

SECTION 31 23 00 – EXCAVATION AND FILL

1.01 ^{A16}**SUMMARY:** This Section covers the design, specification, and construction of various items of work to be carried out at the Site required for the execution of the Works.^{A16} The following items are included.

- A. ^{A16}**Clearing and Grubbing:** Clearing and grubbing the site of trees, shrubs, stumps, roots, brush, and other vegetation; debris; existing foundations; pavements; utility lines; structures; fences; and other items that would interfere with construction operations.^{A16}
- B. **Excavation:** The changing of grade levels, removal of soil and rock, and selection and separation of existing soil in preparation for construction, including the provision of any temporary or permanent erosion- and sediment-control structures required for the execution of the excavation. ^{A19}The excavated material may be utilized for aggregate, fill, or backfill as per the conditions stated in paragraph 1.07 D.1 of Section 01 50 00 (*Temporary Facilities, Accesses and Controls*).^{A19}
- C. **Disposal:** ^{A19}Removal of the excavated material deemed to be unsuitable for use [in the Works; and placing this material at the disposal sites](#) shown on drawings 5803-55 for the Pacific locks and 5802-28 for the Atlantic locks; see Volume II, Part 4 (*Requirement Drawings*).^{A19}
- D. **Dewatering:** Removal of groundwater, seepage, and rainwater flowing toward or into excavations. The Works also include the design, installation, and maintenance of groundwater-monitoring systems.
- E. **Fill:** Appropriate material that is redistributed in accordance with the proposed design to reach the required elevations and slopes.
- F. **Backfill:** Appropriate material that is redistributed to bring excavated areas to the design elevations or grades.
- G. ^{A5}**Ancillary:** Temporary ^{A5} earthwork to facilitate construction by keeping excavations free of water.

1.02 ^{A16}**REFERENCES:** ^{A16}

- A. **American Society for Testing and Materials (ASTM) ^{A7}International^{A7} Standards:**
 - C 136-06 Sieve Analysis of Fine and Coarse Aggregates.
 - D 75-03 Sampling Aggregates.
 - D 422-63 (02) Particle-Size Analysis of Soils.
 - D 1140-00 Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve.
 - D 1556-00 Density and Unit Weight of Soil in Place by the Sand-Cone Method.

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| D 1557-02 | Laboratory Compaction Characteristics of Soil Using Modified Effort [56,000 ft-lbf/ft ³ (2,700 kN-m/m ³)] |
| D 2216-05 | Laboratory Determination of Water (Moisture) Content of Soil and Rock |
| D 2487-06 | Classification of Soils for Engineering Purposes (Unified Soil Classification System) |
| D 2937-04 | Density of Soil in Place by the Drive-Cylinder Method |
| D 4318-05 | Liquid Limit, Plastic Limit, and Plasticity Index of Soils |

^{A13}**B. (Reserved)** ^{A13}

1.03 REQUIREMENTS:

A. Design:

1. ^{A16}**Clearing and Grubbing:** Prior to clearing and grubbing the Contractor shall design and implement a wildlife-rescue program based on the wildlife rescue plan and the environmental management plan/environmental impact statement. ^{A16} Refer to Section 01 57 19 (*Temporary Environmental Controls*).
2. **Excavation:**
 - a. ^{A17}The Contractor shall duly investigate the Site for the design and construction of the Works, subject to the provisions of Sub-Clauses 4.10 (*Site Data*), 4.12 (*Unforeseeable Physical Conditions*) and 5.1 (*General Design Obligations*) of the Conditions of Contract. ^{A17} ^{A16}The Contractor may use the information provided or conduct additional investigation to supplement currently available information as he deems necessary. The final Site characterization shall be based solely on the Contractors’ interpretation of the geotechnical and geological information made available to him and that obtained directly by the Contractor.
 - b. The Contractor shall determine the slopes of his excavations in accordance with standard geotechnical practice. ^{A16} Slope analysis shall consider the short-term (during and immediately after construction) and long-term stability, taking into consideration the effects of deterioration and loss of soil resistance due to local climatic and construction conditions. ^{A11} All permanent slopes shall be design for an equivalent pore water pressure ratio (r_u) with a value not less than 0.30. ^{A11}
 - c. The Contractor shall implement measures to avoid falling of debris, especially boulders, on to the working area ^{A17}of the Site ^{A17} that could result in loss of life, injury of personnel, and cause delays.
 - d. Modification of the Site and grades is required for the construction of structures identified in Section 01 81 16 (*Lock Structures*), 01 81 36 (*O&M Building and Facilities – Program*), 01 86 36 (*Drainage Systems*), 01 89 16 (*Site Construction*), 26 05 43 (*Underground Ducts and Raceways for Electrical Systems*), and 33 81 26 (*Outside Plant*

