Engineer's Post-Restoration Report
Mowitch and Squally Beach Projects
Commencement Bay

Prepared for the

Commencement Bay
Natural Resource Damage Assessment
and Restoration Trustees

RIDOLFI ENGINEERS Inc.

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December 2000

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1.0 INTRODUCTION

This Engineer's Post-Restoration Report summarizes restoration work performed during the year 2000 at two sites in Commencement Bay, Tacoma, Washington (Figure 1). The work was performed on behalf of the Commencement Bay Natural Resource Damage Assessment (NRDA) and Restoration Trustees. The Trustees include the National Oceanic and Atmospheric Administration (NOAA), the U.S. Department of the Interior (U.S. Fish and Wildlife Service), the Puyallup Tribe of Indians, the Muckleshoot Indian Tribe, the Washington State Department of Ecology (lead agency for the State), the Washington State Department of Natural Resources, and the Washington State Department of Fish and Wildlife.

Ridolfi Engineers Inc. (Ridolfi), the design engineers for the project, worked under contract to NOAA, which served as the lead NRDA Trustee. Design efforts were performed by a team that included Ridolfi, Osborn Pacific, Inc., Adolfson Associates, Inc., EVS Consultants, Inc. and the Battelle Marine Sciences Laboratory. Remtech, Inc. (Remtech), the construction contractor for the site work, performed the work under direct contract to NOAA.

1.1 Background

1.1.1 Site Description-Mowitch Site

The Mowitch site, previously known as the Wasser/Winter site or Hylebos Estuary site, is located on land owned by the Port of Tacoma at the junction of Hylebos Creek and the southeast end of the highly-industrialized Hylebos Waterway (Figure 2). The site covers approximately 2.3 acres and includes Hylebos Creek and an adjacent, relatively flat, vegetated upland strip approximately 100 feet wide and 1,000 feet in length immediately northwest of the Creek. The site is bounded on the south by the centerline of the Hylebos Creek; on the west by a railroad right-of-way adjacent to Marine View Drive; on the north by an 8-foot-high cedar fence; and on the west by the pier headline at the southeast end of the Upper Hylebos Waterway turning basin.

Prior to restoration, the site consisted of a relatively flat, vegetated upland (Figure 3). The site includes the north half of Hylebos Creek, which passes through the site in a straight, deep, steep-banked channel (Figure 4). The site sloped slightly toward the creek and the Hylebos Waterway, and included a log ramp at the northwest end of the site. The elevation of the upland portion of the site is approximately 6 to 12 feet above mean sea level (msl) or 12 to 18 feet above mean lower low water (MLLW). See Table 1 for the relationship between the two vertical datums.

1.1.2 Site Description-Squally Beach Site

The Squally Beach site, previously known as the Puyallup Tribal Nursery site or the Puyallup Tribal Conservancy and the Inner Hylebos site, is located along the northern shoreline of the Hylebos Waterway, south of Marine View Drive and immediately west of East 11th Street (Figure 5). The project site consists of approximately 0.66 acres of uplands bordering an extensive area of intertidal mudflats immediately west of the site.

Prior to restoration, the Squally Beach site contained some hardwood trees, blackberry bushes, and a strip of intertidal marsh vegetation approximately 3 to 4 feet wide growing at approximately the mean higher high water (MHHW) elevation. The upland portion of the site was covered with blackberry bushes and other invasive plants and was used as a dump site (Figure 6). The site contains salt marshes and low-gradient mudflats that provide habitat for bottom-dwelling organisms important to the food chain. These organisms are of particular importance to shorebirds and juvenile salmon. The site contains several pilings, logs, and downed wood indicative of previous log storage activities in the vicinity. The Squally Beach site is situated adjacent to the largest area of original mudflats in Commencement Bay (see Figure 4).

1.2 Project Goals and Objectives

Goals and objectives were established by the Trustees for each restoration site. These were refined by the design team for each site in a conceptual design process. This evolution is described for each site in the sections below.

1.2.1 Mowitch Site

The Trustees primary goal for the Mowitch site is to restore the estuarine creek mouth habitat along the northeastern bank where the Hylebos Creek enters the Hylebos Waterway (NOAA, 1998a). Project objectives included increasing the sinuosity of the creek channel and increasing the area and quality of the intertidal habitat.

