitation Unit 90-3	3
Figure 3: Map C, Logging History of Watershed Rehabilitation Unit 90-3	4
Figure 4: Map D, Erosion Control Prescription Map for Watershed Rehabilitation Unit 90-3	9

INTRODUCTION

Watershed rehabilitation project Unit 90-3 encompassed 230 acres in the Bridge Creek basin. The work included treating 0.6 miles of the remaining 1.1 miles of the M-5 Road and .3 miles of the remaining 1 mile of the G-4 Road and .55 miles of the remaining 1.5 miles of the M-7 Road. The purpose of the project was to address erosion problems and to enhance ecosystem restoration on the areas which were impacted by previous timber harvesting activities, and to prepare the M-7 Road for future development of a section of the Redwood National Park Horse trail through Bridge Creek.

Project work consisted of removing road fill from stream channels, moving unstable road fill to more stable areas, removal of the M-7 Bridge across Rogers Creek (informal name) and retrieving buried top soil and recontouring hillslopes in some areas.

Heavy equipment work was performed under IFB contract awarded to J. W. Brashear Construction Inc, of Redding, CA. The contract was awarded for \$191,181.75. Modifications to the contract were \$4,747.05 making for a total cost of \$186,434.70. The contractor used a Daewoo DH180 LC hydraulic excavator, a Cat 225 hydraulic excavator, a Cat D6d dozer, a Cat D8H dozer and a Cat 966C Loader in the summer of 1990 to accomplish the work.

LOCATION

Rehabilitation Unit 90-3 is located in Redwood National Park approximately 7 miles SSE of Orick, California (Figure 1). It is mostly within T9N, R1E, Section 12 and very slightly within T9N, R2E, Section 7. The rehabilitation unit consisted of three separate remanent spur roads mainly within the Bridge Creek watershed, with some work in the Tom McDonald Creek watershed (Figure 2). The road segments were portions of the M-5, G-4 and M-7 Roads. The remanent of the M-5 Road is located on the mid-upper slope of the Bridge Creek and Tom McDonald Creek Watersheds. The G-4 Road is located on the same hillslope as the M-5 Road, approximately 300 feet lower on the slope. The M-7 Road is located lower on the slope within the inner gorge of Bridge Creek and the inner gorge of the tributary creek named by Redwood National Park staff as Rodger's Creek.

ROAD AND LOGGING HISTORY

Analysis of historic air photos reveals that the section of the M-5 Road which was rehabilitated as part of this project was constructed sometime between 1954 and 1962 within the Bridge Creek watershed to the watershed divide with Tom McDonald Creek. The remainder of the M-5 Road into Tom McDonald Creek was constructed between 1962 and 1966. Road construction was contemporaneous with logging (both tractor and cable yarded) on the hillslope from the B-5 Road (above the M-5 Road) down to below the M-Line (Figure 3).

The G-4 Road was built sometime between 1962 and 1966 coincident with extensive logging of vast portions of the hillslope. The G-4 Road was built from the G-Line in Tom McDonald

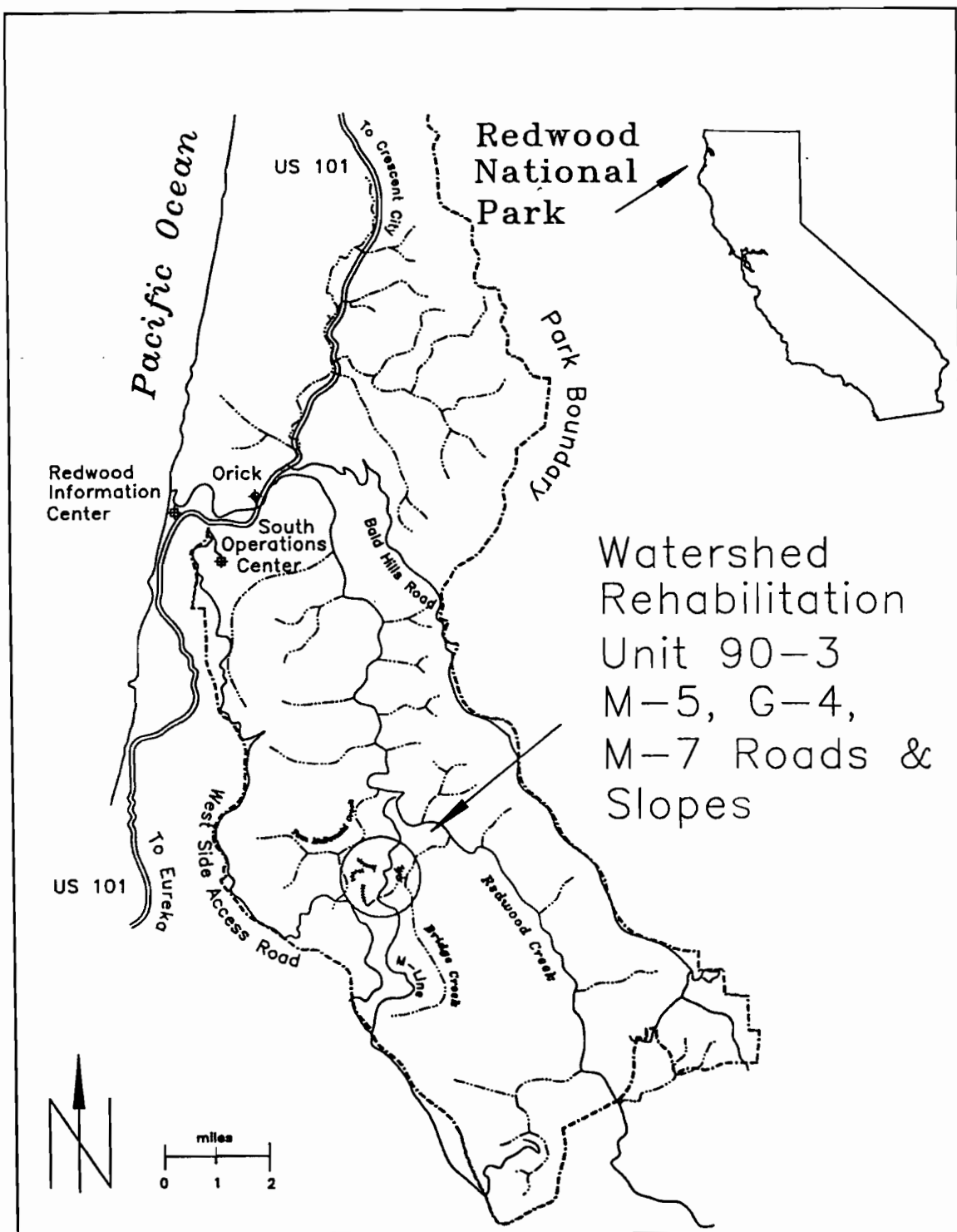


Figure 1. Map A, Location map of Watershed Rehabilitation Unit 90-3.