Pathways for Underground Communications), as well as for other unlisted items that require excavation for proper installation.

e. **Where Blasting is Required:**

- 1) ^{A16}The blasting pattern shall be designed so that little surface preparation will be required at the interaction surface between incompressible bedrock and concrete walls. ^{A16}
- 2) The energy released shall not adversely impact the existing locks or other structures and shall not disturb communities in the vicinity of the blast.
- 3) Refer to 31 23 16.26 for additional blasting requirements.

f. ^{A19}The bottom elevations at the upstream and downstream ends of the Pacific lock and at the downstream end of the Atlantic lock shall be below the bottom elevations of the navigation channels to which they connect.

- 1) The Contractor shall excavate to a bottom elevation of -20.62 PLD from the south end of the Pacific lock to station 8P+700, the bottom elevation at station 9P+021 shall be -17.82 PLD. A transition with a maximum slope of 2% shall be provided between the two elevations. To prevent the accumulation of sediment or debris within the lock area, the Contractor shall provide a trap for sediment and debris between station 8P+700 and the lower end of the transition slope.
- 2) The Contractor shall excavate to a bottom elevation of +6.42 PLD from the north end of the Pacific lock to station 6P+180, the bottom elevation at station 5P+880 shall be +9.14 PLD. A transition with a maximum slope of 2% shall be provided between the two elevations. To prevent the accumulation of sediment or debris within the lock area, the Contractor shall provide a trap for sediment and debris between station 6P+180 and the lower end of the transition slope.
- 3) The Contractor shall excavate to a bottom elevation of -18.42 PLD from the north end of the Atlantic lock to station 4A+050, the bottom elevation at station 3A+750 shall be -15.62 PLD. A transition with a maximum slope of 2% shall be provided between the two elevations. To prevent the accumulation of sediment or debris within the lock area, the Contractor shall provide a trap for sediment and debris between station 4A+050 and the lower end of the transition slope.
- 4) The traps shall be designed based on the expected sedimentation and for a maintenance frequency of one year. The traps shall be sized to permit the removal of the contents by means of a dragline or dipper dredge. ^{A19}

3. **Dewatering with Groundwater Monitoring:**

- a. The Contractor shall dewater the existing 1939 excavation on the Pacific and Atlantic ends of the Canal. ^{A16}The dewatering shall comply with the requirements of Section 01 57 19 (*Temporary Environmental Controls*).^{A16}
- b. The ^{A5}Contractor ^{A5} shall design, install, and maintain a groundwater-monitoring system for each excavation. The system shall include, but not be limited to, geo-hydrological analyses and a network of piezometers and observation wells to be installed by the Contractor. Plans shall establish the method and frequency of observations and the method for recording and interpreting results. Records shall be available for the Employer's Representative at any moment.
- c. The Contractor shall design diversion ditches, dikes, and grading and shall provide an appropriate dewatering system as required to obtain and maintain dry working conditions. ^{A16}The water discharged as a result of the dewatering shall comply with the requirements of Section 01 57 19 (*Temporary Environmental Controls*).^{A16}

4. **Disposal Site:** The design of the disposal site shall meet the requirements of Subparagraph 1.03 B.3.

