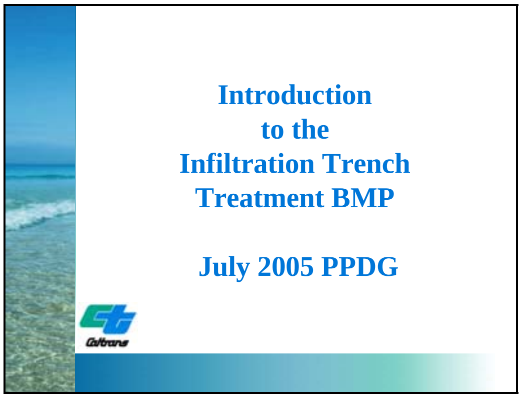
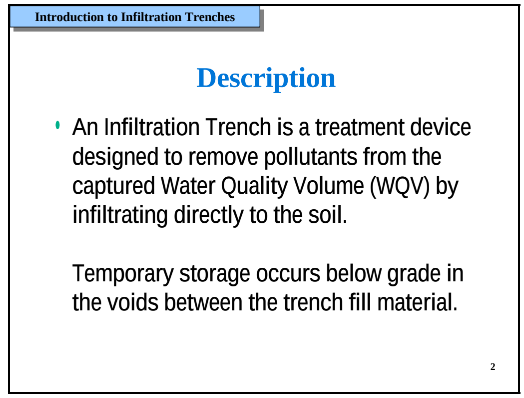
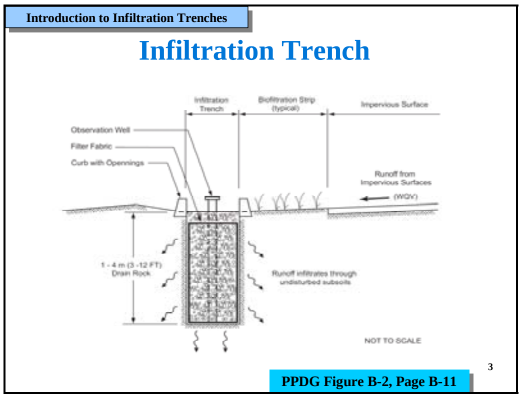


Slide 1: In this module we will review the Infiltration Trench Treatment BMPs.
*An Infiltration Trench is one of the several newly-approved Caltrans Treatment BMPs that can be employed on a project. Infiltration Trenches were approved by Caltrans as a Treatment Best Management Practice in March 2005, and incorporated into the PPDG in July 2005. They previously were 'piloted' and Districts 7 and 11, and were described in a report entitled <u>BMP Retrofit Pilot Program FINAL REPORT</u>, Report ID CTSW - RT - 01 – 050, JANUARY 2004, by California Department of Transportation, and tested at 9 locations: Altadena – D7, Carlsbad – D11, Cerritos – D7, Cerritos – D7, Escondido – D11, Kearny Mesa – D11, San Fernando D7, Tarzana – D7, Westdale – D7.
* The Infiltration Trench is one of two infiltration devices approved by Caltrans for use as a Treatment BMP, the other being the Infiltration Basin.
*In addition to the information presented today, Appendix B of the PPDG (Project Planning and Design Guide) has a 17-page section on the both the Infiltration Basins and Infiltration Trenches. While the designs of each share many similarities, there are sufficient differences such that Infiltration Trenches will be discussed separately.



Slide 2: •An Infiltration Trench is a treatment device designed to remove pollutants from the captured Water Quality Volume (WQV) by infiltrating directly to the soil.
•Temporary storage occurs below grade in the voids between the trench fill material.
*An Infiltration Trench is an excavated trench in which is a stabilizing material, clean "drain rock" is placed to prevent the side slopes from caving; the WQV is held within the void space of the rock, but in the future some plastic 'egg-crate' materials may be piloted, which have nearly 3x the void space of the rock.
*The primary design equation for the Infiltration Trench assumes all infiltration will occur through the trench bottom or invert.
*Recall: The Water Quality Volume (WQV) is discussed in PPDG Section 2 as the: "maximized detention volume determined by the 85th percentile runoff capture ratio." This method is described in Chapter 5 of the *Urban Runoff Management WEF Manual of Practice No. 23*, 1998, published jointly by the Water Environment Federation (WEF) and the American Society of Civil Engineers (ASCE).
* The 85th percentile event can be considered for discussion purposes as a frequently occurring storm, such as a

2-yr storm. It has been found that the more frequent storms contribute by far the majority of runoff, and the economics of capturing for treatment of the smaller storms are favorable relative to capturing the larger but less frequent events.



