CHAPTER 3
MASTER PLANNING

3-1. Sizing

a. User input. The wash facility must be designed to meet the user's needs. The design will determine the type, size, and configuration of the wash facility and treatment system based on information supplied by the installation. Proper initial planning will result in the best final design. The planner will have to assemble data from many sources and use judgment in applying this data to the guidelines provided for sizing the facility components. Where data is not available, estimates must be made.

(1) *Military mission data.* The wash facility must sup--port the particular needs of the installation. Troop types, their vehicle types, and their training program, both current and future, must be considered. This includes resident troops as well as transient troops. The combination of numbers of vehicles, types of vehicles, and frequency of washing will determine the type and size wash facility required. A complete list of each military unit which will use the facility is required, along with its vehicular complement and the expected frequency each vehicle would be washed.

(2) *Wash frequency data.* Certain components of the wash facility will be sized based on long term or average numbers of vehicles washed. Other components are sized on short term or peak use numbers. In both cases, the mix of vehicle types is an important consideration.

(a) The average use of the facility should be provided by the user broken down as weekly or biweekly, monthly, and annually. Seasonal variations must also be a consideration. Where training programs are impacted by seasonal weather or where large numbers of transient units in a particular part of the year impact expected use, the average weekly or monthly numbers would not be a fixed ratio of the average annual numbers. Monthly average should be the average of the six highest use months; weekly should be the average of the ten highest use weeks.

(b) The peak use of the facility should be provided by the user as the largest number of vehicles to be washed in a continuous short term period. If night washing is to be designed for, the peak use may, for example, be a continuous three day (72 hour) period. The peak use will represent full utilization of the wash facility components for the chosen time period. The planner must consider the length of time it will take for all the vehicles scheduled to wash in this peak exercise to return to the cantonment area after training. The rate of movement of these vehicles will help determine the time period to allow for in the peak use operation. Ideally the CVWF would accommodate all units as they arrived, without excessive backup, and at a continuous full utilization of the washing components. It is important that the planner consider the frequency of the defined peak use; in some cases, a large-scale facility may not be justified based on the low frequency of this peak activity. The peak use should be a condition expected to occur at least three times per year.

(3) *Vehicle soiling data.* The types of soil found in the training ranges along with weather conditions are predictors for the amount of dirt which will have be to washed off of the vehicles. This will affect the type of washing components, the time required for washing, the amount of water used and the waste-water treatment components.

(a) A characterization of the soils is needed. A study of the installation maps showing soil types throughout the total training areas should be made to determine if sands, clays, or combinations of soils occur. Samples of Soils should be taken from the range areas, as well as samples taken directly from dirty vehicles returning to the cantonment area after a heavy rain. Separate samples should be collected for each identifiable soil type (3 to 5 gallons each) and analyzed in a soils laboratory. The laboratory should prepare a standard gradation curve of grain size distribution showing gravel, sand, silt, and clay utilizing both a mechanical analysis and a hydrometer analysis down to 0.001 mm diameter. Both a dispersed and a non-dispersed hydrometer analysis need to be performed. The dispersed, which breaks the particles into individual grains, is used for standard classification. This will be used to categorize the soiling expected on the vehicles. The dispersed, which assesses the agglomerated particles, is used in the treatment analysis (chap 6), since the washing operation does not totally disperse the soil. Figure 3-1 shows an example of a cohesive (silty clay) soil gradation curve both dispersed and dispersed. Figure 3-2 shows an example of a noncohesive (sandy) soil.