5. **Fill:**

- a. Fill shall be designed to adequately support the loads to which it will be subjected without producing excessive subsidence or bearing-capacity failures that could result in damage to structures supported on or within the fill.
- b. The Contractor shall apply only unpolluted natural soils and not use waste of any type. The organic-matter content shall be less than 5%.

6. **Backfill:**

- a. Backfill shall be designed to adequately support the loads to which it will be subjected without producing excessive settlement or bearing capacity failures that could result in damage to structures supported on or within the fill.
- b. The Contractor shall apply only unpolluted natural soils and not use wastes of any type. The organic matter content shall be less than 5%.

B. Construction:

1. **Clearing and Grubbing:**

- a. Clearing and grubbing shall be carried out prior to any excavation work.
- b. Should the Employer's Representative require that individual trees, shrubs, and hedges be preserved, the Contractor shall take all necessary precautions to prevent their damage. Any such damage that is not

avoided through these measures shall be made good by replanting or landscaping, as required by the Employer's Representative and entirely at the expense of the Contractor. ^{A16}Refer also to Section 01 57 19 (*Temporary Environmental Controls*), paragraph 1.05.C. ^{A16}

- c. In areas to be cleared, all trees, limbs, logs, brushwood, vegetation, surface trash, loose stumps, and other perishable matter shall be removed to places where it will not interfere with the Works or traffic. These places shall be approved by the Employer's Representative.

2. **Excavation:**

a. **General:**

- 1) The ^{A5}Contractor ^{A5} shall perform slope-stability analysis based on the prevailing conditions at each excavation site.
- 2) ^{A16}The Contractor shall excavate to the lines, grades, and dimensions shown on the final design drawings developed by the Contractor and as required by the specifications also drafted by the Contractor. ^{A16}
- 3) Sharp points of rock protruding beyond the designated line may be left in place with the approval of the Employer's Representative, provided such protrusions do not exceed 10 cm.
- 4) The Contractor shall remove from the designated excavation line all loosened rock, fractured rock, or otherwise loosened material that could slide or fall.
- 5) ^{A16}The Employer's Representative may order, in writing, that the Contractor excavate beyond the designated excavation lines. ^{A16} In such a case, the Contractor shall excavate to the lines designated by the Employer's Representative and shall, after completion of the excavation, submit drawings showing the actual lines and dimensions of the excavation performed.
- 6) ^{A16}All excavation for utilities or foundations of structures shall be performed in dry conditions, except when approved by the Employer's Representative. ^{A16} The bottom of excavations for utilities or foundations of structures shall be even (within the tolerances specified) and free from loosened or fractured excavated material.
- 7) Scaling, trimming, and remedial work to the rock slopes and berms of each area shall be carried out as soon as possible after excavation is completed. Scaling should include mechanical or hand methods to remove loose rock in order to create a safe environment for operators to work.
- 8) Drilling and blasting shall conform to Section 31 23 16.26 (*Drilling and Blasting*).

b. Stability of Excavations:

- 1) The Contractor shall remove or otherwise secure by barriers, nets, or other means any materials which might fall or slide and, thereby, cause damage to the Works or injury to any person.
- 2) It shall be the Contractor's responsibility at all times to ensure the stability and safety of excavations. The Contractor shall take all measures necessary to ensure that no collapse or significant subsidence occurs. The ^{A5}Contractor ^{A5} shall also monitor the excavation progress and take all actions to prevent settlement of existing or new infrastructure as a consequence of the excavation.
- 3) The removal of water shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplifting, and heaving in the excavation's bottom and to eliminate interference with the orderly progress of construction. The Contractor shall monitor the lowering of groundwater in the vicinity of the excavations and take all actions to prevent settlement of existing and new infrastructure as a consequence of the water removal.

c. Ground-Level and Pre-Construction Cross Sections and Groundwater Monitoring:

- 1) ^{A16}The Contractor shall install a groundwater monitoring system with sufficient time to ensure proper monitoring before commencement of any earthwork. ^{A16}
- 2) Prior to commencement of any earthwork, the sites shall be surveyed in the presence of the Employer's Representative to establish existing ground levels. The prevailing groundwater data shall be recorded at this time.
- 3) ^{A16} (Reserved) ^{A16}

d. During excavation, ^{A13}the Contractor shall meet the requirements of paragraph 1.08 of Section 01 57 19 (*Temporary Environmental Controls*) for ^{A13}all archeological, paleontological, or historical findings.

e. The Contractor shall identify and clear all interfering utilities prior to excavation and shall coordinate the removal and relocation of utility lines with the Employer's Representative.

f. The Works include construction of temporary earthwork, such as diversion ditches, banks, grading etc. Ancillary earthwork shall be maintained as necessary during construction to provide dry working conditions or otherwise ensure stability.