Slide 3: *This is an idealized Infiltration Trench.

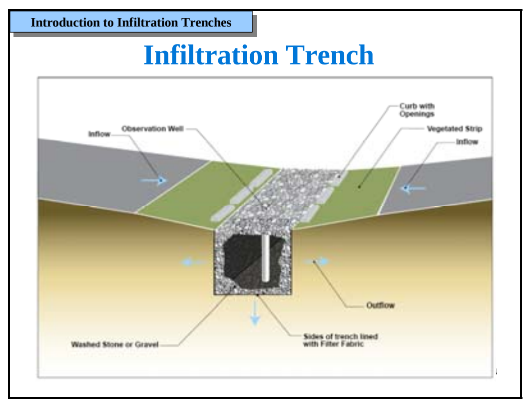
*The typical configuration uses a filter-fabric lined trench (i.e., the trench is formed against bare earth with a fabric as a separator, and without concrete walls) with a curb or dike at its perimeter at the ground surface; the filter fabric is employed between the “drain rock” and the native ground to prevent soil intrusion into the void space.

*Flow into the device is only allowed from the surface, as sheet flow or concentrated flow.

*The sheet flow and/or the concentrated flow must be allowed to enter the Infiltration Trench, so the curbing may have open areas or cutouts.

*The “overflow spillway” for the Infiltration Trench will take the form of a surface conveyance system leaving at the ground surface, usually as a bioswale or lined channel; overflows will then continue downstream without entering the device when it is full, b “bypassing” over the device.

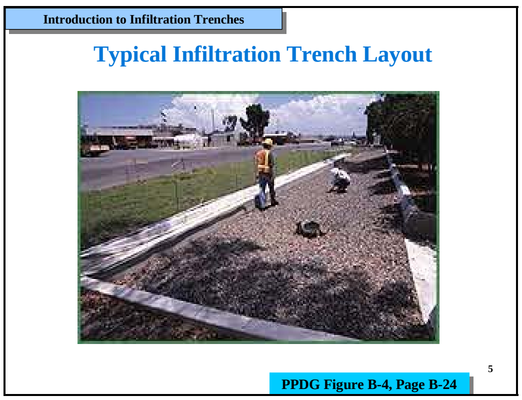
*Not shown in the figure, but sediments will build up over time in Infiltration Trench; sediments will reduce the infiltration ability of any infiltration device, by clogging the native ground with smaller particle. To counter this problem, the design of an Infiltration Trench is conservative in several aspects so that a longer-life can be more reasonably assured: for example, a Factor of Safety of 2 on the infiltration rate; any infiltration through the sides of the trench are ignored in the design process; and by placement of an upper layer of permeable material, typically about 150 mm in thickness on top of a fairly porous filter fabric (this fabric layer would act as an initial filter, and could be periodically removed and replaced as conditions warrant (usually annually) rather than removing the entire rock volume).



Slide 4: *This is another view of idealized Infiltration Trench.

*If properly designed and sited, including an upstream forebay or bioswale to capture sediment, an Infiltration Trench should have a reasonable in-service life before heavy maintenance is needed. As part of designing for a long-life, note the vegetated strips to the left and right of the Infiltration Trench; these will help to filter the runoff prior to entering the

Trench. *An observation well must be placed. Looking at the slide, note on the figure the pipe in the center of the photograph, that is the observation well. Performance of the Infiltration Trench can be monitored using the observation well placed within the Infiltration Trench; this observation well can also be used to access the trench if drainage is required (using a pump or siphon and hose). *Placement of an Infiltration Trench in the median can be considered, but must have District Maintenance concurrence.