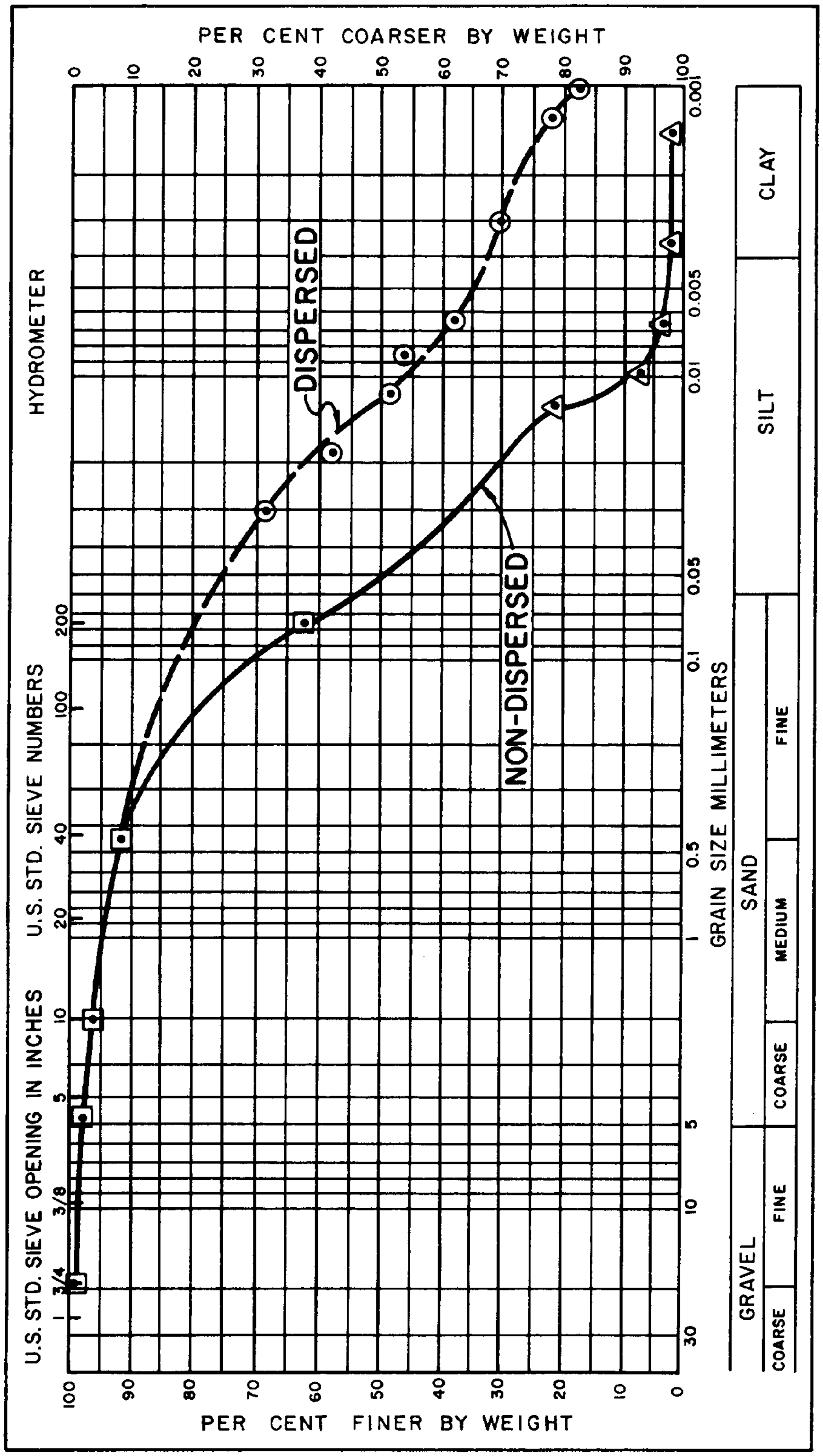

Figure 3–1. Cohesive soil gradation curve.

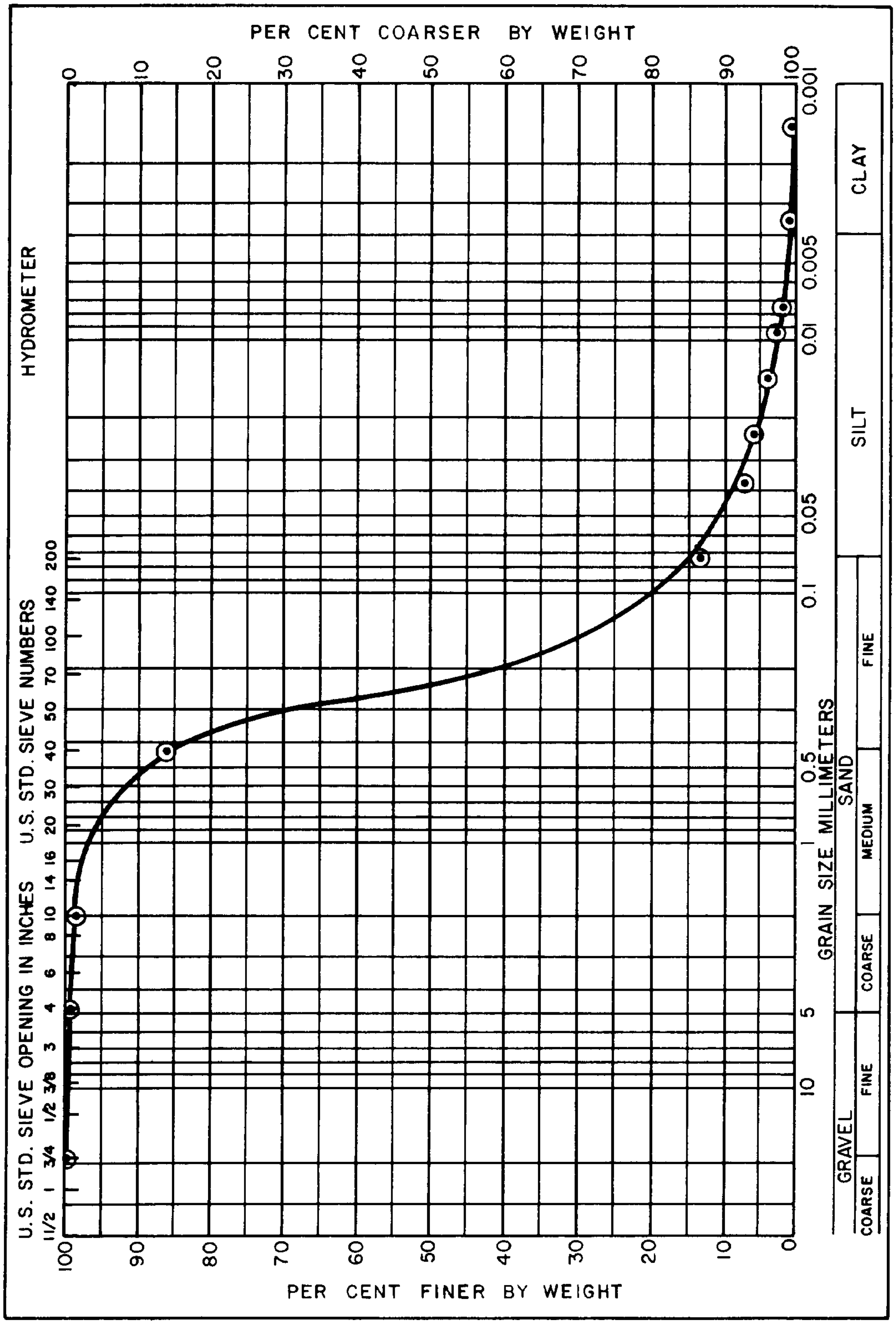

Figure 3–2. Noncohesive soil gradation curve.