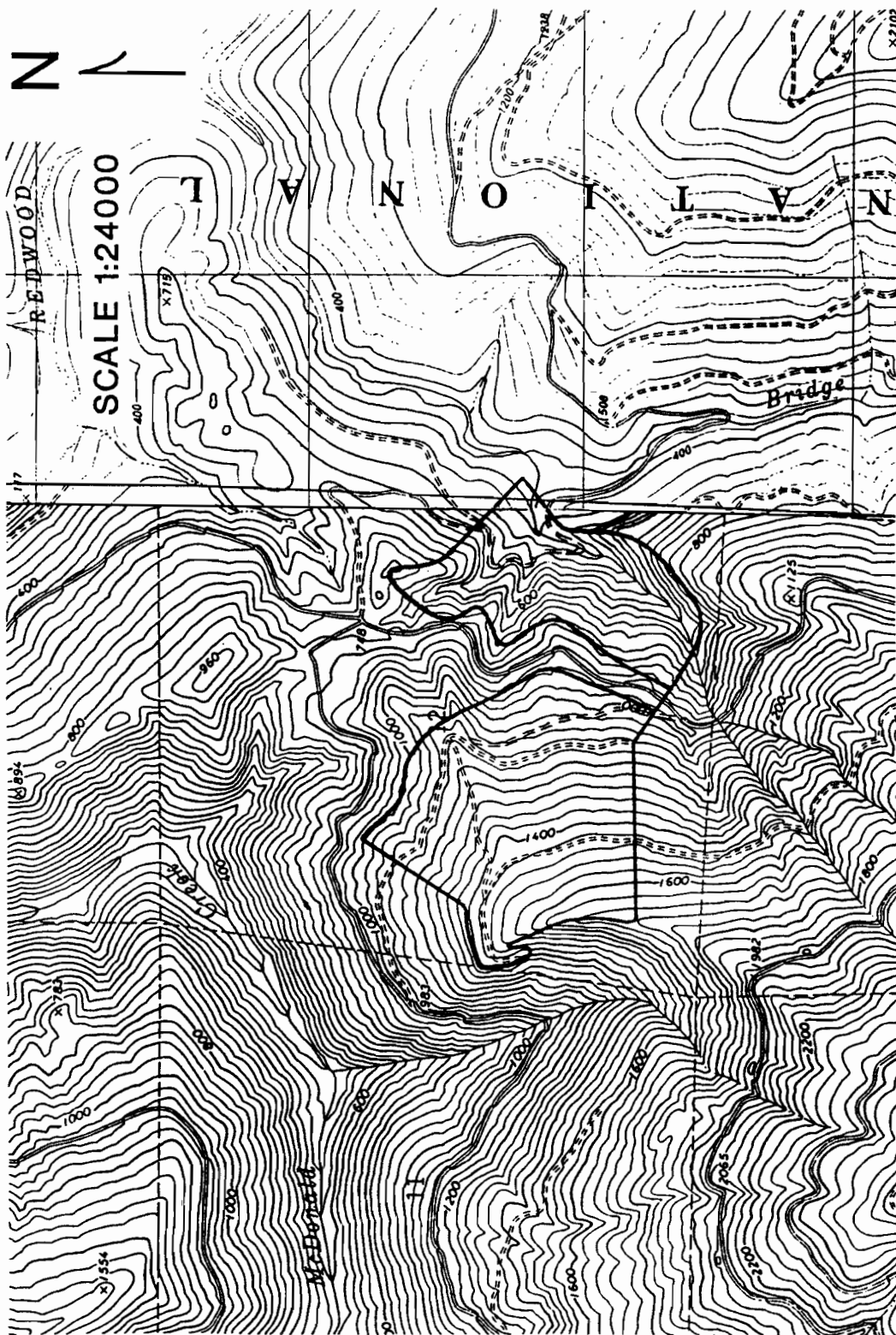


FIGURE 2; MAP B.
 Topographic map of watershed rehabilitation unit 90-3 (from
 Rodgers Peak and Bald Hills U.S.G.S. quadrangle maps)

FIGURE 3; MAP C. Logging History of Watershed Rehabilitation Unit 90-3.

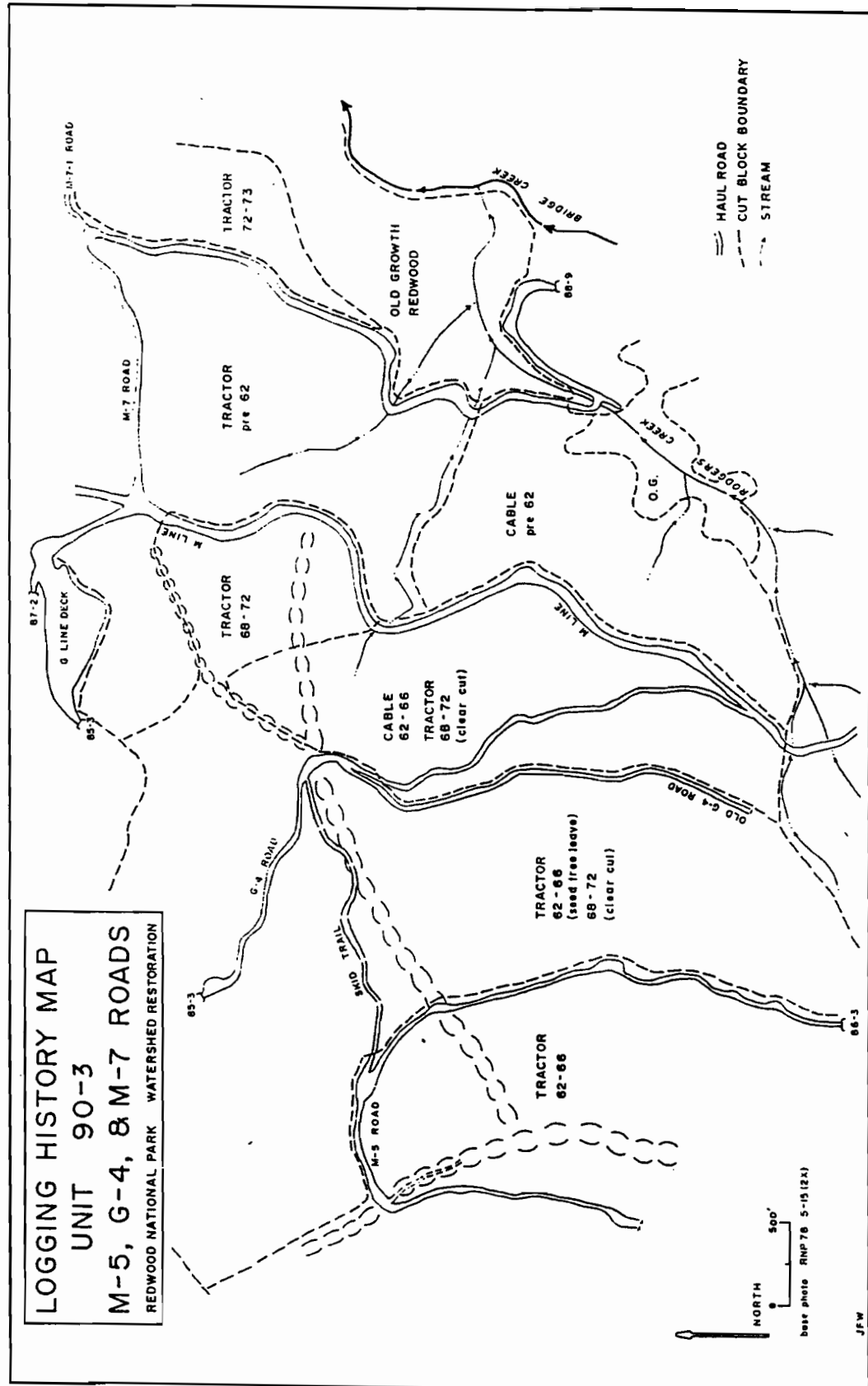


Figure 3. Map C, Logging history of Watershed REhabilitation Unit 90-3.

Creek and proceeded South East around the ridge into Bridge Creek. The road was used to access cable yarding units within the Bridge Creek Watershed. The road terminated above the M-Line at a landing within the Rodger's Creek watershed. The G-4 Road was connected to the M-Line sometime between 1966 and 1968 at a lower elevation traversing across the cable units. This appears to be in response to a large road failure on the M-Line immediately down road from this area. The failure probably occurred in 1964 and first appears in the 1966 air photos. The new G-4 alignment allowed access to the G-Line and back to the M-Line for access to Redwood Creek and Orick. By 1972, the M-Line was rebuilt across the failure in Rodger's Creek, near the intersection of the existing G-4 Road with the M-Line.