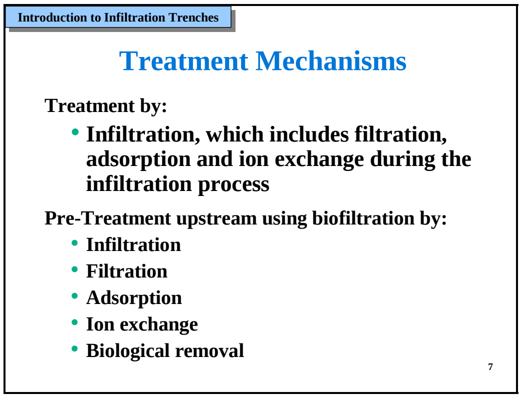


Slide 5: The excavated <u>volume</u> of the Infiltration Trench is quite large compared to the volume of an infiltration basin because the void space between the rock backfill holds the WQV, and that void space is typically about 35% of the total volume of the rock. However, as the Infiltration Trench will be deeper, the footprints of the two infiltration devices are often similar. Other high porosity (having a large void volume relative to the total volume) backfill materials are available, thus reducing the volume of the trench; consult with the Headquarters Division of Environmental Analysis – Policy, Planning and Permitting, and Headquarters Design Office of Storm Water Management if such materials are under consideration for a site.

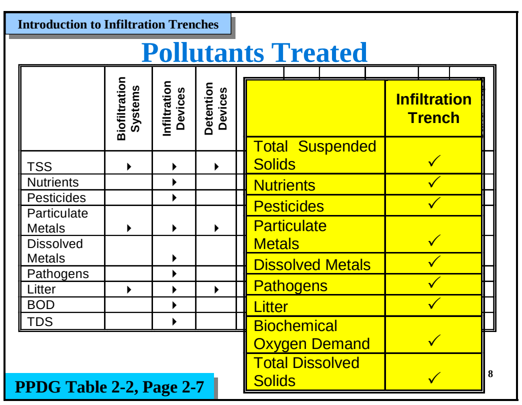
*As mentioned sediment build-up will reduce the effective life of an Infiltration Trench. To minimize that problem, the rock within the trench should not receive vehicle wheel loads to minimize any crushing or relative displacement of the rock within the trench. For that reason, Infiltration Trenches often have a perimeter curb for delineation. The curb may be made using Standard Plan A1-150 (Standard Plan Sheet A87).

Slide 6: A few other design issues:
*A forebay (small detention basin) or bioswale must be placed upstream of the Infiltration Trench to capture sediment, as longevity of the trenches will be severely reduced if heavy sediment loading is allowed to enter. *Infiltration Trench have no shape restriction, bur are often rectangular as shown here. *Note that maintenance access is provided around the Infiltration Trench. *In order to avoid Federal EPA classification of the Infiltration Trench as a regulated injection well (which has more stringent requirements), the Infiltration Trench should be designed as follows: a) the water to be treated should be directed to the Infiltration Trench by <u>gravity, and in an open channel or as sheet flow</u>; b) the water should flow downward within the trench by the action of gravity, and without vertical piping for distribution to lower depths of the trench; and c) the

smaller of the surface dimensions must exceed the depth of the trench.



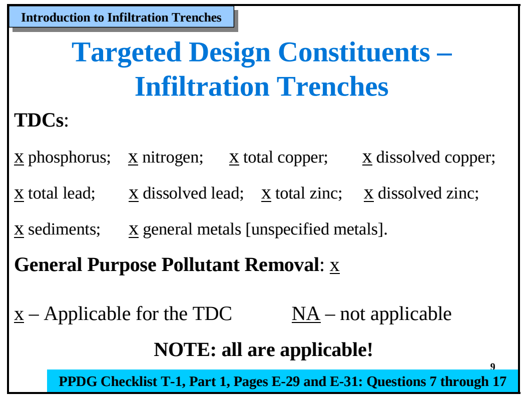
Slide 7: •Treatment by: Infiltration, which includes filtration, adsorption and ion exchange during the infiltration process
•Pre-Treatment upstream using biofiltration by: Infiltration Filtration Adsorption Ion exchange Biological removal.
Infiltration Trenches treat storm water by infiltration, and since pretreatment is required, usually done by Biofiltration, the processes of adsorption, ion exchange, and biological removal are also involved.