(b) A classification of the soils expected to be on the vehicles is needed. By taking the particle size curve previously discussed and plotting the percentage of sand, silt, and clay (dispersed) on a triangular classification chart as shown on figure 3-3, a combined classification can be made. As an indicator of soiling potential expected on the vehicles, the chart is divided into 5 categories or soil type numbers (S_t) The sands and silty sands are given a type number of 1, being the least likely to soil a vehicle and being the easiest to clean. The clays are given a type number of 5, being the most likely to soil a vehicle and being the hardest to clean. Where a particular analysis may plot on the chart close to the line between two types, interpolation should be applied (i.e. a soil could be given a type number of 2.5). Where different soils occur in the training ranges, an average of those found may be used. The designer should use judgment when making this determination and give due consideration to the extreme adverse affects caused by high clay content soils.

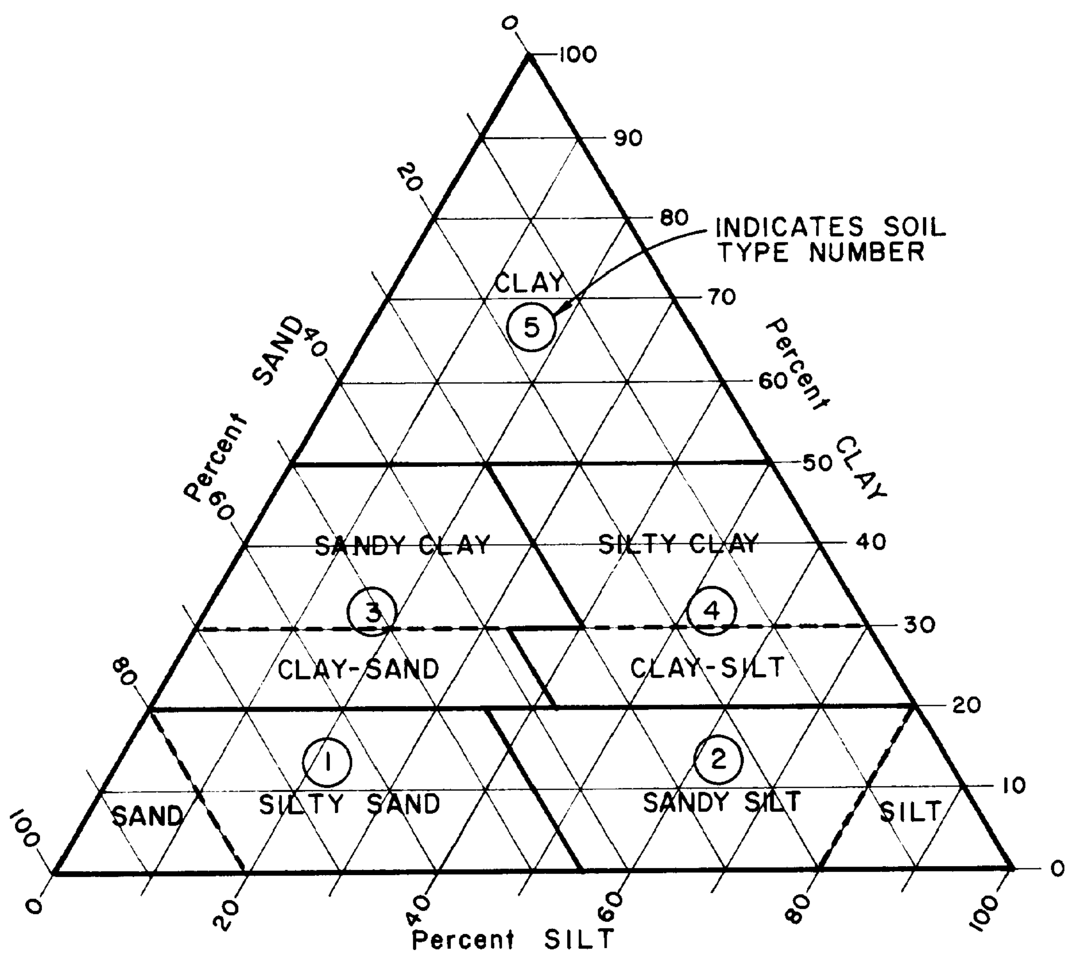

Figure 3–3. Soil classification and soil type number diagram.