The design team built upon this objective to include the following additional factors. The project should maximize the areas to provide residence time for juvenile salmonids migrating from spawning areas in the Hylebos Creek, through the Hylebos Waterway into Puget Sound and eventually into the Pacific Ocean. This factor can be achieved by creating pools and channels in the buffer zone adjacent to the Hylebos Creek. Pools would provide potential resting and feeding areas while channels would provide additional transportation corridors for refuge and feeding. In both cases, the transition zone between the freshwater and saltwater environments would be expanded providing additional space for acclimation.

Additionally, the team noted that landscape connectivity should be provided to the extent possible with the Washington State Department of Transportation (WSDOT) mitigation site located to the southeast of Marine View Drive. The WSDOT Hylebos mitigation site is approximately 5.7 acres and included creation of intertidal areas by excavating the preexisting fill material on either side of Hylebos Creek.

The Trustees selected a backwater pool alternative for the Mowitch site. Important considerations for the selected alternative include:

- Establishing appropriate depths and slopes for the bottom of pools and interconnecting channel to avoid creating conditions that might lead to stranding migrating fish.
- Establishing an appropriate elevation range for flatter areas to promote growth of salt marsh vegetation such as Lyngby's sedge.
- Designing sloping areas between the existing upland elevation and the base of the new channels at an angle to minimize the likelihood of bank failure of the type currently occurring on the banks of the Hylebos Creek.
- Maintaining a sufficient buffer width from the fence and railroad bed to avoid compromising those structures.

1.2.2 Squally Beach Site

As articulated on a fact sheet for the site, the Trustees' primary goal for the Squally Beach site was to establish and intertidal plant nursery at the site to provide native plants for use in Trustee restoration projects (NOAA, 1998b). However, discussions with the Trustees held in early 1999 indicated that expansion of the existing salt marsh vegetation at the site was the primary goal for the project, and that establishing a viable plant nursery was a secondary concern that should not be pursued to the extent that the primary goal is compromised. For example, it was recognized that providing access for harvesting operations would reduce the area available for restoration.

The design team expanded on the goals identified by the Trustees to include habitat creation for small mammals and birds. This could be accomplished by intercepting and using fresh water from the two stormwater discharges that cross the site in a channel or channel and pool system. Additionally, the design team wanted to create more passages from the site to the mudflats area that could convey food such as insects and detritus for use by out-migrating salmonids. This could be accomplished by establishing food source areas such as riparian zones adjacent to the channel system, which would contribute appropriate materials from overhanging branches.

The Trustees selected a dendritic channel alternative for the Squally Beach site. The Trustees selected this alternative based on a desire to maximize production of salt marsh vegetation. Important considerations for this alternative are:

- Distributing the freshwater across the project area as uniformly as possible to maximize the area where high salt marsh plant species can thrive,
- Protecting existing salt marsh vegetation, and
- Reducing negative anthropogenic impacts to the site by limiting site access.

2.0 SCOPE OF WORK

The following sections describe the construction and restoration work that was performed at each site. Mowitch site work is described first, followed by a description of the work performed at the Squally Beach site.

2.1 Mowitch Site

Construction work at the Mowitch site included clearing, debris removal, excavation and grading to reach design elevations, construction of pools, installation of large woody debris and hydroseeding. These tasks are individually described in the following sections.

2.1.1 Clearing, Debris Removal, Excavation and Grading

The first actions at the Mowitch site were to install erosion control and related preparatory measures in accordance with the plans and specifications and an erosion control plan developed for the site (Ridolfi 2000). These measures included installation of:

- Silt fencing along the bank of the Hylebos Creek (Figure 8),
- A floating silt curtain between the site and the Hylebos Waterway,
- Filter fabric in catch basins in Marine View Drive,
- A rock driveway at the site entrance, and
- A ramp to protect the curb (Figure 9).