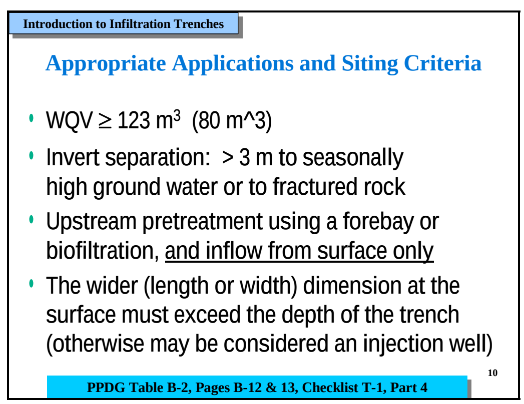
	Biofiltration Systems	Infiltration Devices	Detention Devices
TSS	›	›	›
Nutrients		›	
Pesticides		›	
Particulate Metals	›	›	›
Dissolved Metals		›	
Pathogens		›	
Litter	›	›	›
BOD		›	
TDS		›	

	Infiltration Trench
Total Suspended Solids	✓
Nutrients	✓
Pesticides	✓
Particulate Metals	✓
Dissolved Metals	✓
Pathogens	✓
Litter	✓
Biochemical Oxygen Demand	✓
Total Dissolved Solids	✓

Slide 8: Note that this table indicates Infiltration Devices, of which is the Infiltration Trench is one of the two types, are effective on all pollutants of concern; for this reason, consider an infiltration device whenever feasible for a project that requires consideration of Treatment BMPs. The treatment method is infiltration.



Slide 9: This table shows the target pollutants that Infiltration Trenches and basins are effective in removing. They include totals suspended solids, particulate metals, and litter, although litter removal is not a primary function. Infiltration devices are the first-choice devices in the TDC process for these constituents, and will the first device listed (as Infiltration Devices) for Questions 7 through 17 on Checklist T-1, Part 1.



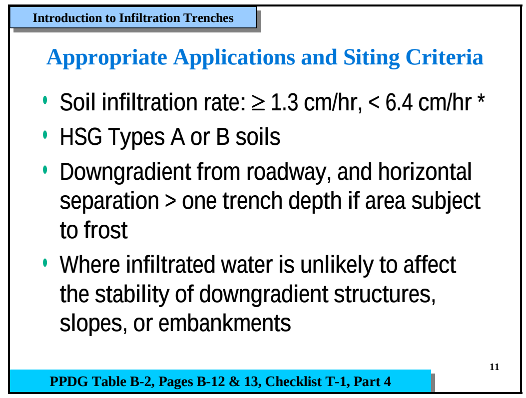
Slide 10: As an overview: Infiltration devices, and specifically Infiltration Trenches, should be considered wherever site conditions allow. Other site requirements: * The WQV exceeds 123 m^3 (0.1 acre-ft, 4,356 ft^3). The minimum WQV of 123 m^3 (0.1 acre-

foot) is common to all the volume-based Treatment BMPs, but contact your District NPDES Coordinator if about 80% of that volume can be captured at one location. *Appropriate sites for infiltration devices should have: a) sufficient soil permeability; b) a sufficiently low water table; c) the influent would not present a threat to local groundwater quality; and d) are at a depth to allow pumping of the device when needed for maintenance purposes while being consistent with reasonable construction costs.

*Separation from ground water and fractured rock will help ensure treatment of the water as it infiltrates and will therefore help protect the quality of the ground water. Separation from seasonally high ground water table > 3 m (10 ft), (or ^{3} 1.2 m [4 ft] if justified by adequate groundwater observations for a minimum of 1 year); for most projects, the minimum clearance of 3 m should be provided; consult with District NPDES and Headquarters Design Office of Storm Water Management if < 3m clearance is being considered. Approval by the RWQCB may be required if separation is less than 3m.

*The upstream pretreatment will help capture sediment that would otherwise lead to a reduction in the infiltration rate. Any infiltration device is prone to clogging and diminished performance if fine sediments are allowed to enter. Rehabilitation of a clogged Infiltration Trench is especially difficult, compared to the rehabilitate an infiltration basin. Because of this, pretreatment to capture sediment in the runoff is required upstream by using biofiltration devices or a forebay of the Infiltration Trench; catchment areas having high sediment loading should be carefully considered even if pretreatment can be placed.

Please see PPDG Table B-2 for a complete listing of criteria.