(c) Actual soiling of vehicles is a function of both soil type and the amount of rain or wet conditions expected in the training areas. Therefore, climatic data must be provided in order to fully assess the potential for vehicle soiling. Arid regions would have minimum soiling potential where rainy regions would have maximum soiling potential. By assigning a climatic factor (Fc) to the area, ranging from 1 being arid to 2 being very rainy or wet, and multiplying this by the soil type number, a soiling index can be obtained for the installation. This is given by equation 3-1.

$$S_i = S_t x F_c \qquad \text{(eq 3-1)}$$

The soiling index will be used to predict times and determine the need for a prewash.

(4) *Climatic data.* As previously stated, climatic data at the installation is necessary. In addition to amount of rain, seasonal variations in moisture and temperature are needed. Areas with long periods of

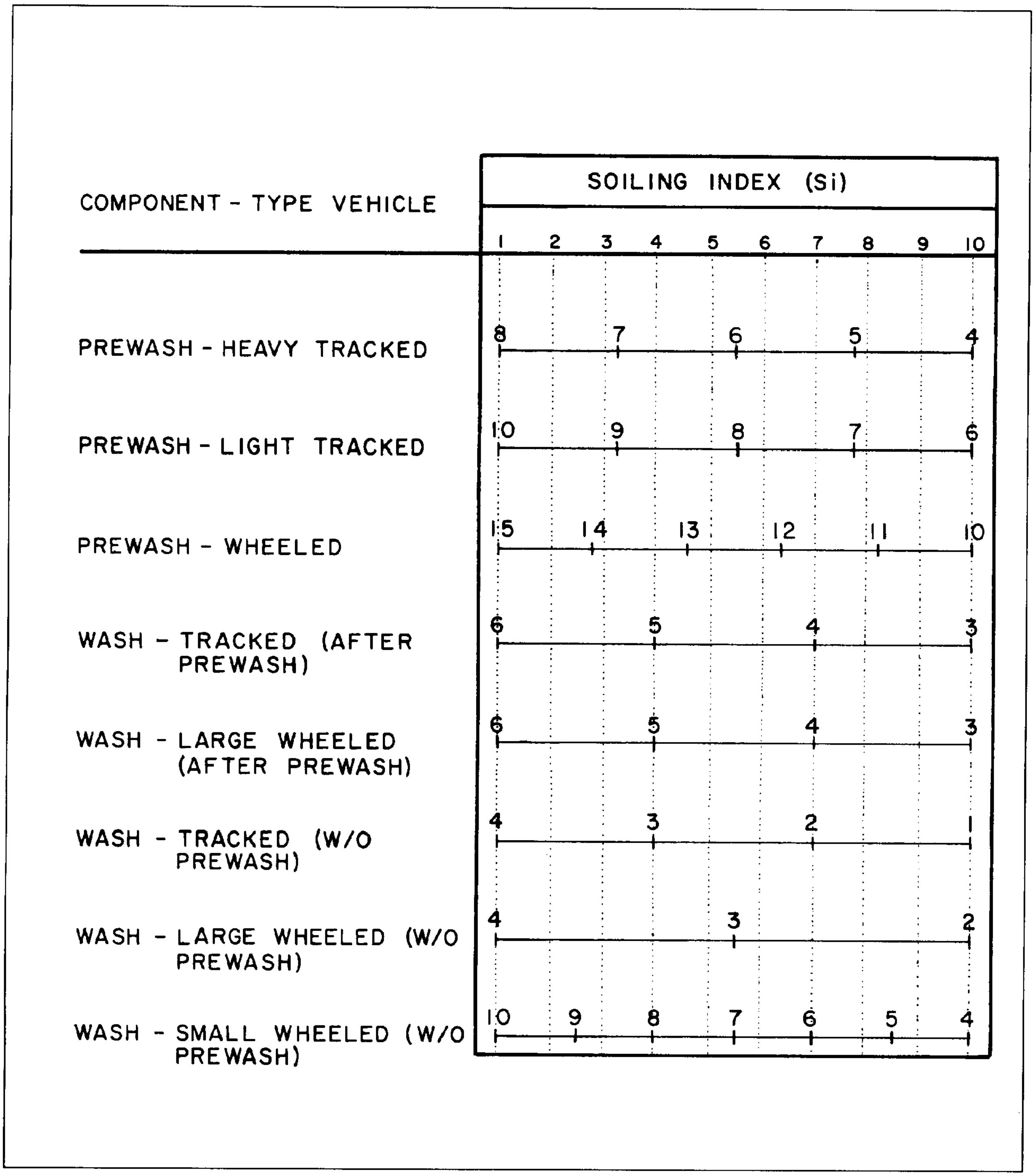

Figure 3-4. Vehicle processing rates.

freezing weather will require special design considerations to protect wash components, pumps and piping. Most of the wash components, particularly the prewash, may not be feasible to operate near freezing conditions because of the safety hazard caused by overspray freezing on the pavement. Enclosed facilities may be warranted, however, they are very expensive from both a capital and operations standpoint. Another climatic consideration in the design is the evaporation rate in the region. In an area with high evaporative losses and low rainfall, certain features of the CVWF may not be practical. For example, a spray stand creates large water losses due to overspray. Use of any prewash system increases the volume required in the treatment system; with the higher water volume, the surface area of the basins must be increased (particularly a lagoon treatment), which promotes evaporative losses even more. The designer must evaluate the potential evaporative loss as it affects the need for make-up water and weigh this against the benefits of either a recycle system or a discharge system.

b. Prewash. A prewash is used to reduce the time needed to wash vehicles, since it removes the bulk of the dirt in a timely, efficient way. Its function is to reduce the amount of time each vehicle must spend at the wash stations.