The M-7 Road was built sometime between 1954 and 1962 from the M-Line out to Bridge Creek, but did not cross Bridge Creek. The road accessed tractor yarding upslope with "leave" trees. The bridge at Rodger's Creek appears to be blown out in the 1966 photos (no doubt in response to the 1964 storms which blew out the M-Line reach above, along with the bridge). The road was rebuilt sometime between 1968 and 1972 and the road was pushed through to beyond Bridge Creek and out to the cable yarded units on Bridge Ridge.

GEOLOGY AND PHYSIOGRAPHY

The area is underlain by Redwood Creek Schist Unit of Franciscan assemblage (Harden, et al, 1982). Total relief on the unit is 1660 feet with elevations ranging from 240 feet at Rodger's Creek confluence with Bridge Creek to approximately 1900 feet on the upper slope.

The rehabilitation unit consists of two distinctly different physiographic units as shown in Figure 2. The M-5 and G-4 Roads traversed the upper slope which consisted of gentle topography with very few incised channels. Stream channels are all intermittent in the upper slope area. Slope gradients in the upper area ranged from less than 10% to 65%, and averaged about 40% overall. The east facing slope above the G-4 Road was often benched at 10 - 20% slope with risers between at 30-50%. Within the Bridge Creek watershed, the M-5 Road traverses a planar hillslope lacking developed stream valleys. The road continues around the ridge dividing the two watersheds and continues into the Tom McDonald Creek watershed on contour. Within the Tom McDonald Creek watershed, the road traverses a concave hillslope, and terminates within 1500 feet of the watershed divide. The G-4 Road segment treated as part of this project was within the Tom McDonald Creek watershed located on the upper mid-slope, below the M-5 Road, where stream valleys become better defined and channel flow is intermittent.

The M-7 Road was located in the steep inner-gorge of Rodger's Creek, a 720 acre watershed. Tributary stream valleys to Rodger's Creek were all well incised. Hillslope gradients within the stream valleys typically exceeded 70% and were as steep as 120%.

SOILS

The soils in the area of the M-7 Road are mainly Ah Pah soils with lesser amounts of copper Creek soils. Along the inner-gorge of Rodger's Creek the soils are identified as Devils Creek,

Lacks Creek and water-saturated colluvium or stripped Devils Creek soils. With the exception of the Devils Creek and water saturated colluvium or stripped Devils Creek soil, the soils are generally well drained and are not prone to mass wasting or gully processes. A detailed description of these soils may be found in the Popenoe and Martin, 1985 inhouse report, "Soils of the M-7 Road at the Bridge Creek Crossing."

The soils along the M-5 and G-4 Roads in the Bridge Creek watershed portion of this rehabilitation site are dominantly Trailhead Series, with lesser amounts of Fortyfour soils. The portion of the M-5 Road which is in Tom McDonald Creek watershed is chiefly copper creek with lesser amounts of Ah Pah soils. The Trailhead soils are susceptible to fluvial erosion when flows are concentrated on the bare soils. These soils are well described in Popenoe and Martin, 1985 "Soils of the M-5 and G-4 Roads and Lower M-Line."

EROSION PROCESSES / HYDROLOGY

Erosion processes in this rehabilitation unit varied greatly from rapid, shallow mass movement dominated processes on the lower, steeper slopes to gully and rill dominated erosion on the upper hillslope. This is due to differences in soil types, hillslope steepness and stream flow volumes.

The upper slopes, occupied by the M-5 and G-4 roads, were generally convex to planar. The slope above the M-Line in Bridge Creek, near the watershed divide with Tom McDonald Creek was typified by gully and rill erosion. Rills were abundant on skid trails and appeared to be associated with post harvest increased runoff. Young alder trees were established in most rills. Gullies formed where road and skid trails concentrated greater amounts of runoff. A particularly large gully system resulting from a long skid trail diversion is present that extends from near the M-5 Road, flowing down the inboard side of the access skid trail from the M-5 Road to the G-4. The gully incised about 2 feet wide x 3 feet deep down the skid trail, diverted across the G-4 Road and down the hillslope to the M-Line. Where it crosses near the G-4 Road, the gully is about 10 feet X 8 feet and exposed a buried volcanic ash deposit (D. Burnson, personal comm.). The ash deposit is still visible in the gully side wall. Some scraping of the wall may be necessary to see the ash. At the M-Line, the gully is about 20 feet wide X 8 feet deep. This gully is evident in the 1966 photos. It probably formed in association with winter storms of December, 1964 in concert with the recently harvested slopes at that time.

The lower slope, occupied by the M-7 Road, has soils of Devils Creek, Ah Pah and Fortyfour. The Devils Creek and Ah Pah soils are exposed in road cuts in steep areas near stream channels and are often associated with emergent or shallow ground water. The lower slope area was typically very steep with slopes of 80-120%. The M-7 Road was within this very steep area which is the inner-gorge of Rodgers Creek and two of its tributaries. The outboard portion of the M-7 Road had failed many times in the past as shallow rapid debris slides. Failures are evident in the historic airphotos and were also evident in the field. Along Rodgers Creek, the road fill reached the creek because of the 120% slopes the road was built upon and the proximity

of the road to the creek. Road failures deposited fill directly into the creeks. Cut banks were often high (20+ ft), in some places exceeding 50 feet.

Airphotos show that at sometime between 1962 and 1966, a great amount of erosion took place in the Rodgers Creek area. This is probably due to the storms of December, 1964 and upslope harvest and road building activities. The M-7 Bridge over Rodgers Creek was "blown-out" during this time. The M-Line crossing upstream on Rodgers Creek had a major failure which torrented downstream toward the bridge. The 1966 photos reveal log debris piled high on the banks on each side of the blown out bridge. The M-Line is completely impassible. A similar blow-out occurred on the stream crossing at station 20+35 (Rx-2), the next stream crossing to the north of the Rodgers Creek Bridge.

Sometime in 1982 or 1983, a landslide occurred on the hillslope near the intersection of the M-7-1½ Road with the M-7 Road. The slide "toed-out" at the creek and the head scarp was within 50 feet above the M-7 Road. The landslide was within a locally unharvested area and some redwoods toppled. The slide moved again in February, 1986 (R. Sonnevil, personal comm.)¹ A longitudinal profile survey and other field evidence suggested a rotational failure style probably due to toe erosion at the creek. The slide was located on a very slightly concave slope. Ground water emerged near the base of the exposed crown scarp. Moisture loving plants, equisetum and rush, had become established in the loose materials below the crown scarp.

Rehabilitation prescriptions for the M-7 Road consisted of treating the entire road length with excavation of fill. All side-casted perched fill was excavated and either hauled to a landing on the M-7 Road or the G-4 Line Deck, or, in road reaches where the cutbank was dry, the fill was placed on the remaining bench (outsloped).

REHABILITATION WORK

EVALUATION AND PRESCRIPTION PHASE

The evaluation phase for most of Unit 90-3 was performed in the winter of 1989-90 by D. Short. The evaluation and prescription phase included: 1) mapping of geomorphic, hydrologic and land use disturbance features through air photo analysis and field mapping; 2) prescription and layout of erosion control work; surveying and calculation of volumes of prescribed treatments; and peer review of proposed prescriptions; 3) establishment of permanent photo points for documentation of erosion control work and future changes resulting from revegetation and channel adjustments; and 4) preparing specifications and plan sheets for inclusion in an Invitation for Bid (IFB)

¹ Park geologist Ron Sonnevil drove across the landslide area in January, 1982. The slide was initiated, but was drivable. The following year, the road had to be rebuilt to allow access for vehicles for rehabilitation work on Bridge Ridge. Ron speculates that the major failure, which evacuated the headscarp area and road bench may have occurred as a result of the prolonged wet winter of 1982/1983.

contract for heavy equipment work. Additional mapping was accomplished as part of mapping for rehabilitation Unit 86-3 by D. Burns, M. Horns, M Sandecki, and D. Steensen in 1985 and 1986. Geomorphology and hydrology of the unit was mapped at a scale of 1:1200 on mylar overlaid on black & white airphoto enlargements. Photos were from 1978 flightline, photos 7-16, and 8-28. Mapping is on file at South Operations Center, Orick. Survey work and Photo documentation were performed in the spring and early summer of 1990 by Darcia Short, Jim Wood, Karen Griffin, Tish Hardt and Bob Gendron. Table 1 (in appendix) summarizes the cost for the rehabilitation work on Unit 90-3.