After the preparatory activities were finished, a tractor was used to mow the grass and shred the vegetation. Next, a large tracked excavator (trackhoe) was used to remove concrete debris from the northwest portion of the site. Subsequently, approximately 20,000 cubic yards (cy) of fill materials were removed from the Mowitch site to achieve design elevations. The fill materials were hauled to a nearby storage facility, which reused the materials on other projects. Excavation began near the Hylebos Waterway on the northwest side of the site and proceeded toward Marine View Drive. Excavation was performed with a trackhoe, which removed materials to the desired depth (Figure 10). The materials were loaded directly into dump trucks for transport to an offsite disposal facility or temporarily stockpiled and loaded into trucks at a more convenient time. Typically, trucks entered the site, turned around and backed into position for loading. This was necessary because the narrow configuration of the site, particularly after pools had been excavated, prohibited pass-through traffic patterns.

Relatively dry excavation conditions were maintained by working during the low-water portion of tidal cycles as required by the grading plan. This was most important in the lower portion of the pools, which are at an elevation of approximately 3 feet above mean lower low water (MLLW). The pools were typically flooded, and only a few hours of work per day were possible in these locations. Fortunately, low tides occurred during daylight hours in the summer when the project was underway.

Soil conditions were generally acceptably firm during excavation. Remtech facilitated good working conditions by establishing temporary grading patterns that avoided creating areas with standing water. In other words, positive drainage from areas under construction back towards either Hylebos Creek or the Hylebos Waterway was maintained to allow water to drain as the tide receded. Soil conditions were more difficult in two areas. First, the soil on the northwestern island was relatively soft and several layers of erosion control fabric were required to stabilize the slopes. Second, running sands were encountered in two areas where groundwater destabilized the slopes. Quarry spalls were placed on the slopes in these areas to increase slope stability (Figure 11).

During construction, grade control was maintained using a laser level and construction staking. A surveyor placed stakes indicating the required final grade and cut or fill at pre-specified locations prior to the initiation of earthwork (Figure 12). Remtech's field personnel used the stakes for control and checked elevations on the cross-sections provided in the construction plans to verify that the subgrade elevation had been achieved (Figure 13). The subgrade elevation was established to allow placement of materials (topsoil or fish rock) at the final design elevation.

2.1.2 Tidal Pool Construction

Three tidal pools were constructed at the Mowitch site. The first pool, Tidal Pool 1, had two entrances: one to Hylebos Creek and one to the Hylebos Waterway. Tidal Pools 2 and 3 had one entrance each directly to Hylebos Creek. The pools were excavated to the required subgrade elevation and fish rock, a mixture of 3/4-inch minus angular gravel and oyster shells, was placed in a six-inch lift below an elevation of +6.3 feet (MLLW). The fish rock was placed on coir (coconut fiber) based mat to reduce the loss of fish rock into the underlying substrate (Figure 14). Fish rock at the toe of the slopes also provides a measure of slope stabilization. Topsoil was placed on the pool slopes at elevations above +6.3 feet MLLW and covered with the same coir matting, used in this context as an erosion control material. The sides of the pool were generally sloped between 2.5:1 and 3:1 horizontal to vertical. These relatively steep slopes were dictated by the site geometry, which is relatively long and quite narrow.

Islands or peninsulas were constructed between the tidal pools and Hylebos Creek. The tops of these features are relatively flat and are at an elevation between +10 and +12 feet MLLW. These flat areas are intended to support development of salt marsh vegetation (Figure 15). Broad flat areas between the pools are at a similar elevation and are intended to support similar vegetation. Grading in these connective areas was designed to allow water to enter the site at the upstream portion of the site and flow downstream toward the Hylebos Waterway.

2.1.3 Large Woody Debris and Boulder Installation

Numerous boulders and large stumps, known as large woody debris or LWD in restoration jargon, were installed in the tidal pools. The purpose of these features is to provide refuge for juvenile salmon that may migrate through the area and to provide habitat diversity. The LWD was generally installed with the trunk end of the stump buried in the slope of the pool and the root ball sitting in the bottom of the pool. One Manta Ray™ anchor was driven at each location prior to installing the LWD as a means of fastening and anchoring the LWD. The anchors were driven using a small tracked vehicle with a hydraulically operated percussion hammer (Figure 16). The anchors were driven 6 to 12 feet into the ground and retracted to engage the folding arms of the anchor. The anchors work like drywall toggle bolts that are commonly used in homes (Figure 17).