(1) *Bath prewash.* A bath prewash is currently the most efficient and effective method to remove dirt from the exteriors of tactical vehicles. A large volume of water is required to fill the bath, but because of the reduced wash time required, the overall water volume required for cleaning a large number of vehicles may be reduced. Lanes specifically designed for washing tracked vehicles can be provided; lanes which can accommodate both tracked and wheeled vehicles (referred to as dual purpose lanes) can also be provided. These are described further in chapter 5. Wheeled vehicles under 2.5 tons would not normally use the prewash bath.

(a) *Process Rate.* In a tracked bath lane, six to ten tracked vehicles per hour can be washed. In a dual-purpose lane, ten to fifteen wheeled vehicles per hour can be washed. The amount of soiling will determine the actual number of vehicles that can be processed through the facility; the heavier the soiling, the slower the vehicles can be processed. By using the Soiling Index (S_i) in conjunction with the processing rate chart shown on figure 3-4, the throughput rate can be determined for a particular design.

(b) *Number of lanes.* The number of lanes for the prewash will depend on two factors: The maximum number of vehicles that must be washed at the facility in a time specified by the installation (peak wash period) and the expected process rate through the facility. Equations 3-2 and 3-3 will help the designer determine the number of each type of lane needed for the prewash system. The installation's requirements will dictate how the result should be treated. If the maximum washing time is critical, the number should be rounded up; otherwise, the number of lanes should be rounded to the nearest whole number.

$$\text{No. tracked lanes} = \frac{\text{Max. no. tracked vehicles to be washed}}{\text{(Process rate x peak washing period)}} \qquad \text{(eq 3-2)}$$

In equation 3-3, only the tracked and wheeled vehicles expected to use the dual-purpose lane should be considered in the equation. The number of tracked vehicles using the tracked vehicle lane should not be included, since they will not be washed twice in the prewash.

$$\text{No. dual-purpose lanes} = \frac{1}{\text{Peak wash period}} \times \frac{\text{No. tracked}}{\text{Process rate}} \times \frac{\text{No. wheeled}}{\text{Process rate}} \qquad \text{(eq 3-3)}$$

(c) An example will better explain how to use the equations. Consider an installation that needs to wash 42 heavy tracked vehicles, 88 light tracked vehicles, and 125 wheeled vehicles in the prewash during peak use. The installation requires that all of the vehicles be washed in 9 hours. Soils at the installation are extremely cohesive clays, so the process rates through the prewash are expected to be slow. The designer had determined that the soiling index (S_i) is 8 and from the chart (fig 3-4 estimates that five heavy tracked vehicles per hour can be washed in each lane; seven light tracked vehicles per hour per lane can be washed; and eleven wheeled vehicles per hour per lane can be washed in a dual-purpose lane. For initial calculations the following will be used.

$$\frac{\text{42 heavy tracked}}{\text{5 veh/hr/lane x 9 hr}} + \frac{\text{88 light tracked}}{\text{7 veh/hr/lane x 9 hr}} = 0.93 + 1.40$$

$$= 2.33 \text{ tracked lanes}$$

$$\frac{\text{125 wheeled vehicles}}{\text{11 veh/hr/lane x 9 hr}} = 1.26 \text{ dual-purpose}$$

The designer realizes that, with three tracked vehicle lanes and one dual-purpose lane, the tracked vehicles will be washed in less than 9 hours, but the wheeled vehicles will require more than 9 hours. To achieve a more even distribution of vehicle washing, the designer recalculates the number of lanes needed by assuming that some of the light tracked vehicles will use the dual-purpose lanes. The designer adjusts the process rate for the light tracked vehicles in a dual-purpose lane. It Will take longer to process a tracked vehicle in dual-purpose lane than in a tracked lane, since the flexors in a dual-purpose lane are not as effective as those in a tracked lane at removing the embedded soil from the tracks.

$$\frac{42 \text{ heavy tracked}}{5 \text{ veh/hr/lane} \times 9 \text{ hr}} + \frac{65 \text{ light tracked}}{7 \text{ veh/hr/lane} \times 9 \text{ hr}} = 0.93 + 1.03$$

$$= 1.96 \text{ tracked lanes}$$

$$\frac{125 \text{ heavy tracked}}{11 \text{ veh/hr/lane} \times 9 \text{ hr}} + \frac{23 \text{ light tracked}}{5 \text{ veh/hr/lane} \times 9 \text{ hr}} = 1.26 + 0.51$$

Two tracked vehicle lanes and two dual-purpose lanes would offer a more efficient use of the bath than would the results given by the first calculations.

(2) *Automatic washers.* The types and number of vehicles in the motor pool must be considered in sizing the automatic wash area. Administrative-type vehicles in a TMP usually return one at a time and are washed as they return. Thus, large numbers of units will not be waiting to be washed in a limited amount of time as is the case with tactical vehicles at CVWFs. Civilians usually are employed to do the washing at TMP wash facilities; therefore, all of the daily washing normally will occur during an 8-hour period during daylight. A one-or-two position automatic prewash unit may be all that is required. Again, number of vehicles per cycle and average time of washing are used to determine the size of the prewash unit.

c. Wash stations. Before sizing the facility, with or without a prewash, the designer must have a clear understanding of the installation's washing requirements. The number of stations needed at the wash facility will depend on whether a prewash system is provided. A prewash will lessen the time that these vehicles must spend at the wash stations, thus reducing the number of stations needed.