LABOR INTENSIVE PHASE

The Labor intensive phase of the work included site brushing for survey work and removal of large standing trees growing on the fill slopes of the M-7 Road and the distribution and spreading of straw mulch on the finished slopes. The costs for this phase of the project are shown in Table 1 (in appendix).

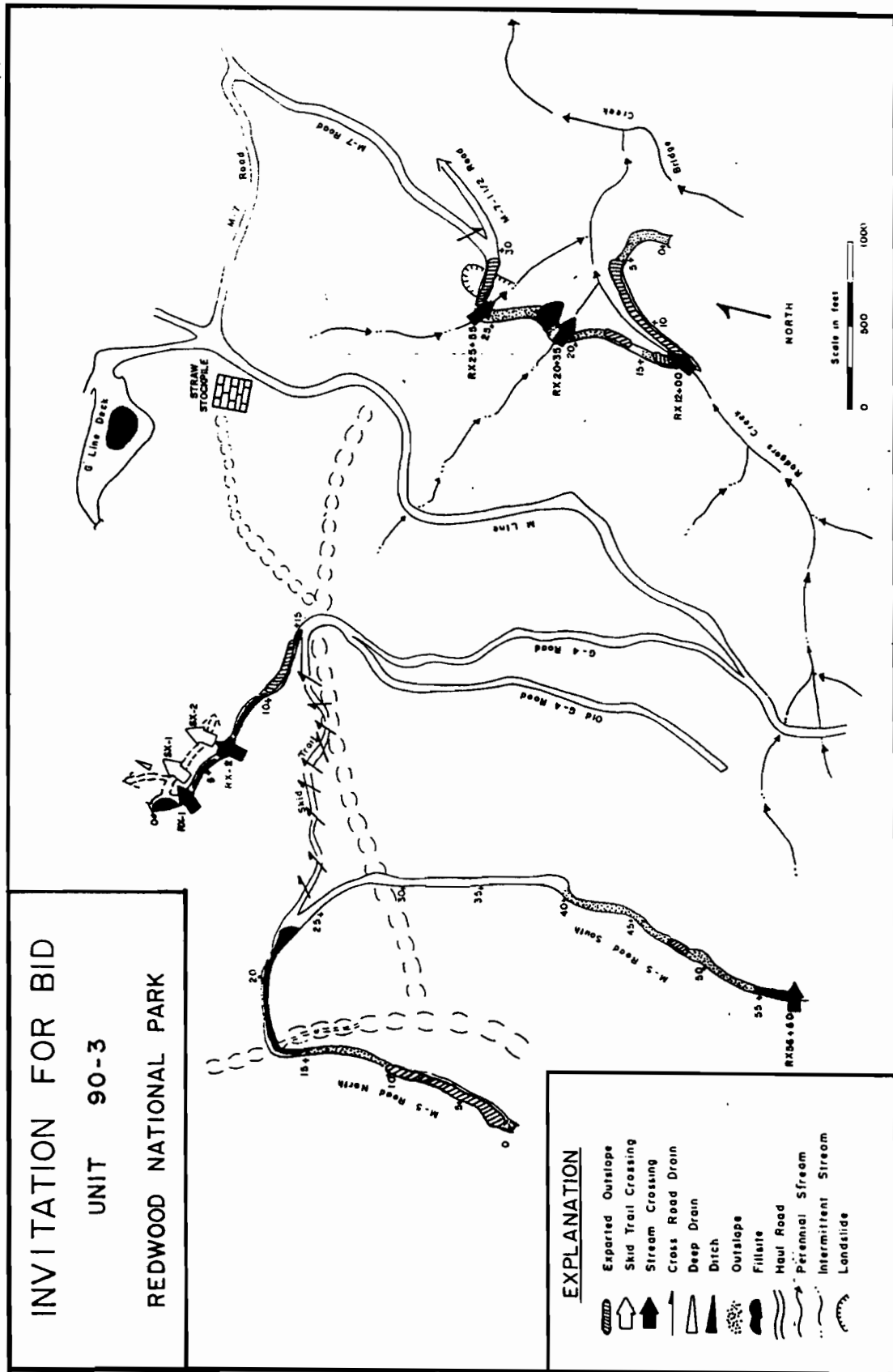
HEAVY EQUIPMENT PHASE

The heavy equipment phase of Unit 90-3 began July 30, 1990 and was completed October 5, 1990. The work consisted of rehabilitating 1.4 miles of logging haul road accounting for 230 acres of watershed treated (Figure 4). Total heavy equipment costs for the site were \$186,434.70 (Table 1; in appendix). Six stream crossings, two skid trail stream crossings, and one deep drain were excavated. Export outsloping (EOS) was prescribed for 3,022 linear feet of road and 3,049 linear feet of road was outslopped (OS).

Heavy equipment work was done under IFB contract awarded to J. W. Brashear Construction, Inc. of Redding, CA. The contractor's bid for the contract, as issued, was \$191,181.75. Modifications to the contract regarding changes in actual volume of fill excavated from stream crossings and export outslope reaches deducted \$4,747.05 from the contract cost for a final cost of \$186,434.70. Other bids received were from Twin Parks Lumber Company of Arcata, CA, \$197,205.00; Carl M. Kjer and Sons of Arcata, CA, \$232,368.15; Fish Construction of Mancos, CO, \$229,105.60; and Roger Brown Construction of Willow Creek, CA, \$242,000.00.

The contractor used five pieces of heavy equipment on the site; a Daewoo DH 180 L.C. hydraulic excavator, a Cat 225 hydraulic excavator, a Cat D6d Crawler Tractor, a Cat D8h Crawler Tractor and a Cat 966C loader. The Daewoo DH 180 had a reach of about 30 feet (horiz) and a 2 yd³ bucket when struck. The Cat 225 also had a 30 foot reach and had a 1.5 yd³ bucket. Four 10 cubic yard dump trucks were on site at various times and in various numbers to haul excavated fill material to disposal sites.

Contract foreman was Fred Anderson. Equipment was operated by Fred, Jerry Westbrook, Joe Gahart and Joe Gibney. All equipment operators on the site were members of the Operating



Engineers Union, Local No. 3. The dump trucks were subcontracted intermittently, on a daily basis from owner / operators Henry Duran, Wm Richards, Marvin McGaughy, and Frank Gist.

The Contracting Officer's Representative was principally D. Short, with duties temporarily assigned to Dave Steensen, and Jim Wood for short periods. Project assistance was provided by training technician Michael Sanders. Numerous park staff visited the site during the course of the project because of their interest regarding the plans for the National Park Horse Trail along the M-7 Road.

Haul Road Stream Crossing Excavations

Haul-road stream crossing excavations are prescribed where a logging haul road crosses a stream channel. The excavation entails the removal of road fill from the buried stream valley and channel. This work eliminates the potential for future diversion of stream flow out of the stream valley and directly removes sediment sources from entering flow courses.

Five haul road stream crossing were excavated on this rehabilitation unit. One was located on the M-5 Road, two on the G-4 Road and three on the M-7 Road. A total of 12,900 yd³ of fill was removed from stream channels and endhailed to stable locations. All stream crossing excavation were designed to be excavated to original (pre-road) configuration. Design specifications were established based on sufficient field evidence indicating valley side-slopes and channel grade and width. Table 2 (in appendix) summarizes the costs and equipment hours for the stream crossing excavations and the two skid trail excavations.