A threaded bolt was attached to the Manta Ray™ anchors, and an eyebolt was screwed on the top of the bolt flush with the ground surface. A cable was then threaded through the eyebolt, wrapped around the LWD, and cinched tight to hold the log in place. Two boulders were placed on each piece of LWD to help resist the buoyant force of the wood (Figure 18). The boulders varied in size from approximately 1 foot to 2 feet in diameter.

2.1.4 Hydroseeding and Straw Mulching

Upland areas of the Mowitch site (elevation above 14 feet MLLW) were hydroseeded with a mix of grasses and forbs as shown in Table 2 (Figure 19). The seed mixture was selected to include native species intended to have a meadow-like appearance when established. The seeds were embedded in a base of tackifier and nutrients to hold the seed in place and provide nourishment. After the seed mix was applied, a two-inch layer of sterile straw was blown over the upland areas to reduce the potential for erosion during the plant establishment period.

2.2 Squally Beach Site

Construction work at the Squally Beach site included clearing, debris removal, excavation and grading to reach design elevations, construction of rock outlet structures, installation of toe logs and hydroseeding. These tasks are individually described in the following sections.

2.2.1 Clearing, Debris Removal, Excavation, and Grading

The first actions at the Squally Beach site were to install erosion control and related preparatory measures in accordance with the plans and specifications and an erosion control plan developed for the site (Ridolfi 2000). These measures included installation of:

- Silt fencing between the site and the mudflats,
- Temporary fencing along Marine View Drive to isolate the site, and
- A rock driveway at the site entrance.

After the preparatory activities were finished, a tractor was used to mow the grass and shred the vegetation. Next, a large tracked excavator (trackhoe) was used to remove concrete and asphalt from a portion of the site. Subsequently, approximately 2,300 cy of soil and fill materials were removed from the Squally Beach site to achieve design elevations. Excavation commenced on the west side of the site and proceeded toward the east. Compared with the Mowitch site, tides were less of a factor at the Squally Beach site, because there were no pools requiring excavation at lower elevations. The lowest elevations for excavation were at approximately +8 feet MLLW. Grade control was maintained using the procedure described for the Mowitch site.

2.2.2 Rock Outlet Construction

Rock outlet structures were installed on each of two stormwater culverts at the Squally Beach site that had previously drained directly to the mudflats. These structures are intended to collect freshwater for distribution across the site and dissipate energy that may be associated with high flows. The rock boxes are pre-cast concrete catch basins attached to the end of the concrete pipe (Figure 20). The top of each box was set flush to the ground surface and small channels were used to route freshwater from the outlet through the site. Cobbles were placed over the grates of the outlet structures to create a more natural appearance (Figure 21).

2.2.3 Salt Marsh Construction

Construction of the salt marsh at the Squally Beach site consisted of excavating to the appropriate subgrade elevations and placing organic-rich topsoil to serve as a growing media. Additionally, four tidal inlets were constructed to allow seawater to flow across the site and to provide drainage points for the diverted stormwater. Elevated berms were graded between the tidal outlets to help control the flow of water.

2.2.4 Toe Log Installation

Toe logs were installed parallel to the shoreline at the Squally Beach site to reduce the potential for erosion in areas with cut banks. The toe logs were 10 to 30 feet in length with diameters in the one- to two-foot range. The end of each toe log was secured with two Manta Ray™ anchors (Figure 22). Ten toe logs were installed at the site.

2.2.5 Hydroseeding and Mulching

As with the Mowitch site, hydroseeding technology was used to place grass and forb seed in upland areas of the Squally Beach site (Figure 23). Following seed application, a two-inch layer of sterile straw was blown over upland areas to provide erosion control.

3.0 PROJECT SCHEDULE

According to Remtech's original schedule, the project was originally scheduled to begin June 2, 2000 and was scheduled for completion on September 29, 2000. Mobilization was scheduled to occur on June 19 after preliminary submittals had been reviewed. The schedule was delayed for a number of reasons, as described below. In the end, the project was substantially completed on October 12, or about two weeks after the originally scheduled completion date. A final site-walk-through was completed on October 16, 2000. Hydroseeding occurred on November 2, 2000 after a seed mix appropriate for the late season was obtained.