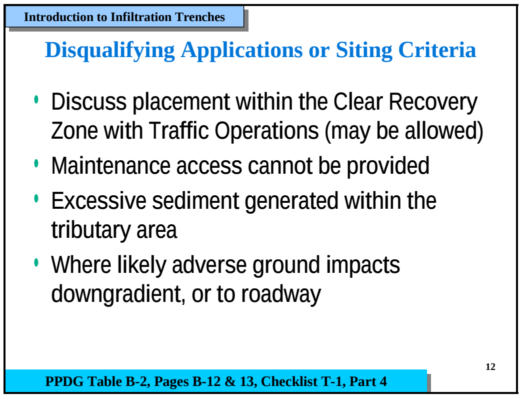


Slide 11: Appropriate Applications and Siting Criteria

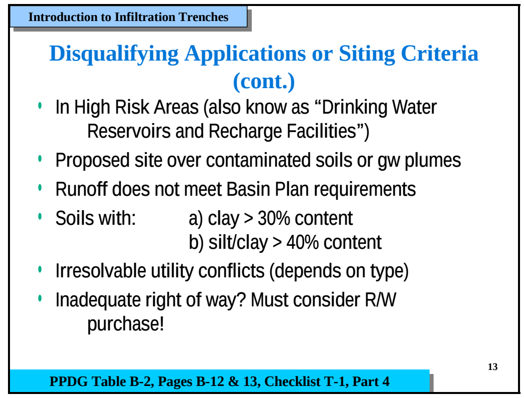
•Soil infiltration rate: 1.3 cm/hr < 6.4 cm/hr * The asterisk next to the "less than 6.4 cm/hr" soil infiltration requirement: approval for sites with infiltration rates greater than this value pose some additional risk to the ground water, and therefore it is Caltrans policy to seek approval for these sites from the RWQCB. •HSG Types A or B soils

•Down-gradient from roadway, and horizontal separation > one trench depth if area subject to frost •Where infiltrated water is unlikely to affect the stability of down-gradient structures, slopes, or embankments

Please see PPDG Table B-2 for a complete listing of criteria.



Slide 12: Other requirements, some of which are disqualifying: *When located with the Clear Recovery Zone, a traffic barrier may be required, although the curbing used to limit vehicle entry is fairly low. *Since maintenance is required, Maintenance access is mandatory. *Infiltration likely to affect the stability of down-gradient structures, or lead to unstable ground conditions; geotechnical considerations, apart from permeability, that may restrict usage; examples include: location in seismic impact zones; unstable areas such as landslides and Karst terrain, soil liquefaction or differential settlement potential; or highly expansive/collapsible soils.
*Infiltration Trenches should not adversely affect the roadway pavement, such as by leading to a saturated subgrade; they should be installed down-gradient from the highway structural section, and should not be placed closer horizontally than the trench depth to the roadway if in a location subject to frost.
Please see PPDG Table B-2 for a complete listing of criteria.



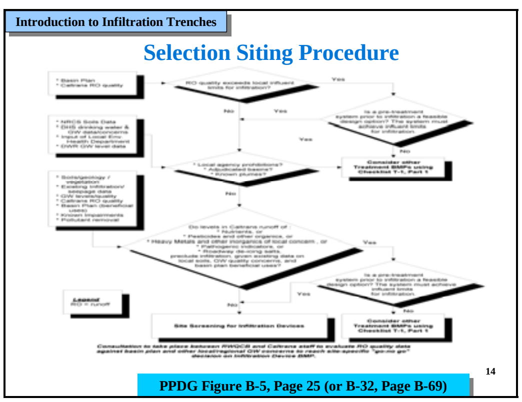
Slide 13: Other disqualifying conditions:
•In High Risk Areas (also know as "Drinking Water Reservoirs and Recharge Facilities") * Infiltration Trenches would likely be considered inappropriate for placement in High Risk areas, due to the difficulty in cleaning in the event of a spill; consult the District/Regional NPDES Coordinator if an Infiltration Trench is being considered in a High Risk Area. High Risk areas defined for our purposes not as locations on the highway where a higher accident rate has been observed but rather as drinking water reservoirs or ground water recharge areas (also known as 'percolation grounds').
•Proposed site over contaminated soils or ground water plumes *Infiltration devices should not be sited in locations over previously identified soil or contaminated groundwater plumes; setback distance should be determined in coordination with the RWQCB.
•Runoff does not meet Basin Plan requirements * Runoff from roadways does certain constituents at some contamination levels; information on these can be found from the DEA website. Runoff proposed for infiltration must not the of poorer quality than allowed by Basin Plans, but usually requirements for infiltration are much less restrictive than for surface water disposal.

•Soils with: a) clay > 30% content b) silt/clay > 40% content * These soil parameters relate to permeability and may be found during the Pre-Screening for the Infiltration Devices; these soils will not have a high permeability.