M-5 Road

The stream crossing on the M-5 Road had been previously partially excavated by heavy equipment as part of the rehabilitation work on the M-5 Road in 1986 (Unit 86-3). This stream crossing was in the process of excavation in the summer of 1986 when an accounting error was recognized in Crescent City and all rehabilitation work in the park was notified to stop immediately, as the park was out of money. The operator on site in 1986 (Wendell Larkin) agreed to smooth up and partially stabilize the crossing excavation at the time, but the finished product was a somewhat tenuous job which required further work when equipment could be afforded.

As part of this rehabilitation project, the stream crossing was further excavated to original ground. A total of 450 cubic yards was excavated from the bottom portion of stream crossing. The outboard edges were laid back more gently and the channel grade was matched with the down slope original channel grade. Fill was placed on the adjacent stable road bench.

G-4 Road

The G-4 Road stream crossing excavations were fairly straight forward and simple. The excavation at RX 1 encountered some wet sticky clay near the channel bottom which occasionally caused the dozer to bog down a little. Fill sites were local pushes and production rates were good. The excavator and dozer had a tough time crossing back out of RX-2 upon

completion of finish work on the downstation fillsite, but overall the excavations on the G-4 Road were straight forward with nothing exceptional occurring.

M-7 Road

The three stream crossing excavations on the M-7 Road consisted of two large culverted crossings located on perennial streams which were flowing at the time of excavation and a bridge crossing on the mainstem of Rodgers Creek. RX2 on the M-7 was an approximately 4600 cubic yard crossing with a 60 inch diameter culvert that received discharge from a 105 acre watershed. The crossing was originally built between 1954 and 1962 and blew out sometime before 1968 (probably in response to the 1964 storms). The road and crossing were rebuilt sometime between 1968 and 1972. The fill was very clean, with very little debris or logs. Fill appears to have been generated for the crossing from the nearby ridge as evidenced from the large (50 foot high) cutbanks and from airphoto analysis. Fill excavated from this site was prescribed for disposal at the adjacent landing. The contractor transported a large proportion of the fill to the fill site by loader with the remaining portion pushed by the dozer and some hauled to the G-Line deck. The precise amount of fill distributed by various equipment to specific sites was not recorded.

RX-3 was located on the smaller of the two tributaries (drainage area is 55 acres). The crossing was composed of relatively clean fill with some log debris within a tight "horse shoe", and had a 36 inch culvert offset from the thalweg by about 60 feet to the right. All fill from this crossing was truck endhauled to the G-Line deck, located 1 mile from the crossing. During the course of the excavation, wood debris was uncovered in the upper portion of the crossing. The debris appears to pre-date road construction and appears to be a debris torrent deposit. The site inspector chose to leave the debris in the crossing for a couple of reasons: first, equipment was having a difficult time working in the crossing because of seeping water and the steep, narrow shape, and, secondly, it was highly likely that once an excavation of deposit was begun, it would likely involve "chasing" woody debris upstream in search of a stable channel. This would be costly, with little net gain.

Rodger's Creek Bridge Removal

Rodger's Creek is a second order tributary to Bridge Creek and drains approximately 720 acres of watershed at the bridge crossing. The Creek was named by park staff after Rodger's Peak from where the headwaters are located.

Air photo analysis reveals that the bridge over Rodger's Creek was constructed sometime between 1954 and 1962. The bridge had blown out by 1966 (probably during the 1964 storms). Sometime between April, 1968 and March, 1972, the bridge was reconstructed of redwood logs. Abutments at each end of the bridge consisted of two approximately three foot in diameter logs laid parallel with the channel, one on top of the other. Nine "stringer" logs were placed perpendicular to the channel across, and on top of these abutment logs. Approximately two feet of fill material was placed on the "stringer" logs to provide a smooth driving surface.

The removal of the bridge as written within the contract is as follows:

NOTE: This stream crossing consists of the removal of a bridge. The bridge is composed of at least 13 large diameter logs, some fill and cable. All logs shall be removed and placed in secure locations downstation, the remaining logs shall be placed upstation. Logs will be placed oriented along the fall line of the finished slope. Fill (60 cubic yards) on top of the bridge shall be placed in a suitable fillsite. All cable shall be buried under at least 3 feet of fill.

The excavation of the bridge went well and reflected the abilities of the experienced operators. Even though the operators had never performed bridge removal before this project, their experience with the equipment, and experience working in steep terrain and with timber evidently provided the necessary skills to complete the task effectively.

Because of the configuration of the road alignment and the bridge as a nice tight horse shoe and with the road on the left bank nearly parallel with the section of road on the right bank, the excavation at the bridge was laid out with EOS on each side of the bridge structure, and the bridge itself as a separate project. Therefore, there is no fill volume associated with the bridge removal. The only fill within the bridge excavation is the fill which was on the top of the bridge, which totals about 60 cubic yards.

Logs acquired from the bridge removal were placed on the finished slopes on both the left and right banks to be used, as needed, for horse trail and camp facilities in the area. Logs were placed oriented along the fall line of the finished slopes so as to not interfere with surface runoff, and to prevent the potential for rolling. Logs were rearranged slightly within these confines to help soften the parallel alignment. Aesthetically, it would have been better to have dispersed the logs over a larger area, however, these logs were fairly time consuming to move around, and in the best interest of costs, were dispersed as they are.

Skid Trail Stream Crossing Excavations

Skid trail stream crossing excavations are prescribed where skid trail cross stream channels. They are treated the same as haul road stream crossings with the removal of fill from the buried stream valley and channel. As with haul road crossing excavations, skid trail crossing excavations eliminate the potential for future diversion of stream flow out of the stream valley and directly removes sediment sources from entering flow courses.

Two skid trail stream crossings were excavated as part of this rehabilitation project. The skid trail stream crossings are located downslope of RX-2 and RX-3 on the G-4 Road. Fillsites were local, requiring blade endhauling.

Outsloping

Outsloping was prescribed for 3,049 feet of road, accounting for 16,630 yd³ of material moved (Table 3; in appendix). Outsloping was done to remove fill from the outboard edge of the road

prism in areas where the dry cutbank allowed for placement of the fill on the inboard edge of the road. Most reaches were outsloped to remove perched fill with failure potential adjacent to stream channel from failing into the channels. Some areas, especially along the M-5 South were outsloped to provide for a permanent free draining finished surface and to provide for the return of top soil to the surface where revegetation processes might benefit from higher nutrient levels.

Outsloping in this rehabilitation site was of some controversy between two schools of thought on rehabilitation within Redwood National Park. One group of Resources Management staff feels that outsloping is not necessary in all areas of the Park, specifically in areas away from visitor use or view or areas which are erosionally stable. Another view of outsloping, which is advocated by park vegetation management personnel, and others, is to outslope where ever feasible to provide the recovery of buried side casted top soil, to recover old viable seeds, to obliterate road scars (recontour) and to restore original dispersed surface hydrology.

The question of whether or not to outslope becomes one of cost (both money and time). Are we forsaking timely progress on the rehabilitation of the watershed by bogging down in the details of restoring specific sites? Are we spending a finite source of funds on a few roads, not leaving enough to treat all roads to some minimal degree?

These questions have always generated interesting discussions within the rehabilitation program and seemed to reach a high crescendo in 1990. As a result, direction was asked of the new park superintendent, Bill Ehorn. During a field trip to the area in March, 1990. Bill Ehorn expressed that total recontouring was the way he wanted to see rehabilitation accomplished. The direction from Bill Ehorn did not quell the controversy and the topic of outsloping is still often debated.

Outsloping on the M-7 Road was necessary to minimize road fill failures into Rodgers Creek and its tributaries. The portion of the M-7 Road which was rehabilitated as part of this project was built within the steep innergorge of Rodgers Creek and within the inner gorges of two large tributaries. The road fill was steeply perched over the stream channels. The outboard edge of the road had sloughed and failed many times into the channels. The base of the fill, in many places, reached to the channel edge.