4.0 FIELD CHANGES

This section describes the field changes and change orders that were processed during the project. These are important because of the associated cost and schedule implications. Limiting change orders is an important part of managing a construction project. Some change orders can be limited prior to construction through additional data collection activities. Others are essentially unpredictable, and it is prudent to include a contingency in both budget and schedule for these eventualities.

4.1 Mowitch Site

4.1.1 Railroad Crossing

NOAA issued a contract modification to Remtech to obtain a permit from Tacoma Rail to construct and use a temporary rail crossing (Figure 24). The requirement for a permit was recognized several months prior to beginning construction but several of the permit conditions were not identified in time to be included in the contract. For example, Tacoma Rail required insurance and specific materials for the crossing and indicated a strong preference for using a specialized subcontractor to install the crossing. Additionally, there was a daily notification requirement in the permit. This issue resulted in a three-day delay and a cost increase of $15,223.

4.1.2 Permit Delay

The U.S. Army Corps of Engineers required more time than anticipated to issue the Clean Water Act 404 permit. The delay was caused by a backlog of permit applications at the Corps, primarily caused by Endangered Species Act (ESA) consultations. This resulted in a delay of three working days in late June and early July and a cost increase of $840.

4.1.3 LWD Anchor Revisions

There was some confusion regarding the type and quantity of anchors necessary for anchoring LWD at the Mowitch site. This was resolved by issuing a contract modification requiring use of one (1) model MR-3 anchor, rather than the larger MR-2 anchors that had originally been specified, and two boulders per piece of LWD. This resulted in a credit of $546 and a one-day time extension to place the boulders.

4.1.4 Slope Stabilization

Quarry spalls were used in three instances at the Mowitch site. First, quarry spalls were placed in a veneer over concrete rubble at the corner of the site (Figure 25). Subsequently, quarry spalls were placed in two areas where the soil was particularly unstable because of groundwater seepage (Figure 11). The quarry spalls cost $12,766 and resulted in a one day time extension.

4.1.5 Buried Logs

Approximately 60 logs were discovered buried just below ground surface under the log ramp at the Mowitch site (Figure 26). It appeared that the logs had historically been used to stabilize the ground surface to allow the use of heavy equipment in the area. The logs were removed and most were transported to a nearly log sorting yard. Six logs were transported to the Squally Beach site for use as toe logs. Disposal of 55.91 tons of logs was paid under the debris disposal pay item at a cost of $2,516. A deduction was made for the volume of soil displaced by the logs, which was estimated to be 120 cy. This resulted in a credit of $660, for a net cost of $1,856. There was no time impact associated with this changed condition.

4.1.6 Contouring Discrepancy

Remtech's site layout survey identified a discrepancy in the contouring that had been performed to generate the design drawings. This discrepancy was traced back to the spacing on the control points used to create the contour maps. There was a gap of approximately 50 feet between control points in an area surrounding a sharp grade change from the relatively flat upland area to the steeper log ramp. Consequently, the contours were unconstrained and were found to be approximately 4.8 feet above the true elevation at control point 15. This caused an over-estimate of the required removal volume at this location. Recalculating the volume based on the correct elevation reduced the volume by 822 cy. This resulted in a credit of $4,521. There was no time impact associated with this changed condition.

4.1.7 Potentially Contaminated Soil

Remtech's field personnel noticed a petroleum odor while excavating near tidal pool number 2. Excavation was suspended in that area until the nature of the soil could be investigated. Ridolfi personnel collected an in-place sample of the affected soil and submitted it Sound Analytical Services in Tacoma for total petroleum hydrocarbon (TPH) analysis (Figure 27). Table 3 shows the results of these tests and lists the Washington Department of Ecology Model Toxics Control Act (MTCA) Method A cleanup standards for residential or unrestricted use. Because the results for sample WWSOIL-1 were below the cleanup standards, the soil was considered suitable for unrestricted use and was subsequently transported offsite.