(1) *Sizing with a prewash.* When a bath prewash is provided, the number of wash stations should be between two and five per tracked vehicle bath lane. A process rate of 3 to 6 vehicles per hour at each wash station can be expected after the vehicles have been washed in the bath. Since all vehicles will not go through the prewash bath, calculations of lanes must account for longer wash times for these vehicles. A process rate of 2 to 4 vehicles per hour for large, odd shaped, or tandem units can be expected. A process rate of 4 to 10 vehicles per hour for small wheeled vehicles such as jeeps or ½ tons can be expected. Installations with a limited washing time or a large percentage of wheeled vehicles to wash will require more wash stations. In any case, the number of stations can be calculated using the processing rates for each type vehicle and its type wash, as shown on figure 3-4, and following the same logical steps used to size the prewash.

(2) *Sizing without a prewash.* If no prewash is provided, the planner predicts the number of wash stations needed based on, soiling conditions and process rates.

(a) The process rate for vehicles at the wash stations will depend on several factors, but usually will be between 1 and 10 vehicles per hour. This range is given to allow an adjustment for the vehicle types and soiling index at the site. Installations that have vehicles soiled with large amounts of cohesive soils (clays) will have slower processing rates than those with only noncohesive soils (sand) or dust on the vehicles. By using the Soiling Index (S_i) in conjunction with the processing rate chart shown on figure 3-4, the throughput can be determined for each vehicle type. The mission of the installation also will affect the process rate. At some installations, vehicles may return to the motor pool immediately for inspection. In this case, the processing rate will be slower than if the vehicle were not being inspected, since the troops will most likely perform a detailed washing. Less time will be taken to clean the vehicles if they will be returned directly to the field for further training.

(b) *Number of wash stations.* The number of tracked and wheeled vehicles to be washed is used in equation 34 to estimate the number of wash stations needed at a facility:

$$\text{No. stations} = \frac{1}{\text{Max. wash period}} \times \frac{\text{No. tracked}}{\text{Tracked process rate}} + \frac{\text{No. wheeled (Lg.)}}{\text{Lg. Wheeled process rate}} + \frac{\text{No. wheeled (Sm.)}}{\text{Sm. Wheeled process rate}} \qquad \text{(eq 3-4)}$$

The user's requirements will determine how this number should be rounded. If the maximum washing time is critical, the number should be rounded up; otherwise, it should be rounded to the nearest whole number.

3-2. Siting

a. Geography. All future development and land uses at the installation must be considered when siting a CVWF. These future plans must not adversely affect the vehicle and equipment movement inside and outside the facility. At the same time, the facility must not interfere with activities in the cantonment and training areas and vice-versa; the land uses should be compatible. Vehicle noise and movement must not interfere with family housing, hospitals, and other installation activities. If night washing is planned, it must not disrupt local activities; for example, the high mast lighting at the facility must not disturb the surrounding area.

(1) *Space requirements.* Planners and designers must consider overall space requirements for the facility. Large, open areas will be needed if a total recycle treatment system is to be installed. Lagoon treatment systems require even larger areas than intermittent sand filter systems. Smaller areas will suffice for partial or total discharge systems. A CVWF with eight wash stations, no prewash, and no recycle system can require 2 to 4 acres; one with 20 wash stations, 4 lane prewash, and a complete recycle treatment system can require as much as 50 acres.

(2) *Cantonment boundary.* The wash facility should be located near the permanent cantonment boundary and between the training areas and maintenance shops/motor pools. The vehicles must be cleaned before they enter the cantonment area; otherwise, the dirt will fall onto the roads and trails within this area. Future changes in the cantonment boundary must also be considered when siting the CVWF.

(3) *Training area.* The facility should be located as close as possible to the main tank trails, access roads from the training areas, or similar sites. The vehicles are washed as they return from the training field areas prior to entry onto cantonment roads. Future locations for training areas also must be considered with respect to the CVWF site.

(4) *Transportation arteries.* Several routes usually enter the cantonment area from many different training areas. A CVWF usually cannot be constructed at each entry point, so new roads or tank trails may have to be built to link the primary routes from the training areas with the wash facility. To prevent the vehicles from becoming soiled immediately after washing, they must return from the wash facility to the maintenance shops/motor pools on paved roads or tank trails. If the exit from the facility is placed close to existing roads or tank trails that are paved, new construction will be kept to a minimum. The facility must also be located to minimize the distance that dirty vehicles must travel on major transportation arteries. Otherwise, the dirty vehicles will drop soil on roads over which other vehicles travel. The number of tank-trail crossings over major roads, both to and from the wash facility, must also be minimized. The entrance and exit of the wash facility should be sited to avoid adverse effects on traffic both there and in the cantonment area. The facility should not be located in congested areas such as near the main gates, major intersections, hospitals, administration offices, and other high traffic areas.