Outsloping on the M-5 South, the M-5 North and the G-4 Road was done to provide for a free draining surface. The roads were built with insloped surfaces and inboard ditches. The M-5 South and the G-4 Road both traversed slopes with trailhead soils which are susceptible to gully and rill erosion. An outslope prescription provides for the dispersal of surface runoff without concentrating flow in ditches or cross-road drains. The outslopes were not deep, generally less than 8 feet at the outboard edge due to the small size of the road prisms. The G-4 Road was outsloped from 11+63 to 14+00. The worksite was identified as an EOS in the contract and in the tables because a portion of the fill (200 cubic yards out of 605 cubic yards) was endhailed to a fillsite at the end of the worksite (to station 14+00).

Exported Outsloping

Exported outsloping (EOS) was prescribed at 12 sites for 3,022 linear feet of road, accounting for 18,235 yd³ of material relocated to stable fillsites (Table 4; in appendix). Exported outsloping was prescribed in reaches where the inboard edge of the road was persistently wet from seeps and springs in the cut bank and/or adjacent upslope area and the fill at the outboard edge of the road had failure potential. Fill removed from the outboard edge of the road was "exported" to stable fillsites at landings and on stable road reaches. Excavation were designed to remove the entire road fill prism. Where the road had been built on a cut bench, the bench was left, although shaped to provide outward sloping surface of 5- 10% to allow for free surface drainage. In road reaches prescribed for outsloping, where cut volumes exceeded available fill storage volumes, the prescription is also called an EOS. This means that only some portion of the fill is endhauled, while some remains local on the remaining bench.

Clearing and scattering trees with Heavy Equipment

The disposition of the vegetation that needed to be cleared from the worksites was of concern on this rehabilitation site because of the proposed horse trail alignment along the M-7 Road. It was generally considered not acceptable to just push the felled trees and brush up skid trails, or to otherwise topple them into the forest, which has been the standard practice for dealing with road vegetation on rehabilitation sites in Redwood National Park in the past. This leaves sites appearing too rough for visitors in a National Park. Along the M-7 Road, and abundance of large alder trees were well established on the fillslopes and along the inboard ditches and cut banks because of the moist, inner gorge growing location. Therefore, the following prescription was included in the contract:

The fillslopes and cut banks in this rehabilitation unit are covered with dense 20-30 year old trees and brush. All vegetation (except for mature conifers) within excavation and fill boundaries is to be removed as part of the work item and distributed evenly on top of the finished slopes. A foot path of four feet in width shall be developed at or near the top of the distributed vegetation to provide access. Removed vegetation shall not be buried in the fill.

Costs associated with clearing and scattering the brush were closely monitored to evaluate the budgetary significance of the work. Larger, more mature trees have become a significant component of the road corridors in Redwood National Park. Scattering the organic debris over the finished sites can be beneficial to site revegetation. The debris acts as a mulch to preserve soil moisture and the decomposing material provides nutrients to the soil. There are also habitat values for small animals and birds.

Most of the time the equipment approach to the task was to have a excavator knock down the trees with the boom and bucket, then pick up the trees as a bunch with the bucket and attached thumb. The trees were placed on the road surface and the dozer then pushed the trees down road about 100 - 150 feet out of the way of the excavator. The excavator proceeded to perform excavations in the area cleared. As the excavation of a reach (50 - 100 feet) of road was

finished, the dozer pushed the tree debris pile toward the excavator, which then picked up a pile and scatter over the finished surface. The excavator could generally just "shake" the pile in the bucket and clamp and the debris would sprinkle out over the surface. The clamp attachment on the bucket proved beneficial to working efficiently with the tree debris. Once the pile of debris was spread, the excavator would work the next 50 - 100 foot reach of road.

Brushing costs, as a percentage of the Total Heavy Equipment costs associated with the rehabilitation site, are 4.4%. Records of time and costs associated with working with brush in another manner have not been documented at Redwood National Park. But, I would suspect that they would be comparable, although probably less. This would be because when debris is just mixed in with the fill, or pushed up a skid trail, the material is handled only once or perhaps twice. When the trees are felled, pushed aside and then spread on the surface, as they were on this project, the debris has been handled by the equipment at least 3 times and in many cases 4 times. This adds to the cost of moving most things. Table 7 summarizes the costs associated with the clearing and scattering.

Table 7. Clearing and Scattering Trees, Time, Costs and Rates, Unit 90-3: M-5, G-4 and M-7 Roads.

	EQUIPMENT HOURS					TOTAL COST	LENGTH OF ROAD	UNIT COST \$/LF
	EXCAVATORS		DOZERS		LOADER			
	DAEWOO	CAT 225	D8H	D6				
M-5 South	11.00	8.25	--	--	--	\$2,076.25	1690 ft.	\$1.23 ¹
M-5 North	1.50	3.25	11.00	6.75	--	1,176.50	1470	0.79 ²
G-4 Road	7.25	2.25	--	2.25	--	1,378.75	1400	0.98 ³
M-7 Road	11.50	10.25	6.75	--	0.75	3,588.75	2912	1.23 ⁴
TOTAL						\$8,211.25	7472 ft.	\$1.10

¹ Cost is higher than total average. Probably because this was the first area the prescription was performed. Operators had to experiment with various approaches.

² Cost is lower than average. Depth of cut was shallow. Vegetation was young conifer.

³ Cost is lower than average. Depth of cut was moderate. Benching down was not necessary. Vegetation was dominantly young conifer.

⁴ Cost is higher than total average. The M-7 Road had very deep fills, requiring benching down to reach to the bottom of the cuts. Alder trees were very abundant and large (60 - 100 feet tall, 8 - 12 inches dbh).

DISCUSSION

This contract was awarded to a contractor who had never worked in Redwood National Park before. The contractor's foreman had significant experience working with heavy equipment in similar (even steeper) terrain working on roads for Caltrans and the Forest Service. This experience, and a congenial desire to do good work made for an overall good project. My experience with this contractor, who had never removed a road following RNP specifications, proved to me that a good, experienced operator in similar terrain is what is perhaps the most critical criteria necessary for implementing Watershed Rehabilitation projects at Redwood National Park. A good contractor (or foreman) will quickly learn the quirks of our specific contracts and be highly proficient with understanding the layout and intent of the projects after completing just a couple of work sites.

This project was also the first one involving road removal implemented and completed by this geologist. As a matter of staffing circumstances, I became solely and independently responsible for all phases of the project, with very little experience in many phases. But, like the contractor I was experienced with similar "terrain" and I feel the park has a fine finished project. The most difficult aspect of the work was in preparing the contract to a level of perfection which has been achieved in all prior rehabilitation contracts at Redwood National Park.

REFERENCES CITED

Harden, D. R., Kelsey, H. M., Morrison, S. D. and Stephens, T. A. 1982. Geologic map of the Redwood Creek drainage basin, Humboldt County, California. U. S. Geological Survey Water Resources Investigation Open File Report 81-496.

Popenoe, J. and Martin, R. 1985a. Soils of the M-7 Road at the Bridge Creek Crossing. Redwood National Park unpublished report. On file at Redwood National Park, South Operations Center, Orick, California.

Popenoe, J. and Martin, R. 1985b. Soils of the M-5 and G-4 Roads and Lower M-Line. Redwood National Park unpublished report. On file at Redwood National Park, South Operations Center, Orick, California.

