The Monterey Bay Economic Partnership and the Central Coast Broadband Consortium held a technical expert group meeting on 16 August 2016 and, after two rounds of reviewing drafts, reached consensus on an initial version of standards for installation of conduit on a prospective basis in public works projects. Items include:

I. General considerations.

A. The City and County of San Francisco's Department of Technology Order No. 1 – Requirements Implementing San Francisco's "Dig Once" Ordinance (draft version 8) and the accompanying report prepared by Columbia Telecommunications Corporation are good general references to use when interpreting these standards or when considering specific design or policy questions.

B. These specifications are guidelines that generally assume that empty conduit is being installed. If conduit is being installed to support a specific user, purpose or fiber project, then those considerations will drive design decisions and feasibility determinations.

II. Conduit installation.

A. Conduit size.

1) 2-inch conduit is sufficient for multiple high capacity fiber cables using current technology (432 strands or more), and can be subdivided using inner-duct that would allow multiple service providers to share a single conduit.

2) 4-inch conduit has even more capacity but, due to its larger size, can present design problems, for example when connecting to vaults. This size of conduit was standard when telecommunications systems depended on thick bundles of copper cables, but is not necessary for most modern fiber applications. However, 4-inch conduit should be considered for installation on bridges, railroad crossings and in other circumstances where future changes would be particularly difficult or impossible.

3) Smaller conduit, e.g. 1.25-inch, is useful when it is not possible to install 2-inch conduit or when many, separate conduits are installed. It may be preferred when conduits are expected to be used by a single service provider, rather than shared among many over time, or when it meets the needs of an anticipated project or service provider.

B. The size and number of conduits installed depends on the particulars needs of any given project, and the number of likely or confirmed participants. For example, installation of a bank of four 2-inch conduits provides sufficient flexibility to accommodate a range of needs, and is a better option than installing two 4-inch conduits. However, because of the ability to subdivide it, installing two

2-inch conduits would not necessarily be less useful than two 4-inch conduits. As a starting point, installation of a bank of four 2-inch conduits can be considered as a reasonable standard when construction is done on a prospective basis on a main street, while a single conduit capable of supporting multiple inner-ducts might be sufficient for a smaller or more peripheral street.

C. An additional factor to consider is whether future conduit installation would be particularly problematic, as with railroad right of ways, or even impossible, which is often the case with bridges. In these circumstances, installation of more and/or bigger conduit than would normally be the case is advisable.

D. Conduit may be located in either streets or sidewalks, however installation in sidewalks is typically easier and less expensive. Traffic control is a much smaller issue, there are usually fewer existing underground utilities, and vault lids do not need to be traffic rated. Contractors are responsible for locating gravity feed lines, and this responsibility should be spelled out in the bid documents and/or the jurisdiction's standards.

E. Sweeping conduit bends should be used to allow cable to be pulled without exceeding pull-tension thresholds when placing high-count fiber cables (e.g. 864-count). Unsupported conduit bends should have a minimum bend radius of 48-inches, and bends utilizing manufactured elbows should have a minimum radius of 36-inches (45-degree elbow maximum). However, when necessary, modern fiber optic cables are capable of supporting bends of up to 90-degrees.

F. A number of factors should be considered in determining if the addition of conduit to a host project is feasible. These factors include:

1) Length of the conduit section that would be installed. There is no absolute, minimum useful length for conduit sections. However, very short or isolated sections might not be cost effective to use, unless installed as part of a larger plan.

2) Proximity to current or planning public facilities and community anchor locations, and economic development needs and plans.

3) Presence of other city or county-owned communications infrastructure, or other open access communications facilities or services.

4) Whether physical constraints (bridges, freeway underpasses, underground utility districts) would make it unlikely that there are cost-effective alternatives in the vicinity if needed in the future.

5) Whether any partners or customers or other users can or will make immediate use of it.

6) The cost of alternative routes, such as placement on utility poles, if needed in the future.

7) Budgetary constraints, or added costs that render the host project infeasible.

8) Time constraints, particularly the possibility of delaying installation of critical infrastructure.

9) Risk of interfering with operation or maintenance of host project facilities.

G. Installing detector wire/warning tape 3 inches to 6 inches above the conduit is a common standard, but circumstances can vary widely and this question should be addressed on a case by case, engineering design basis. Pull ropes should be included as a standard design element. Pull ropes with built-in detector wire are available and, depending on the circumstances, could perform adequately.

H. Choice of material depends on circumstances, however HDPE and PVC are commonly used materials.

I. Backfill type and materials, and other remediation/construction measures should be determined by the standard specifications used by the jurisdiction concerned.

J. When conduit is installed on a generic, "open trench" basis, a minimum standard is to install conduit the entire length of the trench, with sweeps installed to a future access point and with both ends capped and buried for future use. Where possible, vaults or hand holes should be placed at either end, and any lateral conduit that is installed should likewise terminate at an access point.

III. Vault installation.

A. The base size for a vault is 24-inches by 36-inches (#6 vault). A vault this size can accommodate two 2-inch conduits, with some room for splicing, assuming that it is not being used for lateral/customer service purposes. It is an ample size for splicing cables smaller than 432 strands. A 30-inch by 48-inch vault would be generally capable of supporting more splice points and/or larger cables, including those used for lateral/customer service purposes. The minimum size for a vault is 18-inches by 25-inches (#5 vault), although its usefulness could limited. For example, it might not have sufficient room for slack loops or a large number of splices.

B. Standard municipal security specifications should be followed, however bolted-down lids are considered a normal security measure. Labels on lids should include the name of the relevant jurisdiction.

C. The base assumption for vault design is that shared vaults will only accommodate through-splices and connections of main fiber cables, and will not be used for lateral connections, customer aggregation or other service taps or drops. When planning vault locations, sufficient space should be allowed for future installation of third party vaults which can be used for service connection purpos-

es. When possible, designs should assume that at least one additional vault of a similar size will be installed next to every planned vault.

D. Where possible, conduit should enter vaults on an end wall, parallel to the direction of the conduit run, rather than on a side wall or perpendicular to the direction of the conduit run. Vaults should be placed deep enough to allow conduit to enter horizontally, as it is preferable to avoid upward conduit sweeps. 36-inches is a benchmark for minimum depth.

E. Installation of grounding rods is preferred.

F. Electronic markers (EM) are an effective method of marking and locating vaults.

G. Spacing of vaults depends on circumstances and needs. As a general guide in urban and suburban areas, 600-feet is a benchmark for maximum spacing and 300-feet is a common standard when the need to support lateral connections is anticipated. In rural areas, spacing can be greater. 2,500-feet is a benchmark distance for long haul (i.e. no lateral connections anticipated) conduit and can support "blown-in" installation techniques. However, it may be more efficient to install longer segments of 3,500 feet to 4,000 feet in a longer project, such as a highway project, or in rural areas.

H. Prospective installation of vaults is not always necessary or even desirable if there is uncertainty about the eventual use of the conduit or if the additional cost of vaults would make the project infeasible. In many cases, it is not possible to anticipate the future needs of service providers.

IV. Items for future consideration.

A. Specifications and requirements for microtrenching.

B. When to require conduit installation and who should be required to install it.

C. Development of a glossary/reference guide.

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Shadow conduit and vault, installed by City of Berkeley during Comcast upgrade project in 2004.