A similar situation occurred in a second area, located closer to the site entrance. On this occasion, Remtech stockpiled some of the suspect material adjacent to the excavation area. Two samples of the affected soil were collected, one from the within the excavation (INP-1) and a second from the stockpile (SP-1). Table 3 indicates that the analytical results for both samples were below cleanup standards and the soil was transported offsite. There were no cost or time impacts to the contractor associated with either sampling event.

4.1.8 Seed Mix and Straw Mulch

The grass and forb mix applied to each site was different than had originally been planned (Table 2). The forbs were more expensive than those in the original mix resulting in an increased cost of $280. The straw mulch was not included in the original contract. A two-inch layer was placed over both sites for a cost of $1,980. There was a one-day time extension to place the straw.

4.2 Squally Beach Site

4.2.1 Contaminated Soil

An area of contaminated soil and debris was encountered near the central portion of the site. A second area was encountered along the alignment of the concrete culvert on the east side of the site. Remtech ceased excavation in these areas when an odor was detected. Prior to identifying the source of the odor, two truckloads of potentially impacted soil had been hauled to Interwest's staging area a few miles from the Squally Beach site. The soil at the Interwest facility was segregated and covered with plastic pending analysis.

In the meantime, Ridolfi personnel sampled the onsite areas and stockpiled soil to characterize the materials and to help evaluate disposal options (Table 4). Contamination seemed to be associated with a pea gravel-sized fill material that had a pronounced hydrocarbon odor. There may have been more that one type of material involved in a historical release because there was a viscous, slippery oil in addition to a lighter diesel-range fraction present. There was no indication of the source of the release, such as a buried tank or piping. The soil was sampled, excavated, and stockpiled on the east side of the site pending disposal (Figure 28). The Port of Tacoma arranged for waste characterization, transportation, and disposal of the soil. The soil was transported to TPS in Tacoma for treatment using low temperature thermal desorption.

The nature of the material in the bottom of the excavation pit (water-saturated and loose pea gravel) and the tidal influence precluded determining the vertical extent of contamination (Figure 29). Consequently, excavation was terminated, and the pit was backfilled with 4- to 6-inch rock to provide a stable subgrade for subsequent salt marsh construction. Removing and stockpiling the contaminated soil, costs associated with lost time, and placement of quarry spalls resulted in a cost of $11,122 and no time extension.

4.2.2 Toe Log Anchors

As with the LWD at the Mowitch site, the contractor was unclear regarding the number of anchors required for the toe logs. This was clarified in a contract modification that included a change in the type of anchors from a model MR-2 to a model MR-3 and specification of two anchors per log. This resulted in a net increase of $2,265 and a time extension of four days.

4.2.3 Creosote-Treated Wood

Approximately 10 tons of creosote-treated wood was unearthed during excavation at the Squally Beach site. Most of this material was located in and around the location where the contaminated soil was discovered. These materials were segregated and characterized based on a sample of the treated wood analyzed for polycyclic aromatic hydrocarbons (PAHs) by EPA method 8270C. The analytical results are shown in Table 5. Based on the analytical results, the materials were placed in a roll-off bin and transported to the Tacoma landfill for disposal. This activity resulted in a cost of $1,989 and a time extension of one day.

4.2.4 Fence Extension

Near the end of the Squally Beach project, it was determined that the post and wire fence was not long enough to prevent vehicles from entering the site. On the east side of the site, this condition had been exacerbated when brush was cleared to create a stockpile for contaminated soil. To remedy this situation, 10 extra posts were installed to extend the fence to the point where it intersected heavy growths of blackberry bushes. Coated cable, similar to the existing materials, was strung between the posts. This activity resulted in a cost of $1,492 and a time extension of one day.

5.0 FINAL SITE CONDITIONS

At the end of the construction and restoration work described in this report, the Mowitch and Squally Bēach sites were ready for planting. The planting plan includes salt marsh vegetation and riparian or upland plants in buffer zones at both sites. Upland plants were installed by volunteers at the Squally Beach site on November 18, 2000 (Figure 30). The remainder of the planting efforts is scheduled for the spring of 2000. Additionally, temporary irrigation systems will be installed at both sites to provide water for the upland plants until their roots are established.