APPENDIX

Table 1. Rehabilitation work cost summary, Unit 90-3

TREATMENT	WORKSITE QUANTITY	ACTUAL TOTAL QUANTITY	ACTUAL TOTAL COST	AVERAGE UNIT COST \$/YD ³
HEAVY EQUIPMENT				
<u>Primary Treatments</u>				
Stream Crossing Excavations	6	13,125 yd ³	43,865	3.34
Skid Trail Crossing Excavation	2	330 yd ³	2,500	7.58
Outsloping	9	16,780 yd ³	35,455	2.11
Exported Outsloping	12	17,805 yd ³	77,446	4.35
Cross-road Drain	10	--	820	--
Deep Drain	1	40 yd ³	410	10.25
Other (See Table 6)	--	--	25,938	--
TOTAL HEAVY EQUIPMENT COSTS		48,080 yd³	\$186,434	
LABOR INTENSIVE WORK				
Straw purchase		508 bales	1,626	3.20/bale
[Straw distribution (Bid Item)]		508 bales	[3,175]	6.25/bale
Straw spreading		201 ph	2,136	4.20/bale
TOTAL STRAW COSTS²		--	6,937	13.65/bale
Brushing ³		693 ph	10,939	
TOTAL LABOR INTENSIVE WORK⁴		894 ph	\$14,701	
PROJECT IMPLEMENTATION				
<u>Evaluation</u>				
Mapping/Prescription/Survey		1,168 ph	15,913	
<u>Supervision</u>				
Contract Administration		689 ph	9,236	
<u>Documentation</u>				
Costs Analysis and Report		147 ph	1,963	
TOTAL PROJECT IMPLEMENTATION		2,004 ph	\$ 27,112	
TOTAL REHABILITATION PROJECT COST			\$228,247	

² Includes Straw distribution bid cost (which is also in Total Heavy Equipment Costs).

³ Does not include brushing by the contractor (see Table 6).

⁴ Does not include Straw distribution costs which are not a labor cost.

Table 2. Stream Crossing Excavation Time, Rates and Costs, Unit 90-3: M-5, G-4 and M-7 Roads.

SITE AND STA. NO.	EQUIPMENT HOURS										TOTAL H.E.R.E. COST ^a	AV. UNIT COST CONTRACT \$/YD ³	AV. UNIT COST H.E.R.E. \$/YD ³
	EXCAVATORS			DOZERS				DUMP TRUCKS	LOADER	D8H			
	TOTAL QUANT. YD ³	DAEWOO	CAT 225	D6	D6	D8H							
M-5 ROAD													
RX 56 + 60	450 ^c	4.00	--	--	--	3.50	--	7.50	60.0	--	\$ 2,940	\$ 780	\$ 1.73
G-4 ROAD													
RX 02 + 21	885 ^c	6.75	--	--	--	7.00	--	13.75	64.4	--	5,040	1,684	1.90
RX 05 + 87	1,655 ^c	8.75	.50	--	--	4.50	7.75	21.50	77.0	--	8,400	2,316	1.40
M-7 ROAD													
RX 12 + 00	BRIDGE	5.25	.75	--	--	5.25	--	11.25	-- ^e	--	1,680	1,380	-- ^e
RX 20 + 35	4,630 ^b	33.50	--	--	--	14.50	32.25	13.50	57.7	13.50	7,639	9,182	1.98
RX 25 + 55	5,505 ^b	35.75	27.00	--	--	14.25	54.25	119.75	41.9	251.00	18,166	19,881	3.61
TOTAL	13,125	94.00	28.25	--	--	45.50	97.75	133.25	51.6	398.75	\$43,865	\$35,223	\$ 2.58

^a Rate does not include dump truck hours.^b H.E.R.E. is Heavy Equipment Rental Equivalent. This value is for comparison purposes with other projects. It is the cost per hour of renting the equipment with operator. The price is usually based on bids received at Redwood National Park from operators expecting to rent equipment to the park for restoration work. Rental bids were not solicited in 1990. Rental prices were determined by consensus of discussion between D. Short and T. Abel. Rates were estimated from previous years heavy equipment rental bids and local contractors' information. Rates used are: Daewoo DH 180 L.C. excavator, \$125/hr; Caterpillar 225 excavator, \$125/hr; Caterpillar D6 dozer, \$85/hr; Caterpillar D8H dozer w/ rippers, \$120/hr; Caterpillar 966C loader, \$80/hr and Dump Trucks, \$50/hr.^c Volumes determined from pre-heavy equipment design surveys. Actual excavation was very close to design. Any deviation from the design quantity is less than 5% (D. Short).^d Unit priced bid item. Volumes were determined by detailed post-excavation survey.^e Constructed of logs, cubic yard measurement not applicable.

Table 3. Outsloping Excavation Costs, Time and Excavation Rates, Unit 90-3.

SITE AND STA. NO.	EQUIPMENT HOURS										TOTAL H.E.R.E. COST ^a	AV. UNIT COST CONTRACT \$/YD ³	AV. UNIT COST H.E.R.E. \$/YD ³	
	EXCAVATORS			DOZERS				DUMP TRUCKS	TOTAL HOURS	EXC. RATE ^a YD ³ /HR				TOTAL CONTRACT COST
	TOTAL ^c QUANT. YD ³	DAEWOO	CAT 225	D6	D8H	LOADER								
M-5 ROAD														
54+00	3,415	15.25	--	9.25	--	2.50	--	27.00	126.50	8,400	2,892	2.46	0.85	
48+00	725	13.00	--	1.00	--	--	--	14.00	51.80	6,150	1,710	8.48	2.36	
00+00	1,220	6.75	2.75	--	--	3.50	--	13.00	93.80	3,280	1,357	2.67	1.11	
10+45	955	--	13.00	--	--	--	--	13.00	73.50	2,050	1,625	2.15	1.70	
M-7 ROAD														
00+00	5,420	23.50	16.75	--	--	21.25	--	63.75	85.00	8,400	7,761	1.55	1.43	
13+62	515	6.25	--	--	--	.75	--	9.25	55.70	1,025	1,051	1.99	2.04	
18+07	1,000	9.00	--	--	--	2.75	--	12.25	81.60	1,640	1,495	1.64	1.50	
21+00	635	3.50	--	--	--	--	--	3.50	181.4	820	437	1.29	0.69	
22+52	2,895	.50	19.25	--	--	14.00	--	40.75	71.0	3,690	4,708	1.27	1.63	
TOTAL	16,780	77.75	51.75	--	10.25	38.75	18.00	196.50	85.40	35,455	23,036	\$2.11	\$1.37	

^a Rate does not include dump truck hours.^b H.E.R.E. is Heavy Equipment Rental Equivalent. This value is for comparison purposes with other projects. It is the cost per hour of renting the equipment with operator. The price is usually based on bids received at Redwood National Park from operators expecting to rent equipment to the park for restoration work. Rental bids were not solicited in 1990. Rental prices were determined by consensus of discussion between D. Short and T. Abel. Rates were estimated from previous years heavy equipment rental bids and local contractors' information. Rates used are: Daewoo DH 180 L.C. excavator, \$125/hr; Caterpillar 225 excavator, \$125/hr; Caterpillar D6 dozer, \$85/hr; Caterpillar D8H dozer w/ rippers, \$120/hr; Caterpillar 966C loader, \$80/hr and Dump Trucks, \$50/hr.^c Volumes determined from pre-heavy equipment design surveys. Actual excavation was very close to design. Any deviation from the design quantity is less than 5% (D. Short).

Table 4. Exported Outslping Excavation Time, Rates and Costs, Unit 90-3: M-5, G-4 and M-7 Roads.