3. **Disposal:**

- a. Excavated materials, unacceptable [for use in the Works](#) or not used for fill and backfill, shall be placed within the disposal areas designated on drawings^{A17} as per subparagraph 1.01.C.^{A17}
- b. The Contractor shall ensure that disposal areas attain a neat appearance and proper surface drainage. ^{A19}To this end, the Contractor will neatly arrange the slopes of disposal fills to prevent scattering, erosion, or spoiling of the surroundings. Water runoff shall be controlled and channeled at the disposal sites, and the Contractor shall implement temporary and permanent sediment controls to avoid sediments runoff to reach natural water courses or final drainage areas.^{A19} The arrangements may include earth coverage and the excavation of earthen drainage ditches.
- c. Points defining the polygonal limits of spoil areas shall be marked in the field by flags installed on permanent posts of sufficient height to be visible as the spoil embankment rises during the execution of the Contract.
- d. Care shall be exercised by the Contractor in order to avoid:
 - 1) ^{A19}Damaging or obstructing existing drainage ditches or natural watercourses along the sides of the spoil area.^{A19}
 - 2) Disposal outside the limits of the spoil area.
 - 3) ^{A19}Endangering a partly or completely finished structure.^{A19}
 - 4) Impairing the efficiency or appearance of any structure.
 - ^{A19}5) Landslides or subsidence.^{A19}
 - 6) Any actions that would be detrimental to the completed Works.
- e. Disposal of vegetation by burying it under spoil material will be allowed.
- f. The burning of vegetation will not be allowed.
- g. ^{A19}Disposal sites in close proximity to watercourses or drainage channels shall be designed and constructed considering the natural conditions of the areas. [Disposal sites](#) shall be designed and constructed utilizing methods and equipment that will result in stable slopes and will not destabilize the area, and when necessary implement measures to prevent erosion of or otherwise damage of banks against stream overflows.^{A19}
- h. Disposal sites designated or used as land reclamation areas shall be designed and constructed utilizing methods and equipment that will result in a level of compaction that will not cause excessive subsidence or cause unstable slopes.^{A13}

- i. The Contractor shall not place contaminated excavated material or material contaminated with saltwater in the Monte Lirio North disposal site.

4. **Fill:**

- a. Fill shall be placed and compacted utilizing methods and equipment suitable for the particular material and condition. Compaction in the vicinity of structures shall be done in a manner that will attain the required degree of compaction without causing damage to the structures. Compaction shall result in an earthwork body that is not susceptible to excessive subsidence or bearing-capacity failures that could affect structures supported on or within the fill.
- b. Before placing fill, any organic layer and muck shall be completely removed down to the level where suitable material is found. In such a situation, backfilling with suitable materials will be required to bring the site to the finish elevation.
- c. Before placing fill, the underlying surface shall be scarified.
- d. After dewatering the 1939 excavations at the Pacific and Atlantic sites and before ^{A17}commencing construction of ^{A17}any Permanent Works:
 - 1) The existing debris and silt shall be removed. ^{A19}The contents of the debris could be items broken down or destroyed from previous works, an accumulation of rock from previous blasts, materials such as sand, clay, and mud from previous excavations and rubbish. ^{A19}
 - 2) The bed and bank area shall be cleared.
 - 3) Proper surface preparation shall be performed.
 - 4) ^{A16}(Reserved) ^{A16}
- e. The Contractor shall apply only unpolluted natural soils and not use wastes of any type. The organic matter content shall be less than 5%.
- f. The Employer's Representative may perform any test he deems necessary to validate the results of compaction work by the Contractor, who shall be present for such testing and provide all possible assistance required by the Employer's Representative.