(5) *Maintenance shops/motor pools.* Present and future locations for tactical maintenance shops and motor pools must be considered in siting the CVWF. The facility should be located between the training areas and the maintenance shops/motor pools. The vehicles should return from the training areas and, after washing, return to the maintenance shops/ motor pools with minimal travel on cantonmen roads.

b. Weather. The wash facility must be designed with due consideration to all local and regional weather conditions.

(1) *Temperature.* If the installation is in a region with long periods of freezing temperatures, some standard CVWF components, such as the prewash bath may not be useable since the CVWF is not intended to be operated continuously at temperatures below 40°F. In areas with seasonal or occasional freezing temperatures, special piping and plumbing fixtures must be installed at the outdoor facilities to drain the exposed pipes and keep them from freezing. South-facing slopes should be considered for construction sites to take the greatest advantage of the sun for heating during the winter months. The washing structures and treatment system still must be protected from freezing temperatures to prevent pipes and other vulnerable components from freezing and rupturing.

(2) *Winds.* The designer should consider locating the wash facility and treatment system to minimize adverse effects from wind. Wind blowing over basins increases the rate of evaporation. In addition, winds that blow over the long axis of an elongated basin can create waves that will erode the banks. Wind can be used to move surface oil toward the oil skimmer in sediment basins provided the oil skimmer is located properly. Strategically placed vegetation, structures, and fences can reduce the adverse effects of wind. However, vegetation must not interfere with pipes, trenches, pavement, liners, or other functional parts of the facility.

(3) *Precipitation.* Gently sloping ground which is elevated slightly with respect to the surrounding grounds should be chosen to ensure that stormwater can be controlled. Stormwater collected on the pavement during washing operations should be directed toward the treatment system since this water may require treatment; in addition, it can be used as makeup water for a recycle system. Curbing should be installed where the soil and pavement interface, and where it is needed to control the drainage flow and to prevent erosion. Rainwater falling on the surrounding area should be directed away from the facility unless it is to be used as a source of makeup water.

(4) *Vegetation.* The site layout should make effective use of existing vegetation to protect the buildings, personnel, and basins against wind and sunlight.

Trees, shrubs, and grass should not be removed except as necessary for construction or operation. The roots hold soil in place, thus preventing sheet wash and soil deposition onto the paved surfaces and into the stormwater collection system. Moisture in the treatment basins will promote growth of vegetation such as trees and shrubs on the surfaces and along the edges of the basins. Trees and shrubs that grow very close to the filters and the basins must be cleared because their root systems may penetrate the liners and cause leaks. Slopes for berms should be designed to allow convenient maintenance.

(5) *Fauna.* The abundance of water will promote insect and animal life in the area around the basins. Fences may have to be constructed around the basins, especially in arid regions, to prevent wildlife from entering the area to drink or bathe since their activities could damage the slopes and liners. The water also may attract burrowing animals that can damage liners and berms; their presence may, in time, increase maintenance needs.

(6) *Evaporation rates.* The region's evaporation rate must be considered when siting and designing the facility.

(a) *Arid regions.* Wash facilities in arid regions must have the wash structures and treatment system designed to minimize the effects of evaporation. Water from the pavement should be directed toward the treatment system; in this way, stormwater can be collected and used as an additional source of makeup water. In hot, arid regions, the pavement should be light-colored to reflect heat; the evaporation rate will be less when the wash water hits a cooler, lighter surface than when it hits a hotter, darker one. Another major point of evaporation is from the basins in the treatment system. A high rate of evaporation from the basins can increase the concentration of dissolved solids in the water. This higher dissolved solids content can result in spotting on vehicles after washing and increased corrosion. The exposed surface area of the basins should be minimized. The basins' depth can be increased to the upper limits to allow them to hold the required volume while reducing the exposed surface area. Wind blowing over the basins also can raise the evaporation rate. Fences and shrubs can be placed around the basins to help block winds. Vented covers also can be placed over the basins to reduce evaporation. Basin liners and the materials used for filters should be light-colored.

(b) *Water-rich regions.* In water-rich areas, provisions must be made to handle a heavy water volume. Onsite control to prevent stormwater damage to the treatment system becomes critical when heavy rainfalls are expected.

c. Geology.

(1) *Topography.* The site should have some fall if the designer is to consider using a gravity-controlled recycle wastewater treatment system. A 2 to 3 percent slope across the site is desirable, with the high side being adjacent to access roads or tank trails. If the terrain is too flat, the treatment system would require extra pumping in order to recycle the water. This requirement would increase costs for initial construction and for operation. It is essential that the wastewater flow by gravity from the wash structures to the sediment basins. Should the wastewater be pumped before primary treatment, any oils in the water would become emulsified and thus more difficult to remove. Low-lift pumps can be used elsewhere in the facility if necessary. The entire site should be elevated with respect to the surrounding area. Slopes in the immediate area should fall away from the site to help move stormwater and cold air away from the site. It is desirable that the local topography not funnel water or strong winds toward the site.

(2) *Soils.* Soil borings must be taken at the proposed site to determine the soil types, the depth of the bedrock, and the depth of the water table. The soil should be able to support concrete, bentonite, and similar sealers that will be applied to the bottoms of basins, sand filters, and facilities such as pumphouses and control buildings. Large soil particles tend to slide and shift more than small ones; therefore, in sandy areas, the walls of excavated basins will have to be built with a low-sloped angle to prevent this problem. Excavation of a basin at a site with cohesive soils may be more expensive than a site with noncohesive soils. However, it may be more expensive to stabilize the slopes at the site with noncohesive soils. It may also be more cost-effective to use native, cohesive soils for basin construction than other types of liners or imported soil. Bentonite liners may be difficult to seal on noncohesive soils; later, settling and shifting of the soils may create leaks in the liner. Bentonite liners can also be damaged by hydraulic pressure from groundwater, especially when noncohesive soils are present.