SITE AND STA. NO.	EQUIPMENT HOURS										TOTAL H.E.R.E. COST ^a	AV. UNIT COST CONTRACT \$/YD ³	AV. UNIT COST H.E.R.E. \$/YD ³
	EXCAVATORS			DOZERS				DUMP TRUCKS	TOTAL HOURS	EXC. RATE ^a YD ³ /HR			
	TOTAL QUANT. YD ³	DAEWOO	CAT 225	D6	D8H	LOADER							
<u>M-5 ROAD</u>													
56+35	390	3.75	--	1.25	--	2.75	--	7.75	50.3	3,360	795	8.62	2.04
49+99	470	3.00	--	.75	--	2.50	--	6.25	75.2	2,680	639	5.70	1.36
01+87	3,855	.50	42.75	--	9.50	--	57.75	110.50	73.1	16,080	9,433	4.17	2.45
<u>G-4 ROAD</u>													
06+38	110	1.25	--	--	--	1.50	--	2.75	40.0	1,680	276	15.27	2.51
10+08	1,080	2.00	--	--	3.50	--	--	5.50	196.4	3,780	670	3.50	.62
11+63	605	9.50	--	--	5.00	2.25	--	16.75	36.1	5,040	1,967	8.33	3.25
<u>M-7 ROAD</u>													
04+69	4,490	21.00	13.50	--	17.75	1.25	--	53.50	83.9	14,707	6,542	3.18	1.46
10+63	715	3.00	10.25	--	.75	1.25	--	15.25	46.9	2,274	1,846	3.12	2.58
12+12	1,600	11.50	--	--	20.25	16.25	48.00	96.00	33.3	9,120	5,407	5.70	3.38
15+14	2,030	8.00	--	--	12.50	13.50	21.75	55.75	59.7	11,390	4,667	5.61	2.30
17+09	1,265	5.50	.75	--	2.00	4.00	8.50	20.75	103.3	3,360	1,766	2.66	1.40
26+75	1,195	5.25	11.00	--	--	--	20.50	36.75	73.5	3,975	3,056	3.33	2.55
TOTAL	17,805	74.25	78.25	2.00	71.25	45.25	156.50	427.50	65.7	77,446	37,064	4.35	2.08

^a Rate does not include dump truck hours.

^b H.E.R.E. is Heavy Equipment Rental Equivalent. This value is for comparison purposes with other projects. It is the cost per hour of renting the equipment with operator. The price is usually based on bids received at Redwood National Park from operators expecting to rent equipment to the park for restoration work. Rental prices were not solicited in 1990. Rental prices were determined by consensus of discussion between D. Short and T. Abel. Rates were estimated from previous years heavy equipment rental bids and local contractors' information. Rates used are: Daewoo DH 180 L.C. excavator, \$125/hr; Caterpillar 225 excavator, \$125/hr; Caterpillar D6 dozer, \$85/hr; Caterpillar D8H dozer w/ rippers, \$120/hr; Caterpillar 966C loader, \$80/hr and Dump Trucks, \$50/hr.

^c Volumes determined from pre-heavy equipment design surveys. Actual excavation was very close to design. Any deviation from the design quantity is less than 5% (D. Short).

^d Unit priced bid item. Volumes were determined by detailed post-excavation survey. ^e Constructed of logs, cubic yard measurement not applicable.

Table 5. Miscellaneous Excavations Time, Rates and Costs, Unit 90-3: M-5, G-4 and M-7 Roads.

SITE AND STA. NO.	EQUIPMENT HOURS										TOTAL H.E.R.E. COST ^a	AV. UNIT COST CONTRACT \$/YD ³	AV. UNIT COST H.E.R.E. \$/YD ³
	TOTAL QUANT. YD ³	EXCAVATORS		DOZERS			DUMP TRUCKS	TOTAL HOURS	EXC. RATE ^a YD ³ /HR	TOTAL CONTRACT COST			
		DAEWOO	CAT 225	D6	D8H	LOADER							
CROSS ROAD DRAINS	--	--	.50	--	1.50	1.00	--	2.00	NA	NA	820	250	NA
DEEP DRAIN	40	.75	--	--	--	--	--	.75	53.3	410	410	94	10.25
SKID TRAIL CROSSING (2)	330	2.75	--	1.75	--	1.00	--	5.50	60.0	2,500	2,500	572	7.58
Open Roads ^f					4.50	1.25							
TOTAL	370	3.50	.50	1.75	6.00	3.25	--	8.25	59.2	3,730	3,730	915	7.86
													1.80

^a Rate does not include dump truck hours.

^b H.E.R.E. is Heavy Equipment Rental Equivalent. This value is for comparison purposes with other projects. It is the cost per hour of renting the equipment with operator. The price is usually based on bids received at Redwood National Park from operators expecting to rent equipment to the park for restoration work. Rental bids were not solicited in 1990. Rental prices were determined by consensus of discussion between D. Short and T. Abel. Rates were estimated from previous years heavy equipment rental bids and local contractors' information. Rates used are: Daewoo DH 180 L.C. excavator, \$125/hr; Caterpillar 225 excavator, \$125/hr; Caterpillar D6 dozer, \$85/hr; Caterpillar D8H dozer w/ rippers, \$120/hr; Caterpillar 966C loader, \$80/hr and Dump Trucks, \$50/hr.

^c Volumes determined from pre-heavy equipment design surveys. Actual excavation was very close to design. Any deviation from the design quantity is less than 5% (D. Short).

^d Unit priced bid item. Volumes were determined by detailed post-excavation survey.

^e Constructed of logs, cubic yard measurement not applicable.

^f M-5 Road opened across many road slumps and boggy areas for Dump trucks (D8 = 2.00). M-7 road opened across landslide near M-7-1 ½ Road (D8 = 2.50, Loader = 1.25).

Table 6. Other Miscellaneous Costs, Unit 90-3: M-5, G-4 and M-7 Roads.

SITE AND STA. NO.	EQUIPMENT HOURS										TOTAL HOURS
	TOTAL CONTRACT COST ^A	TOTAL H.E.R.E. COST ^B	EXCAVATORS		DOZERS				LOADER	DUMP TRUCKS	
			DAEWOO	CAT 225	D6	D8H					
BID ITEMS											
MOVE IN	4,125	--	--	--	--	--	--	--	--	--	--
MOVE OUT	4,125	--	--	--	--	--	--	--	--	--	--
WALK	3,750	2,698	5.00	5.25	.75	7.25	5.25	1.25	24.75	24.75	
RIP	5,700	1,471	--	--	10.25	5.00	--	--	15.25	15.25	
RECORD KEEPING	5,063	--	--	--	--	--	--	--	--	--	
DISTRIBUTE STRAW	3,175	951	.25	--	--	--	11.50	--	11.75	11.75	
NON BID ITEMS											
DISCUSSION	--	2,820	13.75	1.50	4.75	3.25	1.50	--	24.75	24.75	
LUNCH	--	1,644	5.75	.50	2.50	2.75	4.00	--	15.50	15.50	
BRUSHING	--	8,481	31.25	17.75	17.25	6.75	1.00	--	74.00	74.00	
IDLE	--	36,884	64.00	59.75	35.0	32.50	181.75	--	373.00	373.00	
FUEL/SERVICE	--	4,176	12.25	8.00	3.00	8.00	4.75	1.00	37.00	37.00	
DOWN	--	9,629	3.25	40.50	--	29.00	6.00	4.00	82.75	82.75	
TOTAL	\$25,938	\$68,754	135.50	133.25	73.50	94.50	215.75	6.25	658.75	658.75	

^A Value of contractor bid

^B H.E.R.E. is Heavy Equipment Rental Equivalent. This value is for comparison purposes with other projects. It is the cost per hour of renting the equipment with operator. The price is usually based on bids received at Redwood National Park from operators expecting to rent equipment to the park for restoration work. Rental prices were not solicited in 1990. Rental prices were determined by consensus of discussion between D. Short and T. Abel. Rates were estimated from previous years heavy equipment rental bids and local contractors' information. Rates used are: Daewoo DH 180 L.C. excavator, \$125/hr; Caterpillar 225 excavator, \$125/hr; Caterpillar D6 dozer, \$85/hr; Caterpillar D8H dozer w/ rippers, \$120/hr; Caterpillar 966C loader, \$80/hr and Dump Trucks, \$50/hr.