•Irresolvable utility conflicts (depends on type) * Utility relocation for the construction and operation may not prove possible.

•Inadequate right of way? Must consider R/W purchase! * Right of way: Recall that purchase of additional right of way must be considered for placement of all Treatment BMPs if the existing R/W is insufficient. Also recall that a cooperative agreement with a Local Agency (for joint use) might also include joint building and operation of the device (with both agencies sending runoff to the device).

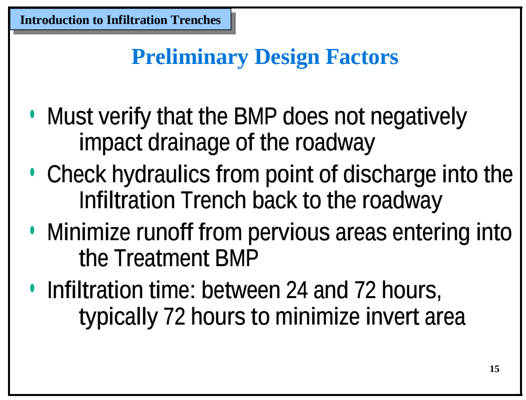
Please see PPDG Table B-2 for a complete listing of criteria.



Slide 14: We will not go over this chart except to note that it is in the PPDG on the page noted. This flowchart, "BMP Siting Procedure for Infiltration Devices," is shown on this slide for information only. The decision tree checklist is found in the PPDG on page B-25. District 7 should follow the procedure found on Page B-69, but in general there are the same.

Many of these questions are incorporated into the Checklists T-1, Parts 1 and 4.

You will note that there are questions on this flowchart revolve around the quality of the water that will be infiltrated, and the existence of regulatory limits (such as found in a "Basin Plan") for the project area; if you do not have that information, consult the District/Regional Environmental Unit, or the NPDES coordinator.



Slide 15: These bullets are true for every Treatment BMP.

•Must verify that the BMP does not negatively impact drainage of the roadway * Consult with District Hydraulics to ensure that the design will not compromise the upstream roadway drainage.

•Check hydraulics from point of discharge into the Infiltration Trench back to the roadway

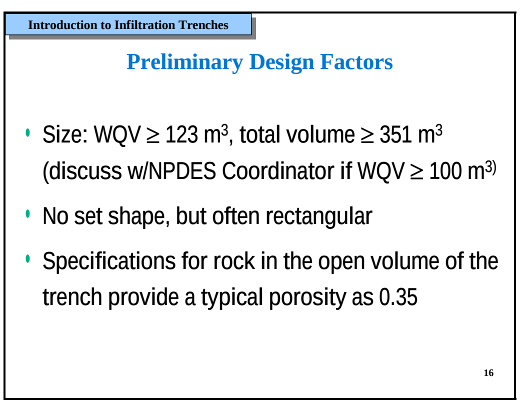
•Minimize runoff from pervious areas entering into the Treatment BMP: Regarding the this bullet: while it is true that it is goal to only treat runoff from the impervious areas (i. e., the roadway surface), if the runoff from those surfaces cannot be routed around the treatment device, then this additional area must be considered when determining the design volume for the treatment device, and treated if possible;

if it is neither possible to prevent commingling nor to provide a larger Treatment BMP device to handle the commingled volume, attempt to treat the WQV determined from the impervious area.

•Infiltration time: between 24 and 72 hours, typically 72 hours to minimize invert area: Hold times can vary, but the longer the time selected for design, the smaller the footprint of the Infiltration Trench; the WQV is assumed to arrive in its entirety at time t = 0 ("static" or "slug" inflow, conservative)

*Note that 'flood routing' is not considered in the design process for water quality purposes; if the Infiltration Trench is placed for purposes of complying with local agency requirements about detaining/minimizing runoff or for hydromodification related requirements with respect to the downstream body, an inflow/outflow hydrograph must be developed; this would usually be done by District Hydraulics, and is beyond the scope of this presentation.

Please see PPDG Table B-2 for a complete listing of criteria.