(3) *Bedrock.* The site should have deep bedrock since shallow bedrock hinders excavation. An excavation into bedrock may penetrate into fissures that are part of a subsurface water recharge network for a public water supply; this supply could become

contaminated by wastewater from the facility. Excavation into bedrock also increases construction costs. If no other site is available, fill material may be used to increase the soil depth at the site. Another alternative would be to excavate material that is easy to remove down to the bedrock, then use the excavated material to build a berm around the basins. The gradient of the berm slopes must be low enough to avoid interfering with operations and maintenance (O&M) and to prevent sheet erosion of the slope.

(4) *Water table.* The planner must know the depth of the water table at the proposed construction site. Sites near marshes, swamps, or low areas should be studied to determine if the water table will have an adverse effect on construction or O&M of the facility. The facility must be placed above the maximum height of the seasonal and permanent water tables. Areas with high water tables may require complex drainage systems, usually with high construction costs. Should the basins and filters be constructed when the water level is low and then water rises and surrounds the structures, the hydraulic pressure can damage the liners and cause leaks. Clay lenses or other impervious subsurface features can create a high, perched water table. Excavation to repair the subsurface structures would be hindered by the high water table; it would also be expensive because the groundwater would have to be removed from the site to allow personnel to work.

(5) *Drainage.* It is important that wastewater generated by the facility not contaminate drinking water supplies. Therefore, wastewater from the washing structures must not drain into a surface or subsurface water recharge area for a public drinking supply. Surface and shallow subsurface water should be directed away from the site unless it will be used as a source of makeup water. The area will be wet due to washing, storage, and treatment; in certain climates, ponding and uncontrolled collection of stormwater can cause discomfort to the workers (i.e., from being cold and wet) and speed the rate at which equipment wears. Sites with permeable soils allow surface waters to percolate, which prevents ponding and sheet erosion.

(6) *History.* It is important to have historical knowledge of the site. Past uses of the site may make it unsuitable; this could be from an archaeological standpoint such as old burial grounds, or from a hazardous standpoint such as old landfills or old firing ranges and impact areas.

d. Utilities. The planner must consider all utilities required at the facility with respect to those available at the site. If some of the utilities are not available, the best alternative must be found.

(1) *Water.* The wash facility should be sited near existing water or supply lines if possible. Water meters should be installed so that the potable and recycled water can be metered.

(a) *Potable water.* A potable supply must be provided as drinking water for personnel. If it is not feasible to tie the facility into the potable water system, portable equipment can be used to supply drinking water. Signs must be posted informing personnel not to drink the wash water and telling them where drinking water is available.

(b) *Makeup water.* Potable water is not required for washing the vehicles; however, the water must be free of particulate matter that would interfere with pump operation and cause premature wear of the wash equipment. The water source must charge and maintain a working water level in the treatment system. A dedicated well may be used if that proves more economical than tying into the existing water lines. If the planner considers using an untreated well, the groundwater must be of an acceptable quality and must provide a consistent supply. If the area is water-rich, rain can be used as a source of makeup water. Ponds, lakes, and streams are other potential raw water supply sources for the facility. The amount of water needed at the facility will depend on several factors: frequency of washing, number of vehicles, types of vehicles, and type and size of treatment system provided. The planner must also consider the best source and method of charging a recycle treatment system initially. Once a recycle treatment facility is charged, the only demand for water will be to makeup that lost to vehicle carry-off, evaporation, and leakage.

(2) *Electricity.* The wash facility should be located near existing power lines. If electrical power is not available at the site, new lines must be run. Electricity will be required to run the pumps that circulate water throughout the facility and to provide power for security and night lighting. The amount of power that the planner should expect the facility to use will depend on the volume of water treated, recycled, and discharged; the type of washing operations; the frequency and duration of washing at night; and the number of washing operations performed each year. It is important that electrical lines not span areas of vehicle movement. Vehicle antennas, especially on wet vehicles, must not come

into contact with electrical lines as this occurrence would pose a safety hazard to the area. At remote locations, it may be necessary to have the electrical power generated onsite.

(3) *Sanitary*. The facility should be located near the sanitary sewer lines if possible. This arrangement allows the designer to tie latrines at the wash facility into the sanitary lines. Other options such as pit latrines, composting chemical toilets, or septic tanks with field lines are possible; selection will depend on local practices and preference. A location near sewer lines also allows the designer to divert all or part of the wastewater to the installation's sewer plant. If this type of discharge system is used, the planner must determine if the sewage treatment facility can handle the discharged wastewater, including the hydraulic and solids loadings created. The cost of connecting with and maintaining the sewer lines must also be considered when deciding whether to tie the facility into the sewage treatment system.

(4) *Communication*. Communication lines should be provided at the site. These lines must not span areas of vehicle movement. As with electrical lines, wet vehicles with free antennas would create a safety hazard should the antennas contact these lines.