6.0 PROJECT PERFORMANCE

The preliminary restoration objective of grading the sites to desired elevations has been achieved. It is too early to determine whether the ultimate goal of providing a functional habitat will be achieved. First, the salt marsh plants must be installed and allowed to grow. The plant community may take several years to develop, and it may progress in a trajectory different than envisioned in the design. In addition to development of a floral community, it is anticipated that a diverse faunal community will develop at each site as overall habitat conditions improve. Again, faunal development may take years to achieve, and monitoring will be required to document the progression.

7.0 PROJECT COSTS

Project costs for these projects were controlled primarily by the amount of excavation required to reach appropriate elevations for restoration of salt marsh vegetation. Table 6 provides a comparison of estimated and final construction costs.

As shown in Table 6, the engineer's estimate and the bid received from the contractor were nearly identical.

Change orders as described in section 3.0 increased the final project cost by approximately 14 percent. NOAA had established a contingency fund for the restoration efforts and it was sufficient to cover the change orders. Consequently, progress on the project was not impeded.

8.0 LESSONS LEARNED

In general, the restoration projects proceeded within normal limits for projects of this type. The work was essentially completed as planned. The project schedule and budget increased slightly because of unforeseeable site conditions and circumstances. These positive results can be attributed at least in part to a strong working relationship between NOAA as the owner, Ridolfi as the design engineer providing field oversight, and Remtech as the Contractor. An important part of the working relationship was frequent, ongoing communication between field personnel (both contractor and oversight engineer) and office staff regarding conditions in the field compared to construction plans.

For example, early in the Project, Ridolfi's field engineer noted that slopes on surfaces at the Mowitch site were steeper than anticipated. Ensuing communication indicated that Remtech was not using the cross sections to guide grade control between control points. This issue was clarified with a few telephone calls, and subsequent work progressed according to plans without lost time or duplicated efforts. Less frequent inspections or more formalized lines of communication might have allowed this type of problem to grow into a dispute costing time and money.

Starting with the specifics of this example, the following list provides areas where modifications in contract documents or other items might contribute to smoother project implementation.

(1) Cross-sections provide a precise means of conveying desired site conditions. The construction plans should emphasize that the contractor should use the cross-sections to direct grading of the site.

(2) For larger sites, it may be useful to include a grid system in the survey requirements. This would entail establishing a regular grid on 100 to 500 foot intervals, depending on the size of the site, to facilitate locating features in the field.

(3) The number of anchors required to anchor LWD should be clearly specified in the plans and specifications.

(4) Weighing soil for disposal should be considered as a means of quantifying this type of material. Remtech was somewhat confused by this pay item. Their personnel were counting trucks and they anticipated being paid on this basis. (The contract stated that soil excavation would be paid on an "in-place" basis.

(5) Obtaining a "rate sheet" from the contractor at bid time can be used as a means of administering contract modifications and change orders during construction. Rate sheets may also help when evaluating and comparing bids.

9.0 NEXT STEPS

The next step at both sites is to plant the desired upland and salt marsh vegetation. Upland vegetation was planted at the Squally Beach site on November 18, 2000 by citizen volunteers (Figure 30). Many of the volunteers were coordinated by Citizen's for a Healthy Bay. Others were associated with local schools and universities. A similar effort will occur at the Mowitch site in the Spring of 2001 for both upland and salt marsh plants. Salt marsh plants will also be installed at the Squally Beach site at the same time.

Temporary irrigation systems are planned for each site to provide water for the upland plants. For logistical reasons, these systems will be installed under contract to the City of Tacoma.

After the plants are installed at both sites, a monitoring program will be instituted to document project performance. This program will involve chemical, physical and biological monitoring to evaluate whether the sites perform as intended. This will include measurement of parameters to evaluate form such as elevation, soil type and salinity. Additionally, measurements will be made to evaluate function such as the density and diversity of plants, insects, and macroinvertebrates. This monitoring program will be conducted by the Trustees as part of a wider effort to evaluate restoration effectiveness in Commencement Bay.

10.0 REFERENCES

Ridolfi Engineers Inc. 1999. Conceptual Design Report for Commencement Bay NRDA Habitat Restoration Projects. September.