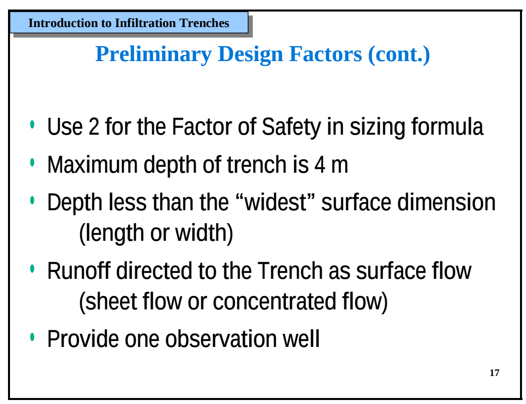


Slide 16: •Size: minimum WQV = 123 m^3 (0.1 acre-ft, 4,356 ft^3), giving as excavated volume = 351 m^3 (13,070 ft^3), Discuss w/NPDES Coordinator if WQV at least 80% of the minimum WQV can be captured at one location.

•No set shape, but often rectangular

•Specifications for rock in the open volume of the trench provide a typical porosity as 0.35: Note that the total excavated volume of an Infiltration Trench is 3x the WQV. Rock meeting Rock Slope Protection, Method B Placement, Class 3 (Standard Specification 72-2.02, "Materials") should be used in Infiltration Trenches with the gradation as shown on page B-13 of the PPDG. There are proprietary trench media that have a higher porosity, which would reduce the depth of the trench – consult with HQ OSWM if these are being considered for the project.

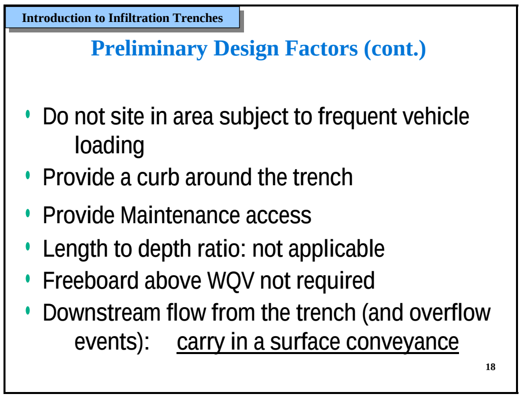
Please see PPDG Table B-2 for a complete listing of criteria.



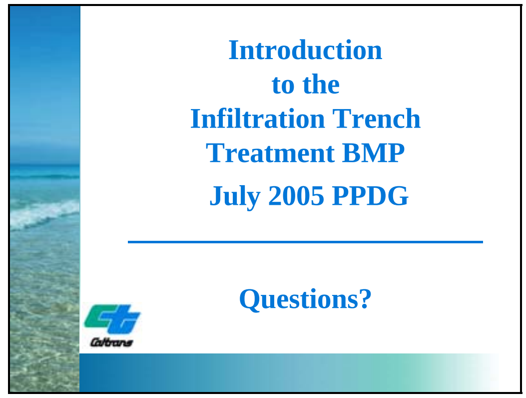
Slide 17: •Use 2 for the Factor of Safety in sizing formula * A factor of safety is provided directly in the formula provided in the PPDG and used later in this training to estimate the invert of an Infiltration Trench. This provides some factor of safety on the accuracy of the permeability.

•Maximum depth of trench is 4 m (13 ft): A maximum depth for the trench is set so that deeper (and hence more costly) excavations and potentially shoring will not be considered, these

being judged beyond the MEP (maximum extent practicable) Fiscal Feasibility siting requirements.
•Depth less than the "widest" surface dimension (length or width)
•Runoff directed to the Trench as surface flow (sheet flow or concentrated flow)
Please see PPDG Table B-2 for a complete listing of criteria.



Slide 18: •Do not site in area subject to frequent vehicle loading
•Provide a curb around the trench
•Provide Maintenance access
•Length to depth ratio: not applicable
•Freeboard above WQV not required
•Downstream flow from the trench (and overflow events): <u>carry in a surface conveyance</u>
Another item to consider: Infiltration devices should not be placed in service within a construction contract until all upstream runoff is stabilized, or shall be protected from sediment-laden runoff. Infiltration Trenches: maximum depth of trench is 4 m, depth less than the widest surface dimension, and WQV should be directed to trench as surface flow, and allowed to gravity-flow downward to the invert of the trench.
Please see PPDG Table B-2 for a complete listing of criteria.



Slide 19: Please contact your NPDES coordinator if, later in the design process, you have questions that were not answered today, or call the Headquarters Design Office of Storm Water Management.
End of the presentation.