5. **Backfill:**

- a. Backfill shall be placed and compacted utilizing methods and equipment suitable for the particular material and conditions. Compaction in the vicinity of structures shall be done in a manner that will attain the required degree of compaction without causing damage to the structures. Compaction shall result in a material that will not be susceptible to excessive settlement or bearing-capacity failures that could cause damage to structures supported on or within the fill.

- b. Prior to the commencement of placing backfill materials adjacent to structures, the backfill areas shall be cleared of all remaining concrete forms, other Temporary Works, and unsuitable materials. The areas shall be subject to the approval of Employer's Representative.
- c. ^{A16}All backfill operations shall be performed in dry conditions unless approved by the Employer's Representative. ^{A16}
- d. ^{A19}The Contractor shall apply only natural soils without contamination and not use wastes of any type. ^{A19} The organic matter content shall be less than 5%.
- e. ^{A16}Backfill material shall not be placed and compaction shall not be permitted adjacent to concrete that has been poured within the last 14 days unless approved by the Employer's Representative. ^{A16}

1.04 DESIGN CRITERIA/SYSTEM DESCRIPTION AND PERFORMANCE:

A. Design (Including Specifications):

- 1. All work shall comply with the Section 01 57 19.13 (*Environmental Management Systems*).
- ^{A4}2. The Contractor shall compute settlements of new fills under structures/facilities and develop measures to mitigate settlements if they are deemed unacceptable (see ^{A5}Section 01 82 13 ^{A5} – Foundations). ^{A4}
- 3. Drawings 5802-28 and 5803-55 show approximate capacities for the disposal sites at the elevations indicated. These capacities are provided for estimating purposes only and shall not be construed as the design capacity for the disposal sites. The Contractor shall determine the capacity of each disposal site in accordance with the requirements for the Works and design them to ensure their stability and compliance with the requirements specified herein.
- 4. Disposal No. 5 shown on drawing 5803-55 has been assigned to other contractors, but it is programmed to be available to the Contractor by January 2010, through a notice from the Employer's Representative; the approximate capacity shown is that available before use by other contractors. After the notice from the Employer's Representative, if the Contractor requests the use of Disposal site No. 5, the Contractor shall be responsible for determining its capacity in accordance with the requirements for the Works and for its design designing the disposal site to ensure guarantee its stability and comply with the requirements specified herein.

B. Construction:

- 1. The Contractor shall demonstrate that all settlement and movement of the excavations, including the support systems if any, will be within specified tolerances before proceeding with construction of the Permanent Works.
- 2. The Contractor shall establish baselines to monitor distress on slopes, buildings, structures, and facilities (e.g. settlement, lateral movements, ground velocity if blasting is used, etc).

3. The Contractor shall establish baselines to monitor groundwater-flow limits during construction.
4. The Contractor shall develop and implement mitigation actions if the above baselines are not met.
5. The Contractor shall install permanent settlement monuments and benchmarks.

1.05 SUBMITTALS: All drawings, specifications, and other submittals shall be submitted in accordance with the requirements of Section 01 33 00 (*Submittal Procedures*) and the requirements of this Section for the following phases.

A. ^{A17}**Intermediate Design:** ^{A17 A16}When the design has advanced sufficiently to acquaint the Employer with the earthwork design, the Contractor shall submit the following to the Employer’s Representative for review. ^{A16}

1. Drawings:

- a. A plan showing the location, alignment, and profile of the drainage system with the underlying geo-hydrological starting points.
- b. A plan showing the limits of excavation and filling, including the existing and finish grades (topography).
- c. Longitudinal and transversal sections showing the limits of excavation. The type of materials shall be identified in the sections.
- d. Longitudinal and transversal sections showing the limits of the fill and final grade. The sections shall identify the type of materials utilized.
- e. Detailed plans and cross sections of any excavation-support systems, if required.
- f. Transversal sections showing the limits of the backfill and final grade. The sections shall identify the type of materials utilized.
- g. The layout for the temporary storage areas for the excavated material that is to be utilized as fill or backfill.
- ^{A19}h. A plan showing the location of disposal areas, including the existing and final elevation of the disposal areas, final grade slopes, location, alignment, and profile of the drainage system, temporary and final erosion and sediment controls, and other pertinent information. ^{A19}
Drawings shall indicate the estimated capacity (cubic meters).

2. Documentation:

- a. ^{A16}(Reserved) ^{A16}
- b. A dewatering plan with the geo-hydrological background of the Site.
- c. Stability analyses of the excavation and fill slopes, including the suitability of the fill material for complying with stability requirements.

- d. Settlement calculation for the fills and backfills with the related compaction requirements.
- e. Proposed plans for slope stabilization, if required.
- f. Design calculations used in the determination and design of excavation-support and dewatering systems.
- ^{A13}g. Method of disposal, including description of haul roads, drainage within the disposal area and throughout any adjacent areas where the drainage has been affected by the deposition of the excavated material, and final grading of the spoil area.
- h. ^{A13} All relevant specifications.

B. ^{A17}Final Design Documentation: ^{A17} ^{A16}When the design has reached a level that is apt for construction, the Contractor shall submit the following to the Employer's Representative for review.

- 1. A plan for clearing and grubbing including the proposed method of disposal of materials. The documentation shall include proof of the execution wildlife rescue and relocation plan. ^{A16}
- 2. Results of tests demonstrating that the proposed fill and backfill material meets the design requirements.
- 4. Reports from an independent testing laboratory that compaction tests were conducted in accordance with the standard practices within the trade and that they demonstrate compliance with design requirements.
- 5. The name and credentials of the independent testing laboratory, with sufficient additional information to enable the Employer to determine that the laboratory is acceptable. This information shall be furnished before any excavation or compacted filling is performed under the Contract.
- 6. Prior to beginning any excavation work, the Contractor shall submit a stockpile-and disposal-area plan consistent with the drawings. The plan shall show, in addition to the proposed location and size of stock and waste piles, the Contractor's plan for excavation, describing the sequence and manner in which the material will be handled.
- 7. Prior to beginning any excavation work, the Contractor shall submit an excavation plan consistent with the drawings. It shall describe the sequence and manner in which the excavation and plans for its support-system (if any) will be executed.
- 8. ^{A16}Drawings showing existing conditions including as a minimum cross sections, and plans of existing ground levels. ^{A16}
- 9. ^{A17}Final versions of the design drawings and documents specified as intermediate design submittals, Subparagraph (1.05.A). ^{A17} Plans shall indicate the estimated volume of excavated material to be disposed at the disposal sites and the remaining capacity left in accordance to the design capacity.

1.06 QUALITY ASSURANCE:

- A.** The Contractor shall, through his quality manager, verify conformance with the requirements of this Section. All requirements in Section 01 40 00 (*Quality Requirements*) shall apply to this Section.
- B. General Testing and Procedures:**
1. The Contractor shall submit a list and technical data of instruments and equipment for inspection and testing.
 2. The Contractor shall submit a designation showing the standards that will govern how quality control testing will be performed.
 3. The Contractor shall submit technical procedures and methods for performing quality-control inspections for all features of the work.
- C. Laboratory Testing:**
1. **Control and Verification Testing:** Within his specification and based on his method of construction, the Contractor shall submit, to the Employer's Representative for review, the testing criteria, procedures, methods, and other information upon which the control tests shall be made for each phase of the work. When such routine control tests are performed, a duplicate sample of the first laboratory tests of each type shall be submitted to the Employer's Representative. The Employer's Representative may, at his discretion, submit it for verification testing. Thereafter, duplicate samples shall be furnished for 10% of all other laboratory-control tests performed.
 2. **Capability Check:** The Employer's Representative reserves the right to check laboratory equipment for compliance with recognized standards and to check the laboratory technician's testing procedures, techniques, and qualifications.

END OF SECTION